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# INNOVATION IN EDUCATION CREATIVITY AND TECHNOLOGY IN CLIMATE CHANGE EDUCATION



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**WP2**

**PROJECT NAME:** Game Time for a Green Future:  
Make Your Move Against Climate Change!

**Project ID:** 2024-1-IS01-KA220-SCH-000243341



## Institutions:



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Action KA220-SCH - Cooperation partnerships in school education

# Make Your Move Against Climate Change! ("Game Time for Green Future")

Project ID: 2024-1-IS01-KA220-SCH-000243341

## PARTNERS:



**SCHWERPUNKT ZENTRUM GMBH** – a German company located in Dusseldorf specializing in training and mobility programs. The organization provides workplace-based training, professional development, and entrepreneurship support, with a focus on employability, digital skills, and transversal competencies. Activities also include initiatives related to climate change awareness and education. Services are offered to students and educators from across Europe.

 <https://sch-bildung.de>



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**ACADEMIA BARCELONA** Founded in 2017, Academia Barcelona is an Erasmus+ training center with locations in Barcelona, Málaga, and Córdoba. The institution offers vocational training, school education, and internships, focusing on innovation, inclusion, sustainability and climate change. More than 50 institutions across Europe benefit annually from its project support and expertise.

 [www.academiabcn.es](http://www.academiabcn.es)



**The Icelandic Seal Center (ISC)** is a non-profit private limited company that was established in 2005 in Hvammstangi, north Iceland. Its main objectives are seal research and promoting sustainable seal watching tourism. In addition to seal research ISC operates a tourist information center, a museum about seals and walrus and a small souvenir store. It also participates in various international projects, mostly connected to topics such as sustainability, regenerative tourism, climate change and biodiversity.

 <https://selasetur.is/en/>




**Mariagerfjord Gymnasium** is an upper secondary school located in Hobro, Denmark, offering the academic programs STX and HF. The school emphasizes academic excellence, democratic values, and intercultural understanding. With a strong commitment to international collaboration, Mariagerfjord Gymnasium has participated in several Erasmus+ projects, focusing on themes such as student empowerment, civic engagement, sustainability, climate change and intercultural dialogue. The school has experience in coordinating large-scale events and facilitating cross-border educational activities, making it a dedicated partner in European educational initiatives.

 <https://mf-gym.dk/>




**BALIKESİR ÖZEL BİLNET ORTAOKULU**

Founded in 2017, Balikesir Özel Bilnet Ortaokulu is a private secondary school committed to equipping students with 21st-century skills through innovative, bilingual, and student-centered education. The school offers a diverse learning environment supported by advanced facilities including robotics and software labs, a swimming pool, and a professional broadcasting studio. Bilnet actively participates in Erasmus+ projects (KA2, KA220), international robotics competitions, and national science fairs, consistently achieving top national and global rankings. The school places strong emphasis on digital education, STEM, and sustainability.

 <https://balikesir.bilnetokullari.com/>



**Hvammstangi Elementary School** is a comprehensive school (grades 1–10) with approximately 150 students and is located in North-West of Iceland. The school emphasizes a positive learning environment where respect, joy, and care are central values. Students actively participate in their education and school community, with a focus on diverse teaching methods and strong support services. The school stands out for its vibrant arts program, creative projects, and close collaboration with the Húnaþing vestra School of Music and the local community. The school regularly engages in projects related to climate change, aiming to raise awareness, promote sustainability, and encourage student involvement in environmental issues. It is currently participating in its first Erasmus+ project, further strengthening its commitment to climate education.

 <https://grunnskoli.hunathing.is/>





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**WP2:**

# **Green Learning: Climate Awareness and Innovation in Education**



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# INTRODUCTION

Climate change is one of the most pressing global challenges of our time, requiring innovative solutions and collective action. Education plays a crucial role in equipping individuals with the knowledge and skills needed to address climate-related issues effectively. However, traditional teaching methods often fall short in fostering the engagement, critical thinking, and problem-solving abilities necessary for tackling such complex challenges.

This report explores the role of innovation in climate change education, emphasizing the integration of creativity, technology, and experiential learning. By analyzing modern educational techniques—such as gamification, project-based learning, and blended learning approaches, the report highlights how these strategies can enhance student engagement and deepen their understanding of climate science.

Aimed at educators, policymakers, and students, this report seeks to bridge the gap between conventional environmental education and the rapidly evolving landscape of digital learning. It underscores the need for interdisciplinary, interactive, and technology-driven approaches to empower future generations with the tools they need to combat climate change effectively.

## CHAPTER 1

### 1.1. Background and Relevance of the Report

United Nations Sustainable Development Goals (SDGs) aim an integrated reform of society, economy and the environment. The 2030 Agenda for Sustainable Development, adopted by all UN member states in 2015, serves as a unified framework for promoting global peace and prosperity, both now and for future generations. At its core lie the 17 Sustainable Development Goals (SDGs), which call for collective action from all nations—both developed and developing—through international collaboration. These goals emphasize that eradicating poverty and other hardships must be integrated with efforts to enhance health and education, reduce inequality, and drive economic progress, all while addressing climate change and safeguarding natural ecosystems like oceans and forests. (United Nations, 2025)



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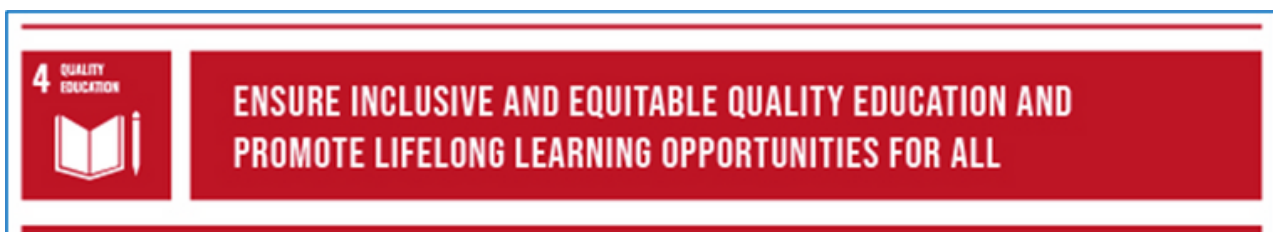


Figure 1: Sustainable Development Goals of UN



Source: (Nations, 2023)

Figure 2 Aim of SDG4 according to UN

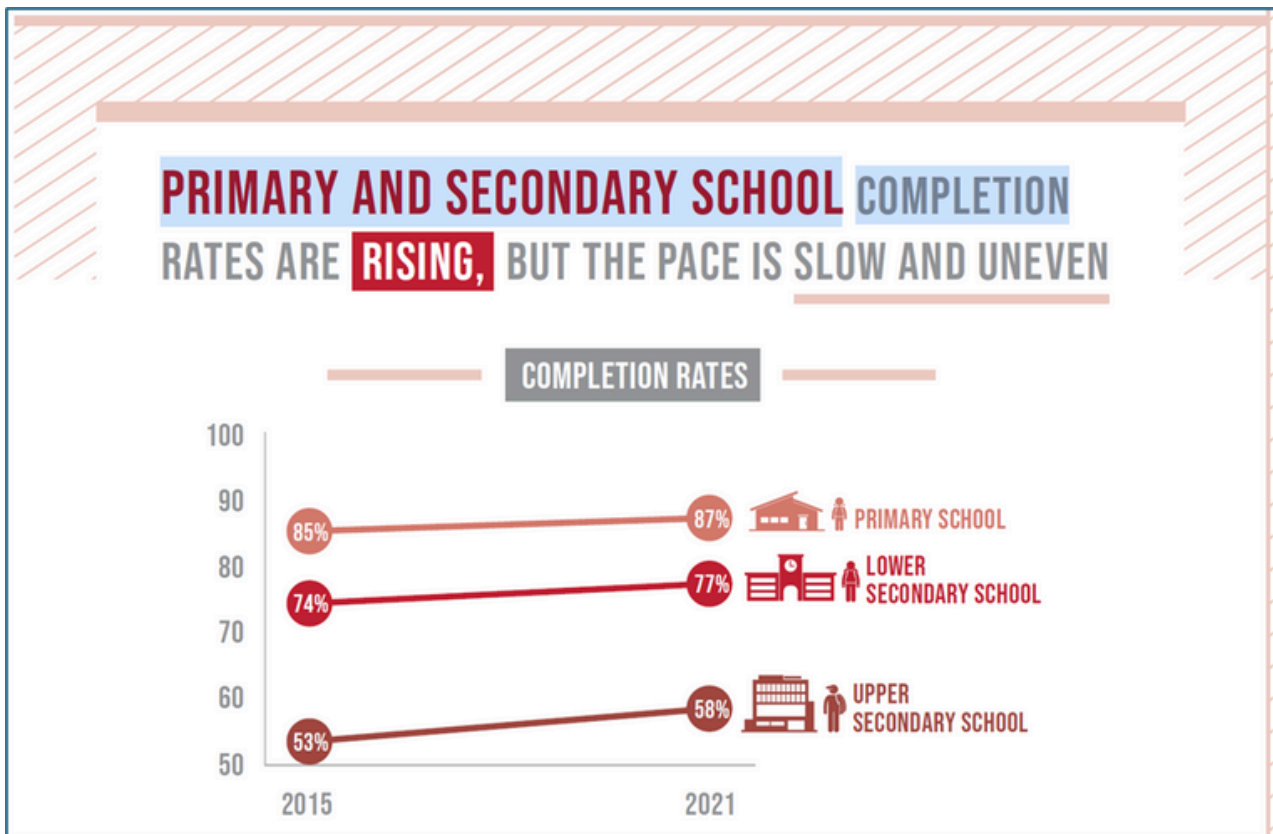


Sustainable Development Goal 4 (SDG4) focuses on Quality education that concentrates on inclusive and equitable quality education and promote lifelong learning opportunities for all.

According (Nations, 2023) the world is falling far behind in achieving quality education. If additional measures by 2030 are not taken 84 million children and youth will be out of school, 300 million of students will lack basic numeracy/literacy skills and only 1 in 6 countries will achieve universal secondary school completion target.

Climate change represents one of the most pressing global challenges facing humanity. Addressing this issue requires a multifaceted approach, with education serving as a key element in raising awareness and driving action.

Education is a powerful means of equipping individuals with the knowledge and skills necessary to understand and address the complexities of climate change. It fosters informed citizens capable of participating in decision-making processes and adopting sustainable practices. For educational initiatives to be truly effective, they must begin at an early age. While discussing climate change education in primary and secondary school education, United Nations also highlights the importance of completion rates of primary and secondary school. According to (Nations, 2023) the completion rates of primary and secondary education are slightly rising from 2015 to 2021; however, the pace is slow and uneven as it is indicated in the figure below.



Climate change education at the primary and secondary levels is crucial in tackling this significant global threat. By promoting a thorough understanding of climate science, its effects, and potential solutions, education empowers individuals to make informed decisions and take responsible actions.



First, climate change education enhances awareness of the causes and consequences of climate change, helping individuals grasp the interconnectedness of natural systems and human activities. This awareness is essential in encouraging behavioral changes that reduce carbon footprints, such as adopting sustainable consumption habits and supporting renewable energy initiatives.

Second, it empowers students and communities to become proactive agents of change. Education motivates learners to engage in climate action, advocacy, and policymaking, thus amplifying collective efforts to combat climate change. This participatory approach instills a sense of responsibility and urgency, particularly among younger generations who will bear the long-term impacts of current environmental decisions.

Additionally, incorporating climate change education into national curricula fosters the development of critical thinking and problem-solving skills. These competencies are crucial for understanding the complexities of climate challenges and devising innovative solutions. It also promotes interdisciplinary learning by linking subjects like science, geography, economics, and social studies, offering a well-rounded perspective on the issue.

Lastly, climate change education enhances resilience by preparing individuals and communities to adapt to the inevitable impacts of a changing climate. By understanding local and global climate risks, learners can help develop adaptive strategies that protect ecosystems, livelihoods, and infrastructure.

In conclusion, climate change education is a vital tool for building an informed, engaged, and resilient society capable of addressing the multifaceted challenges of climate change. While its importance is clear, further steps with innovative approaches are necessary to enhance its effectiveness for future generations.

Environmental education has been a part of school curricula for many years, yet the ongoing issues of global warming, coastal and river flooding, drought, extreme precipitation, and wildfires demonstrate the need for innovative approaches. Traditional climate change education, often focused on rote learning, memorization, and standardized assignments, is gradually shifting towards more autonomous, student-centered methodologies. These modern approaches aim to enhance student development by promoting cooperative learning, social-emotional skills, and inquiry-based exploration of climate-related topics.



Traditional environmental education faces several key challenges. First, it often depends heavily on a one-way transmission of information from teacher to student, lacking the integration of interdisciplinary perspectives necessary for understanding the interconnected nature of environmental issues. Climate change education must encompass economic, social, and political dimensions to provide students with a comprehensive understanding of its multifaceted nature.



Another significant challenge is the minimal focus on experiential learning. Without hands-on experiences and real-world applications, students may find it difficult to relate theoretical knowledge to practical solutions, thereby diminishing the educational impact on their environmental attitudes and behaviors.

As climate change is a rapidly evolving subject, traditional educational materials often become outdated, causing students to miss out on the latest developments and technological advancements in the field. Additionally, the insufficient training of teachers in climate change topics further limits the effectiveness of education. A lack of deep subject knowledge and appropriate teaching tools can hinder students' understanding.

Traditional methods also often overlook the importance of social-emotional learning, which is essential for cultivating responsibility, empathy, and motivation to address environmental issues. Without nurturing these emotional and social aspects, students may fail to develop a meaningful, personal connection to environmental concerns.

Lastly, there is often a lack of emphasis on collaborative and community-based learning, which can restrict opportunities for students to work together, share diverse perspectives, and engage in collective actions to tackle environmental challenges.

These limitations hinder the effectiveness of traditional climate change education, making it challenging for students to gain a profound understanding and commitment to the issue. To address these gaps, more innovative and holistic educational approaches are crucial.

Our world is caught between the need for economic development and the limitation of its resources. Both activities are contributing to the further deterioration of our planet. Education is one of the most important tools to prolong the life of our planet earth.



Another significant challenge is the minimal focus on experiential learning. Without hands-on experiences and real-world applications, students may find it difficult to relate theoretical knowledge to practical solutions, thereby diminishing the educational impact on their environmental attitudes and behaviors.



As climate change is a rapidly evolving subject, traditional educational materials often become outdated, causing students to miss out on the latest developments and technological advancements in the field. Additionally, the insufficient training of teachers in climate change topics further limits the effectiveness of education. A lack of deep subject knowledge and appropriate teaching tools can hinder students' understanding.

Traditional teaching needs changes due to previously mentioned deficiencies. According to Burbules et. al., 2020 information technology is driving force for educational reform. If a significant increase in educational productivity is expected, it is essential to make fundamental structured changes supported by technology in education systems. The technological revolution in education can no longer be captured by simply looking at computers in the classroom. (Burbules, 2020)

The Covid-19 pandemic highlighted the critical role of technology in education. As pandemic restrictions took hold, the demand for online learning and teaching platforms surged. Despite the sudden and unprecedented nature of the situation, both educators and students adapted remarkably quickly.





After experiencing online learning tools, students find conventional classroom education less engaging. As stated by Burbules et al. (2020), the use of visualization and virtualization technologies has led to a shift in the space and context of learning. These technologies foster a sensory learning environment, establishing a unique and distinctive kind of space.



The world is undergoing a remarkable transformation driven by rapid technological advancements. Education must adapt to keep pace with these developments. One of the most significant tools in this transformation is artificial intelligence (AI). Additionally, promising technologies like Augmented Reality (AR) and Virtual Reality (VR) offer innovative ways for students to gain hands-on experience with environmental and climate change topics. These technologies also enable students to explore 3D design and spatial design. The integration of these tools is expected to foster curiosity and encourage experimentation among students.







According to (MATSH, 2024) Education is evolving rapidly with the growing use of technologies like artificial intelligence (AI) and virtual reality (VR) in schools. Notably, 82% of college students have embraced AI, compared to just 58% of high school students, highlighting a significant gap in technology adoption between educational levels.

Additionally, AI usage among students and teachers is nearly equal, with 67% of students and 66% of teachers incorporating these tools. This shift indicates that students are playing an active role in shaping the future of technology in education.

**Table 1:** AI usage among students and educators

Category	Percentage (%)
College Students using AI	82
High school students using AI	58
Students adopting AI	67
Teachers adopting AI	66

Source: (MATSH, 2024)

In 2023, the global virtual reality (VR) market in education was valued at \$14.55 billion and is projected to continue expanding. By 2032, the U.S. market alone is expected to reach \$11.36 billion. This growth is driven by innovative teaching approaches, the demand for remote learning, and the increasing integration of AI in education. (MATSH, 2024)

The digital transformation in education is accelerating, with technologies like AI and VR becoming more widespread. The global VR market in schools is projected to expand significantly, increasing by \$47.28 billion between 2024 and 2028. This rapid growth is driven by VR's ability to create immersive learning experiences, with major companies like Microsoft, Facebook, Acer, and HP leading the way. VR is increasingly being used to make education more engaging and interactive. In 2023, the augmented reality (AR) and VR education market was valued at \$3.8 billion and is expected to reach \$14.2 billion by 2028. Schools and classrooms are experiencing the fastest growth in this sector. (MATSH, 2024)

One of the significant reforms in education is the incorporation of gaming as a teaching tool, which has gained popularity among the younger generation as a promising learning innovation. Another advanced method is known as "adaptive instruction" or "intelligent tutoring." In this approach, students interact with an online instructional program that collects their responses on various topics. The program aggregates these responses across all learners on the platform and uses analytical models to identify common mistakes. Based on this data, algorithms generate customized tutorials tailored to each learner, aiming to enhance their understanding and improve their critical thinking skills (Burbules, 2020). Adaptive learning benefits not only learners but also educators. This technology allows educators to monitor their students' progress and identify knowledge gaps, enabling them to intervene and address deficiencies effectively.



## 1.2. Purpose and Scope

- The primary objective of this report is to explore the role of innovative educational approaches in climate change education. By examining modern teaching methodologies, such as gamification, project-based learning, and experiential learning, the report aims to highlight how these strategies can enhance student engagement and comprehension of climate science. Additionally, it seeks to provide actionable insights for educators and policymakers on integrating these innovative techniques into educational curricula.

•

### Key objectives include:

- Assessing the effectiveness of traditional climate change education methods.
- Identifying gaps in current educational approaches and proposing innovative solutions.
- Highlighting the role of technology, creativity, and interdisciplinary learning in fostering environmental awareness.
- Providing recommendations for teachers, policymakers, and students on improving climate change education.

### Target Audience

This report is intended for a diverse audience, including:

- **Teachers and Educators:** To equip them with innovative teaching strategies that enhance student engagement and climate literacy.
- **Policymakers and Education Administrators:** To inform policy decisions and curriculum development for integrating climate change education into national and institutional frameworks.
- **Students and Learners:** To provide them with new learning methodologies that make climate education more interactive and impactful.

### Scope of Analysis

The report focuses on the role of innovation in climate change education, analyzing the effectiveness of various educational techniques. The scope includes:

- Comparative analysis of traditional and modern teaching methods.
- Integration of technology in climate change education, including AI, AR/VR, and gamification.
- Experiential learning approaches, such as outdoor education and project-based learning.
- Case studies and best practices from successful climate education programs worldwide.
- Recommendations for implementation, addressing challenges and opportunities in adopting innovative teaching models.



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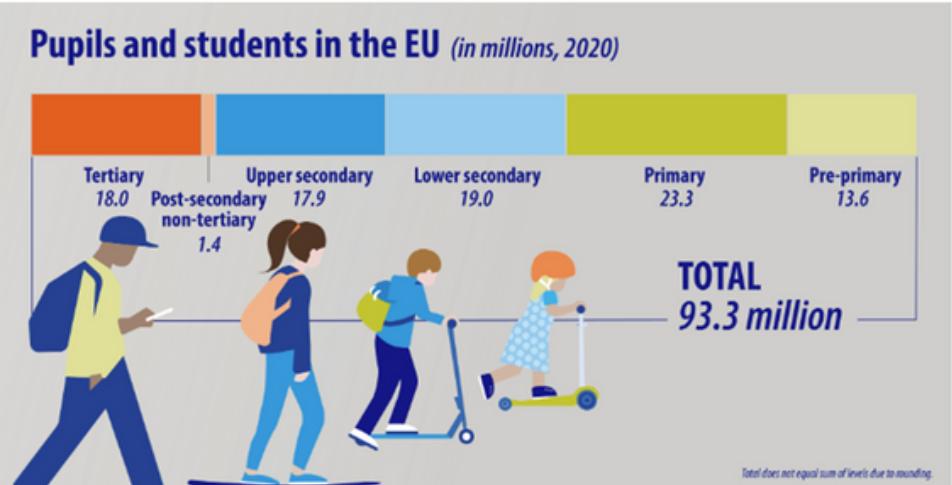


By addressing these areas, the report provides a comprehensive guide for educators, policymakers, and students to enhance climate literacy and empower future generations to take meaningful action against climate change.

### 1.3. Target audience

The primary beneficiaries of this report are primary and secondary school educators and students, as they play a critical role in shaping climate awareness and action.

**Figure 4:** Number of students in EU countries in 2020



Source: (eurostat, 2024)

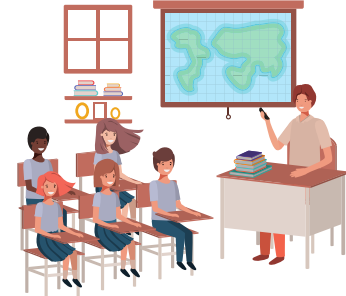
**Table 2:** Number of students and educators in EU countries in 2022

Category	# Students	# Teachers
Primary School	23M	1,89M
Lower Secondary School	18,9M	1,7M
Upper Secondary School	18,2M	1,6M
Post Secondary School	1,4M	1,8M

Source: (eurostat, 2024)

In Europe the number of students in primary and secondary education is given in the table 2 along with the number of teachers in the same education level. They are the numbers that are target groups of this study. Table 3 shows the number of students in primary school level along with the student-teacher ratio. The student-teacher ratio is a measure may be indirectly be used to analyze the quality of schooling. (eurostat, 2024)

Table 3 below shows the student-teacher ratio in primary schools in project partner countries compared to the EU average of 13.3 students per teacher. Iceland has the lowest ratio at 4.4, indicating smaller class sizes and more individualized attention.



Germany also has a relatively low ratio of 9, suggesting better teacher availability per student. Denmark follows with a ratio of 10.3, which is below the EU average, implying a balanced education system with manageable class sizes. Spain has a ratio of 12.6, slightly below the EU average. Turkey has the highest student-teacher ratio in the table at 17.6, significantly above the EU average, which may indicate larger class sizes and potentially less individual attention for students. The data highlights significant variations across countries, with Northern European nations generally having lower ratios, while Turkey has a higher ratio, which could impact the quality of education. (eurostat, 2024)

**Table 3:** Number of Primary school students and student teacher ratio for project partner countries

Category	Primary school Students	Student-Teacher Ratio
Iceland	32.967	4,4
Denmark	435.507	10,3
Türkiye	2.433.806	17,6
Spain	5.433.901	12,6
Germany	3.078.700	9

Source: (eurostat, 2024)

Table 4 presents data on the number of students in secondary education across different levels (lower secondary, upper secondary, and post-secondary non-tertiary) along with the student-teacher ratios in Project partner countries. However, some data is missing for certain categories.

For lower secondary education, the EU average student-teacher ratio is 11.6. Among the listed countries, Iceland (10.0) and Denmark (10.9) perform better than this average, indicating fewer students per teacher. Spain (10.9) also meets this standard. However, Germany (12.8) and Türkiye (13.6) exceed the EU average, meaning they have a higher number of students per teacher.

In upper secondary education, the EU average student-teacher ratio is 11.2. Spain (10.1) is the only country in the table that performs better than the EU average, suggesting a relatively smaller class size. On the other hand, Germany (12.0), Denmark (12.7), and Türkiye (12.8) have higher student-teacher ratios, implying that teachers handle larger groups of students. Data for Iceland in this category is missing.

For post-secondary non-tertiary education, most countries have missing data except for Germany (12.2), which has a relatively high student-teacher ratio. Spain has data on student numbers but lacks the student-teacher ratio.

Overall, Iceland and Denmark stand out with favorable student-teacher ratios at the lower secondary level, while Spain has the lowest ratio at the upper secondary level. Türkiye has the highest student numbers across all levels, with relatively high student-teacher ratios.

**Table 4:** Number of secondary school students and student-teacher ratio for project partner countries

Category	Lower Secondary	Student-Teacher Ratio	Upper Secondary	Student-Teacher Ratio	Post-secondary non -tertiary	Student-Teacher Ratio
Iceland	14.162	10,0	22.523	missing value	1.632	missing value
Denmark	244.531	10,9	291.964	12,7	missing value	missing value
Türkiye	5.293.067	13,6	6.543.599	12,8	missing value	missing value
Spain	1.739.274	10,9	1.897.577	10,1	44.478	missing value
Germany	4.470.501	12,8	2.357.587	12	708.256	12,2

Source: (eurostat, 2024)





- **Primary and Secondary School Educators:**

Teachers are at the forefront of delivering climate change education. This report provides them with innovative strategies and tools to enhance student engagement, critical thinking, and problem-solving skills. By integrating modern educational techniques—such as gamification, project-based learning, and experiential education, teachers can create more dynamic and effective learning environments. Additionally, the report offers insights into how technology, such as AI and virtual simulations, can support climate education.



- **Primary and Secondary School Students:**

Young learners are the future decision-makers and environmental stewards. Providing them with an engaging, interdisciplinary, and hands-on climate education experience will empower them to develop a deeper understanding of climate science, sustainability, and environmental responsibility. By adopting innovative teaching methods, students can actively participate in climate discussions, develop solutions, and apply their knowledge in real-world contexts.



## How the Report Aligns with the Needs of These Groups

This report is designed to bridge the gap between traditional education methods and the evolving needs of students and educators in the context of climate change. It aligns with their needs in the following ways:

- **For Educators:**

- Provides a framework for integrating innovative teaching strategies into climate change education.
- Highlights the benefits of experiential and technology-driven learning to enhance student engagement.
- Offers recommendations on interdisciplinary approaches to teaching climate-related topics.
- Addresses challenges such as a lack of training and outdated curriculum materials.



- **For Students:**

- Introduces interactive and engaging learning methods that move beyond rote memorization.
- Encourages active participation in environmental problem-solving and decision-making.
- Equips them with digital and critical thinking skills needed for addressing climate challenges.
- Supports the development of environmental awareness and advocacy skills.



By focusing on these target groups, the report aims to foster a **more effective and impactful climate change education framework**, ensuring that both educators and students are well-equipped to tackle the challenges of a changing environment.



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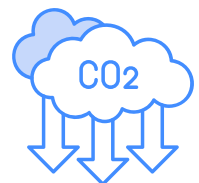


## CHAPTER 2: The Role of Innovation in Climate Change Education



### 2.1. Why Innovation is Critical in Addressing Climate Change

Climate change, driven by human activity, is increasingly impacting global ecosystems and societies, with rising temperatures, biodiversity loss, and extreme weather events causing widespread disruption. To combat these challenges, countries have set ambitious goals, such as the EU's net-zero emissions by 2050 and the U.S.'s aim to halve emissions by 2030, inspired by the 2015 Paris Agreement. According to OECD (2021) the impacts of climate change are not only environmental but also social, cultural, ethical and economic. Increased and fluctuating temperatures, loss of biodiversity, extreme events like floods, droughts and storms are affecting people's lives and livelihoods globally. Effective responses require coherent policies, coordinated governance, and the integration of education to support broader climate action. (OECD, 2021)



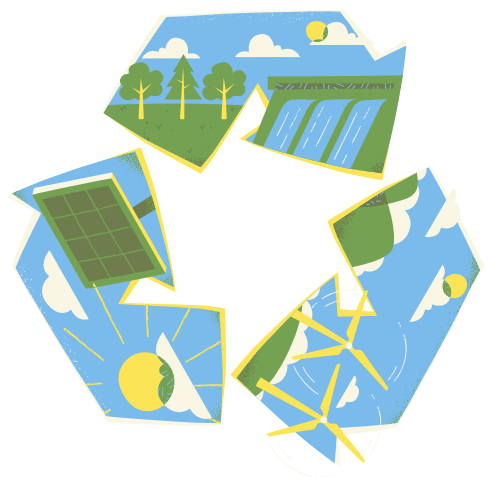
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Although young people are not solely responsible for solving these complex challenges, education can play a crucial role in supporting students by helping them engage in and promote sustainable practices in various ways. Climate and environmental education serve various purposes in developing students' climate literacy. It provides them with the knowledge, skills, and attitudes necessary to understand the fundamental principles of Earth's climate system and explore solutions to human-caused climate change. It empowers students to identify credible information, find reliable sources, and make informed decisions about climate change. Additionally, it encourages students to develop a sense of personal responsibility and self-confidence as they engage in individual and collective actions. Education also equips students with tools to manage both positive and negative emotions related to climate change and its associated challenges. It inspires their academic, career, and life choices, influences their attitudes, beliefs, and social norms, and prepares them to communicate accurately and effectively about climate change with their families and communities.



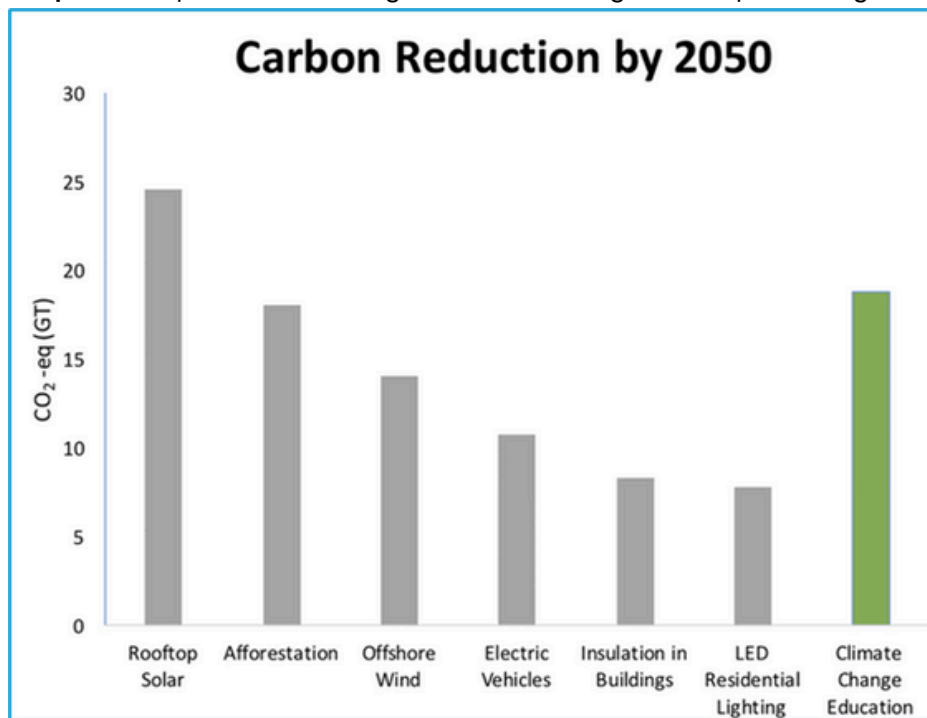
The impacts and socioeconomic effects of climate change are highly diverse and rapidly evolving. Strategies to control climate change often focus on clean technologies such as renewable energy, electric vehicles, solar panels etc. However, the importance of quality education is always underestimated, young generations equipped with high quality climate change education can have long lasting impacts on global climate change challenges. (Cordero, Centeno, & Todd, 2020)



A survey conducted by Cordero et al. (2020) compared various existing technologies over a 30-year period (2020–2050) to assess their potential in reducing global carbon emissions. The technologies examined included rooftop solar, afforestation, offshore wind, electric vehicles, building insulation, LED residential lighting, and climate change education. The results indicated that, when appropriately designed, climate change education could be as effective as other mitigation strategies in reducing emissions. The same study also claims that if only 16% of high school students in high- and middle-income countries were to receive climate change education, it is expected to see nearly 19 gigaton reduction of carbon dioxide by 2050.

Graph 1 shows different strategies for reducing CO<sub>2</sub> emissions, measured in gigatons (GT). The highest potential reduction comes from rooftop solar, which can cut emissions by approximately 25 GT. Afforestation follows as the second most effective strategy, contributing to a reduction of around 20 GT. Offshore wind power also plays a significant role, though its impact is slightly lower. Other measures such as electric vehicles, insulation in buildings, and LED residential lighting show moderate reductions in carbon emissions. Climate change education, represented in green, stands out as an important factor, with a potential reduction comparable to offshore wind and electric vehicles. The data suggests that while technological advancements like solar and wind power are crucial in reducing emissions, education on climate change can also lead to significant carbon savings by promoting awareness and behavior change. (Cordero, Centeno, & Todd, 2020)

**Graph 1:** Comparison of existing various technologies to help reduce global carbon emissions



Source: (Cordero, Centeno, & Todd, 2020)

## 2.2. Understanding the Intersection of Creativity, Technology, and Education

Creativity refers to the capacity to generate fresh, innovative ideas or creations. It involves leveraging imagination and originality to bring forth something entirely new or previously unexplored. This skill can be expressed in various forms, such as art, writing, music, dance, design, and more.

While creativity is often linked to the arts, its scope extends far beyond this domain. It is also present in fields like science, business, and other aspects of daily life. In fact, creativity is a crucial skill that can be nurtured and developed over time. It thrives on openness to new concepts, curiosity, a willingness to experiment, and the ability to think beyond conventional boundaries.

Creativity is widely regarded as a valuable asset. It empowers individuals to solve problems, innovate, develop new products or services, and propose ideas that fuel progress and transformation. As a fundamental aspect of human experience, creativity plays a key role in helping us adapt to and flourish in a constantly evolving world.

Creativity plays a crucial role in education and benefits students of all ages. Here are some key reasons why fostering creativity in the classroom is essential:

**Problem-Solving:** Creativity enables students to think outside the box and devise innovative solutions to challenges. This skill is versatile and critical for success in today's rapidly evolving world.

**Self-Expression:** Through creativity, students can express their ideas and emotions authentically. This helps build their confidence, self-esteem, and a strong sense of identity and purpose.

**Engagement:** Creative activities make learning more engaging and enjoyable. When students are encouraged to be creative, they are more likely to take an active interest in their education and feel ownership of their learning journey.

**Collaboration:** Creativity fosters teamwork by encouraging students to share ideas and collaborate. This not only strengthens their problem-solving skills but also deepens their interpersonal connections.

**Adaptability:** Being creative helps students adapt to new situations and think on their feet. This flexibility is a vital skill that will benefit them throughout their lives.

Incorporating creativity into education enables students to develop critical skills and confidence to thrive in a modern, dynamic world. By nurturing creativity, educators can empower students to reach their full potential.



Technology is revolutionizing the way we teach and learn, offering numerous benefits in the classroom:

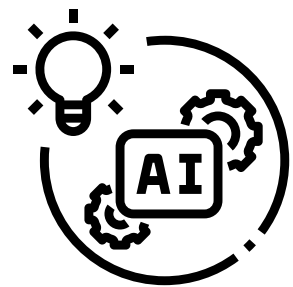
- **Engagement:** Technology makes learning interactive and engaging. Tools like educational software, games, and virtual simulations capture students' attention and keep them motivated.
- **Accessibility:** Technology ensures education is accessible to all students, regardless of their backgrounds or abilities. Digital materials can be customized to meet diverse needs, while online platforms provide universal access to resources.
- **Collaboration:** Technological tools facilitate communication and collaboration among students, teachers, and parents. Platforms like online forums, collaborative editing tools, and virtual meetings encourage idea-sharing and teamwork.
- **Personalization:** Technology supports tailored instruction by adapting to individual learning styles and needs. This allows students to learn at their own pace and focus on topics most relevant to them.
- **Future-Readiness:** As technology becomes integral to society, students must develop digital skills to succeed. Incorporating technology in classrooms helps prepare them for careers in a tech-driven world.

Overall, technology can significantly enhance education by making it more engaging, inclusive, and effective. Educators should strive to integrate technology thoughtfully to maximize its impact on student learning and success.

One of the primary ways creativity and technology intersect is by enhancing and streamlining the creative process. Digital tools and computer programs enable artists and designers to create, manipulate, and refine images, sounds, and other media. These technologies allow creators to explore new ideas, experiment with techniques, and produce work more efficiently and effectively.

Another area where creativity and technology overlap is in the emergence of new platforms that enable creative expression. Social media and online platforms have empowered a new generation of creators to share their work with a global audience. This has created unprecedented opportunities for artists and designers to showcase their talents, reach broader audiences, and connect with clients or fans in innovative ways.

In addition to transforming the creative process, technology is reshaping how we perceive and understand creativity. For instance, data analysis and machine learning algorithms are being used to identify patterns and trends in creative works, offering insights into what ideas might be most successful. This approach is unlocking fresh perspectives on creativity and paving the way for new innovations.



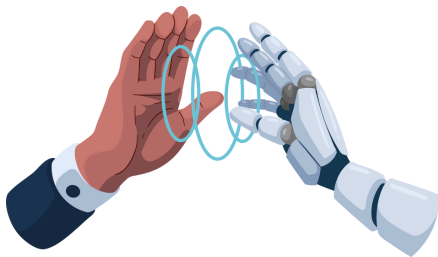
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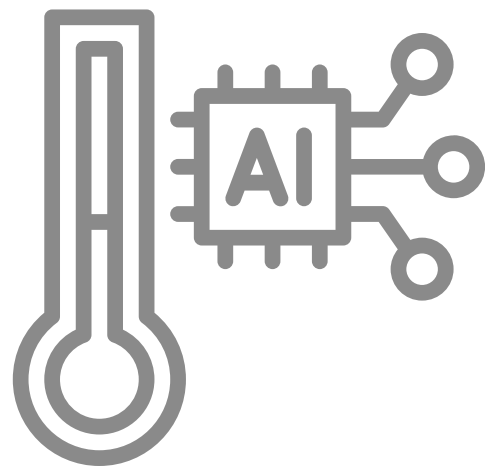
The intersection of creativity and technology is a dynamic and ever-evolving space where human ingenuity meets technological progress. As technology continues to advance, it will increasingly influence how we create, share, and engage with creative works. For artists, designers, and anyone who values creativity, this era presents exciting opportunities to explore, innovate, and redefine what's possible in the creative field.



Artificial intelligence (AI) has emerged as a revolutionary force in the field of technological advancement, with the potential to transform various aspects of our society. The connection between artificial intelligence (AI) and climate change is becoming a major focus in education. As technology advances and environmental issues grow, it's clear that these two areas need to be part of how we teach and learn.

By using AI tools and teaching about climate change, schools can help students develop the skills needed to solve future challenges. This approach encourages critical thinking, creativity, and a focus on sustainability.

Bringing AI and climate topics into education helps prepare students for a fast-changing world and empowers them to build a more sustainable future. AI's capability to process large amounts of data enables the creation of personalized learning experiences. By tailoring education to each student's needs, AI improves understanding while accommodating different learning styles and speeds. This approach promotes inclusivity and ensures that every student can thrive.



AI-driven educational tools help students better understand climate change, its causes, and possible solutions. With AI-powered virtual reality, students can explore ecosystems impacted by climate change, offering a powerful, immersive experience beyond traditional lessons. This hands-on approach raises environmental awareness and inspires students to advocate for sustainability (Emirates Scholar, 2024).



There are many creative ways to teach human impact on climate change. The impact of human activities on climate change is undeniable (Labster, 2024). Scientists, professors, and educators are essential in addressing environmental challenges by guiding efforts to reduce the impacts of human activities.

The use of interactive models and simulations is one of the ways for teaching climate change at schools. Including models and simulations in lessons about anthropogenic climate change can help students gain a deeper understanding and appreciation for natural ecosystems and the climate.

By using situation-based learning modules in these simulations and ensuring model parameters include accurate, up-to-date scientific data, educators can create a dynamic and engaging educational experience. This approach not only enhances learning but also equips students with the critical thinking skills needed to address real-world environmental challenges. Adopting interactive methods, such as game-based teaching, allows educators to simplify complex environmental concepts and make them more engaging for students. This approach fosters active participation, deepens understanding, and encourages problem-solving skills in a fun and interactive way.



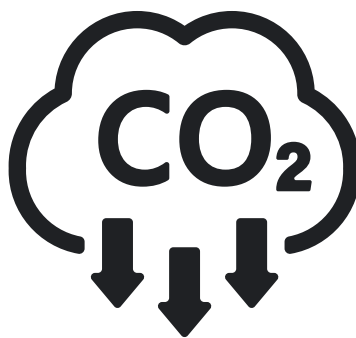
Modern teachers can leverage technology to explain climate change more effectively, fostering scientific inquiry among students about global issues like human impacts on the environment.

Organizing webinars and in-person seminars with climate change experts allows students to learn about real-world applications of climate science. Additionally, virtual field trips to renewable energy facilities or conservation sites can provide firsthand insights into how climate change affects ecosystems and communities, making learning more impactful and engaging.

Connecting the topic of climate change to real-world issues is essential to highlight its practical applications and relevance in addressing global challenges. Here are some ways to achieve this:

- **Illustrate Human Impact:** Discuss examples like habitat loss affecting biodiversity or rising sea levels threatening coastal communities to show the direct effects of human activities.
- **Highlight Sustainable Practices:** Emphasize the urgency of adopting sustainable behaviors, such as reducing waste, conserving resources, and transitioning to greener lifestyles.
- **Climate Modeling and Policy:** Explain how climate models and computational tools predict future trends, providing critical data for shaping policies and solutions.
- **Global Emission Reduction:** Showcase scientific efforts and international collaborations aimed at lowering greenhouse gas emissions.
- **Promote Green Energy:** Stress the importance of renewable energy sources, like solar and wind, in reducing dependence on fossil fuels and combating climate change.

This approach not only deepens students' understanding but also inspires them to see the value of their actions in contributing to a sustainable future.



### 2.3. Current Gaps in Traditional Climate Change Education

In the conventional teaching-learning framework, the primary goal is for students to gain knowledge, with the success of teaching evaluated based on how well students learn. Typically conducted in a classroom environment, traditional methods involve students passively receiving information delivered by the teacher. This model places the teacher at the center of the process, with classrooms functioning in a structured and controlled manner. Collaborative learning and group activities are often minimal, as lectures serve as the main source of instruction.



The primary focus of this approach is frequently on preparing students for exams and attaining strong academic results. In this teacher-centered model, educators maintain primary authority, using standardized assessments and evaluations to measure student performance, emphasizing objective grading systems. (Renau Renau, 2023)



Hybrid education, often referred to as blended learning, combines traditional face-to-face classroom instruction with online learning elements. By integrating Information and Communication Technologies (ICTs) into the educational system, institutions can establish flexible and inclusive learning environments that cater to diverse student needs, foster digital literacy, and prepare learners for the challenges of the digital age. This teaching approach, which blends conventional in-person instruction with online components, has attracted significant attention from researchers.

Prominent contributors include Graham and Dziuban (2007) (Graham & Dziuban, 2007), who emphasize the design of effective blended learning environments. Christensen et al. (2011) (Christensen, B., & Johanson, 2011) examine how disruptive innovation could reshape the education system. They contend that traditional education models fall short in addressing the varied needs of students and argue that disruptive technologies, such as online and blended learning, hold the potential to revolutionize education. Their approach advocates for a student-centered model that utilizes technology to deliver personalized learning experiences tailored to individual learning styles and speeds.



## CHAPTER 3: Analysis of Innovative Educational Techniques

### 3.1. Gamification in Climate Change Education

Although traditional teaching methods certainly have their strengths, the ever-evolving challenge of climate change calls for fresh, creative approaches. One such approach is using video games as an engaging way to educate students about climate change without causing distress.

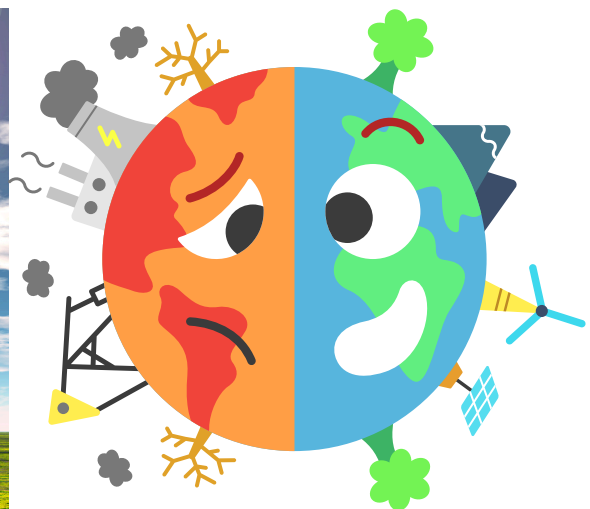
Gamification, which involves applying game design concepts to non-gaming situations, has been utilized to encourage environmentally friendly behaviors. These principles have been incorporated into board games, team challenges, digital games, mobile applications, and even apps created by researchers primarily for data collection purposes.

According to the Gamification Guide 2024 by Eurodesk, gamification plays a crucial role in enhancing climate change education. By incorporating game elements such as points, leaderboards, and challenges into educational contexts, gamification increases engagement, motivation, and learning retention. Given that climate change education requires critical thinking and behavioral change, gamification can facilitate a deeper understanding of the subject while encouraging proactive actions. (Eurodesk, 2024)



Researchers define gamification as "the process of making activities more game-like," emphasizing that not all non-game contexts using game design elements qualify as gamified. Instead, gamification involves carefully selecting, applying, implementing, and integrating these elements to enhance the user experience, making it more engaging and enjoyable—similar to the feel of traditional gameplay. Video games have the unique ability to simulate the outcomes of different decisions, giving players firsthand experience of how their choices affect the environment. This interactive approach effectively illustrates the cause-and-effect relationship between human activities and climate change, making the lessons both engaging and impactful (Filament Games, 2023).

One effective approach is the implementation of point-based systems, where students earn points for completing climate-related tasks such as sustainability quizzes, tracking personal carbon footprints, or engaging in eco-friendly activities. Additionally, badge systems can be used to recognize achievements such as waste reduction, participation in reforestation programs, or advocacy for climate policies. Interactive quizzes and challenges further reinforce learning by covering topics such as renewable energy, conservation, and climate policies in an engaging manner. Social media and digital platforms also contribute to gamification by enabling students to share eco-friendly habits, participate in climate challenges, and track their progress through gamified mobile applications. (Eurodesk, 2024)





According to Pew Research Center (Pew Research Center, 2015) Nearly half of American adults (49%) play video games at least occasionally, while 10% identify as gamers. Public perceptions of video games and their players, however, remain nuanced and often ambivalent, reflecting a mix of appreciation, skepticism, and uncertainty.



When tackling the challenges of climate change, a variety of games and interactive tools help to deepen to understand its complexities. For example, Climate Interactive has created role-playing games like Climate Action Simulation and World Climate, which are used in settings ranging from middle school classrooms to executive management training. Increasingly, the potential of games is being recognized, with entities ranging from government agencies and NGOs to groups of teenagers working to develop games aimed at addressing climate issues. Below, we've highlighted some notable climate and sustainability-themed games. (Pew Research Center, 2015)

Several successful examples illustrate the effectiveness of gamification in climate education. For instance, eco-themed escape rooms—whether virtual or physical—challenge players to solve climate-related puzzles to "save the planet." Climate change treasure hunts encourage students to discover information on sustainable practices within their surroundings, while sustainability-focused role-playing games (RPGs) allow students to assume roles such as policymakers, scientists, or activists, simulating climate negotiations and decision-making processes. Moreover, AI-powered adaptive learning platforms tailor climate education content to individual students, ensuring a personalized and effective learning experience.

Climate-related educational games can be classified as group-based role playing games, computer games, board games and apps. (Climate Interactive, 2023)



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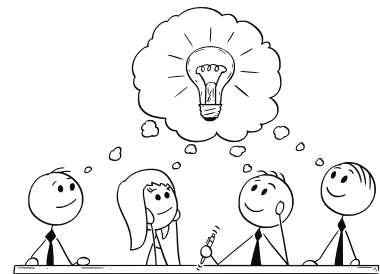


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### Group-Based Games for Climate Change Education:

- **Climate Action Simulation:** A highly interactive role-playing game where participants take on the roles of various stakeholders to explore and negotiate solutions for combating climate change.
- **World Climate:** This role-playing game simulates UN climate negotiations, with participants acting as regional and national representatives working to draft a treaty to limit global warming to 2°C or less.
- **Stabilization Wedge Game:** Designed to educate players on strategies for reducing carbon emissions, this game uses the concept of "wedges" to illustrate the diverse pathways available for achieving climate goals.
- **Climate Fresk:** A science-based, collaborative workshop that helps participants understand the causes and consequences of climate change through teamwork and critical thinking.



These group-based games foster teamwork, engagement, and critical thinking, making them powerful tools for understanding and addressing climate challenges. Emerging technologies further enhance gamification in climate education. Augmented Reality (AR) and Virtual Reality (VR) provide immersive experiences, allowing students to explore climate-affected regions or simulate future climate scenarios. Additionally, gamified learning applications such as EcoChallenge, JouleBug, and Climate Quest engage users by incorporating missions and leaderboards to promote sustainable practices. (Eurodesk, 2024)

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### Computer Games for Climate Awareness and Action:

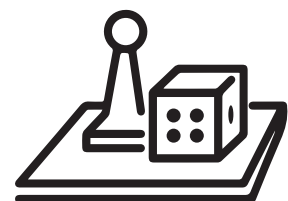
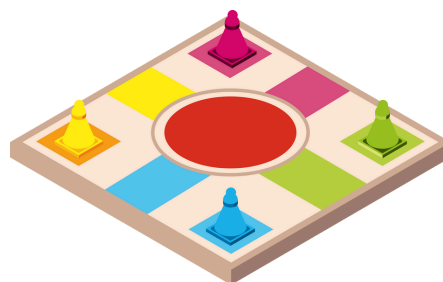
- **Survive the Century:** A narrative-driven game rooted in real science, exploring the political, environmental, and social challenges humanity faces from 2021 to 2100.
- **Floodland:** A city-building strategy game set in a world submerged by rising seas due to global warming. Players must balance diverse cultures and scarce resources to guide their community to a sustainable future.
- **Crunch Time 2.0:** An interactive science and sustainability quiz game for kids, playable individually or in classrooms to foster engagement with sustainability concepts.
- **The Climate Game:** Created by the Financial Times, this game challenges players to achieve net zero emissions by 2050 while minimizing the negative effects of climate change.
- **Terra Nil:** A reverse city-building game focused on ecosystem restoration. Players transform barren landscapes into thriving ecosystems, reintroduce wildlife, and leave no trace behind.

These games blend education and entertainment, offering engaging ways to explore the complexities of climate change and inspire action.



### Board Games for Climate Awareness:

- **Climate Catan:** A variation of the popular Settlers of Catan, this version introduces oil as a resource. While it accelerates development, overusing it can lead to climate disasters that jeopardize players' progress.
- **Keep Cool – Gambling with the Climate (German):** Players assume the roles of national political leaders tasked with tackling climate change. They must make strategic decisions about economic growth, navigate lobbyist pressures, and manage natural disasters.



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- **Polar Eclipse Game:** In this game, players face critical decision-making challenges to chart a course toward a future that avoids the most severe temperature increases caused by climate change.
- **Energetic:** A board game focused on New York City's energy future. Players work together to understand the scale of transformation and cooperation needed to align the city's energy systems with the Paris Agreement's goals.
- **Daybreak:** Developed by the creators of Pandemic, this cooperative game envisions a hopeful future. Players collaborate to implement breakthrough technologies and build resilient societies, all aimed at decarbonizing the planet and mitigating climate change.



These games provide engaging ways to inspire collaborative problem-solving and increase awareness of the complex dynamics involved in combating climate change.



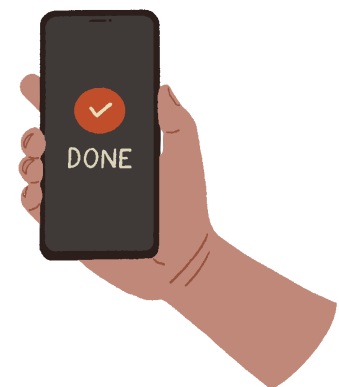
### Climate-Themed Apps:

- **Change Game:** In this app, players build and manage cities while balancing resource allocation and emissions control. The more emissions players generate, the more challenging the game becomes, testing the resilience of their cities and their ability to mitigate climate impacts.

This app provides hands-on experience of urban planning and climate resilience, helping players understand the delicate balance between development and environmental sustainability.

**Gamification** fosters intrinsic motivation by making learning enjoyable and interactive, thereby encouraging long-term commitment to sustainable behaviors. It also promotes social and collaborative learning by facilitating teamwork, discussion, and shared responsibility for climate action. Moreover, real-time feedback mechanisms, such as points and rewards, enhance engagement and improve learning outcomes. (Eurodesk, 2024)

Despite its advantages, the implementation of gamification in climate education presents several challenges. Ensuring accessibility and inclusivity is essential, requiring the development of climate games that accommodate diverse learning styles and backgrounds. Furthermore, it is important to avoid superficial engagement by integrating gamification with real-world applications to drive meaningful behavioral change. Lastly, providing educators with the necessary training and resources is crucial to effectively incorporating gamification into climate education curricula. (Eurodesk, 2024)



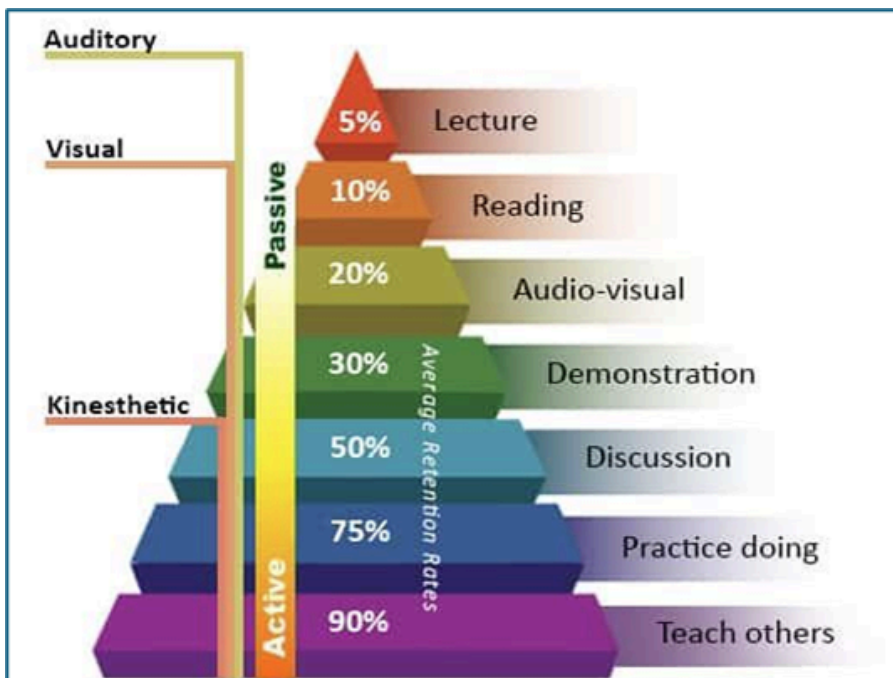


### 3.2. Project-Based Learning (PBL) with Environmental Themes

Project-Based Learning is a teaching approach where students develop knowledge and skills by engaging in an in-depth exploration of a meaningful, intriguing, and complex question, problem, or challenge over an extended period of time. The environment is a fantastic theme for Project-Based Learning (PBL) because it connects students to real-world issues and encourages them to explore complex challenges. Students can examine a wide range of topics, such as climate change, sustainability, conservation, or pollution, allowing them to investigate causes, effects, and potential solutions. By working on these types of projects, students not only gain knowledge but also learn valuable skills such as collaboration, problem-solving, critical thinking, and communication, which are essential in tackling real-world issues. Plus, they can see the immediate impact of their efforts, making the learning experience more meaningful and motivating.

According to the "Learning Pyramid" model developed by the National Training Laboratory, students typically retain only 10% of the information they read from textbooks but remember up to 90% of what they learn by teaching others. This model emphasizes that certain study approaches are more effective than others and that incorporating a variety of methods promotes deeper understanding and long-term retention. (Loveless, 2025)

Figure 5: Learning Pyramid



Source: (Loveless, 2025)



The insights from the Learning Pyramid strongly align with the principles of Project-Based Learning (PBL). In PBL, students engage in hands-on, collaborative work to solve real-world problems, which naturally incorporates some of the most effective learning methods highlighted by the pyramid, such as active participation and teaching others.



For example:

- **Active Learning:** Students in PBL learn by doing, which involves discussions, experimentation, and real-life application of knowledge—methods proven to deepen retention.
- **Teaching Others:** A key element of PBL is presenting findings or solutions to peers, teachers, or the community. By explaining their work to others, students reinforce their understanding and remember the material more effectively.
- **Diverse Methods:** PBL integrates various learning methods like research, collaboration, presentations, and hands-on creation, reflecting the value of varying study techniques to improve retention and engagement.

By embracing these strategies, PBL not only boosts academic performance but also fosters skills like problem-solving, critical thinking, and effective communication, ensuring a more meaningful and lasting learning experience.

When applying Project-Based Learning (PBL) to environmental education, the connection to the Learning Pyramid becomes even more evident, as students actively engage in meaningful, real-world environmental challenges.



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This approach ensures deep learning, long-term retention, and the development of practical skills. Here's how it relates:

### Active Learning Through Real-World Environmental Challenges

Environmental education often involves tackling authentic issues like pollution, climate change, or biodiversity loss. In PBL, students might work on projects such as designing a recycling program for their school or creating a sustainability plan for their community. These hands-on experiences align with the Learning Pyramid's emphasis on learning by doing, which significantly improves retention.



### Teaching Others Through Environmental Advocacy

A core aspect of environmental PBL projects is sharing findings and solutions with others, whether through presentations, awareness campaigns, or public service announcements. Teaching others about topics like renewable energy or water conservation not only reinforces students' understanding but also creates a lasting impact in their communities, reflecting the 90% retention rate associated with teaching others.



### Diverse Study Methods in Environmental Education

PBL naturally incorporates a variety of study methods, such as:

**Research:** Students analyze data on local environmental issues.

**Collaboration:** Teams work together to develop creative solutions.

**Presentation:** Final projects may include interactive exhibits, reports, or digital media campaigns.

This variation promotes deeper understanding and supports the long-term retention highlighted in the Learning Pyramid model.

### Example: Environmental PBL in Action

Imagine a project where students investigate local water pollution. They collect samples, analyze data, consult with experts, and develop solutions like creating a community clean-up initiative. They then present their findings to local stakeholders or teach younger students about water conservation. This process not only deepens their understanding but also empowers them to make a tangible difference in their environment.

Project-Based Learning (PBL) begins with a real-world question or challenge that ignites curiosity. Students explore this inquiry through research, innovation, and critical thinking. Key elements include a driving question, a need to know, student autonomy, and 21st-century skills such as problem-solving and collaboration. The process emphasizes feedback, revision, and the creation of a public product that demonstrates learning outcomes. PBL allows for dynamic learning through cycles of inquiry, feedback, and skill-building. (Green Ninja, 2024)

**Figure 6:** Key elements of PBL



Source: (Green Ninja, 2024)

By integrating PBL with environmental education, students not only master academic content but also develop a lifelong commitment to sustainability and environmental stewardship, supported by proven effective learning strategies.



### 3.3. Experiential Learning and Outdoor Education

Primary and secondary school students are at a particularly formative stage in their development. Introducing them to environmental science can cultivate a sense of environmental responsibility by equipping them with the knowledge and tools needed to comprehend the natural world and their role within it. Through environmental science education, students can build a meaningful connection to the environment by exploring the complex interactions between humans and nature. This exposure also promotes hands-on, experiential learning, such as participating in outdoor activities or tackling environmental projects. By engaging in these initiatives, students gain a more profound understanding of environmental challenges and acquire practical skills to address real-world issues. Additionally, these experiences can foster a sense of ownership and accountability for their local surroundings, inspiring a commitment to protecting and conserving the environment (Mansfield, 2023).

A study published in the International Journal of Environmental and Science Education highlights the benefits of outdoor education in enhancing students' environmental knowledge and attitudes (Liu & Chen, 2017). The research revealed that outdoor education programs significantly improved students' comprehension of environmental issues and their understanding of the interconnectedness within natural systems. Furthermore, participants developed more favorable attitudes toward the environment and a stronger sense of personal responsibility for its preservation. These results indicate that outdoor education is a valuable tool for promoting environmental literacy and encouraging a deeper sense of stewardship for the natural world.



Embedding education in outdoor environments is increasingly recognized as an effective method for fostering a wide range of skills and benefits for children. Outdoor spaces are seen as valuable extensions of the traditional classroom, providing diverse learning opportunities that enhance children's social, physical, and emotional well-being. Outdoor learning allows children to connect with nature, promoting social skills and personal growth in ways that indoor environments cannot replicate.



In primary schools, outdoor learning plays a strategic role in fostering the holistic development of children. It extends beyond the traditional classroom, providing students with valuable exposure to the natural environment, which is crucial for building social and personal skills.

For example, schools with access to gardens can significantly enhance social development through structured playtime. Implementing effective outdoor learning programs creates numerous opportunities for both educators and students, enriching the learning experience.





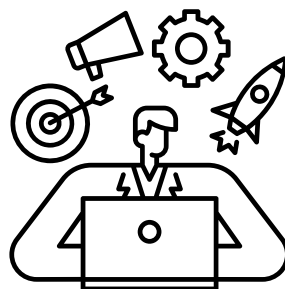
### 3.4. Blended Learning Approaches for Environmental Awareness

In the rapidly changing world of education, blended learning has emerged as a highly effective hybrid approach. By combining the strengths of traditional classroom methods with digital tools, this innovative model provides students with a dynamic and personalized learning experience. Blended learning, or hybrid learning, integrates traditional in-person instruction with digital components to create a flexible and adaptable learning environment. This approach aims to harness the strengths of both methods, enriching the educational experience by incorporating technology while maintaining the core elements of traditional teaching.

A major advantage of blended learning is its ability to accommodate diverse learning styles. Traditional classroom methods offer a structured and interactive environment, while digital elements provide flexibility for self-paced learning. This combination enables students to engage with the material in ways that align with their unique preferences and needs.



Blended learning encourages active engagement by incorporating a variety of teaching methods. Classroom activities like discussions, group projects, and hands-on experiences are complemented by digital tools such as interactive simulations, educational games, and multimedia resources. This integration keeps students actively involved, promoting a deeper understanding of the subject matter. In an increasingly digital world, blended learning helps students build essential digital literacy skills. By using online platforms, collaborating virtually, and utilizing digital resources, students gain the technological proficiency necessary for success in the 21st-century workforce (Trigyn Technologies, 2023)

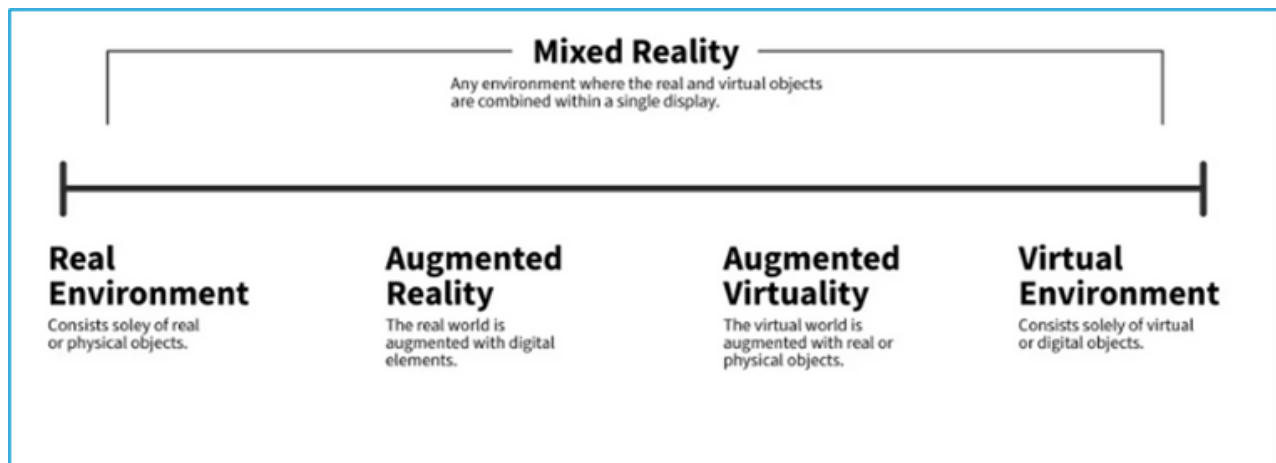


## CHAPTER 4: Leveraging Technology for Climate Change Education

### 4.1. Virtual Reality (VR) and Augmented Reality (AR) in Learning

Traditional curriculum development is increasingly being enhanced by digital and virtual learning tools to assess and address risks and vulnerabilities. Advanced visualization technologies, such as virtual reality (VR) and augmented reality (AR), have introduced interactive experiences that are widely utilized in simulation-based training systems. As VR creates a fully digital environment that mimics real-world settings, enabling users to engage with their surroundings immersively, AR enriches the physical environment by overlaying virtual elements, studies have demonstrated that VR and AR effectively facilitate immersive and engaging learning experiences, allowing children to virtually visit distant locations or experience historical events firsthand. (Bovienzo, 2024)

**Figure 7:** Reality–Virtuality Continuum



Source: (Interaction Design Foundation, 2022)

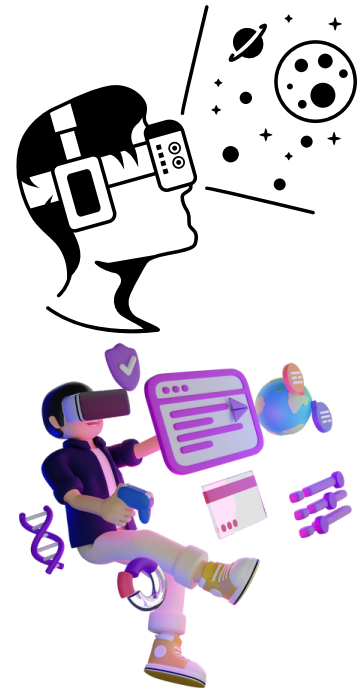
Education is undergoing a profound transformation, driven by the rapid evolution of Augmented Reality (AR) and Virtual Reality (VR). While traditional teaching methods remain effective, they often struggle to fully engage students in a way that fosters deep comprehension and long-term retention. AR and VR address this challenge by providing immersive, interactive learning experiences that enable students to visualize complex concepts, participate in hands-on training, and explore real-world scenarios without physical constraints.

From medical students honing their surgical skills in a safe VR simulation to K–12 learners exploring STEM subjects with AR-powered 3D models, immersive technology is reshaping the way knowledge is absorbed. Various industries, including corporate training, automotive engineering, history education, and military defense, are also leveraging AR and VR to enhance skill development and strategic thinking (Digitaldefynd, 2025).



Cleveland State University, in partnership with Merge EDU, has introduced an innovative Augmented Reality (AR)-driven method to enhance STEM education for K-12 students. Aiming to overcome the challenges of traditional STEM learning—such as passive textbook-based instruction, restricted access to lab resources, and lack of student engagement, this initiative utilizes AR technology to create dynamic, interactive experiences that make science, mathematics, and engineering concepts more tangible and engaging.

A recent study suggests that using virtual reality (VR) in classrooms to illustrate the impact of climate change increases students' interest in environmental issues and encourages eco-friendly behaviors.



Given the limited research on how VR technology affects environmental education, a team of US researchers explored whether experiencing a virtual, climate-altered ecosystem could change students' perspectives on their role in the world. At Paul Smith's College Visitor Interpretive Center (VIC), researchers created an immersive educational program that simulates warmer climate scenarios using advanced video game technology. Visitors to the Adirondacks-based center in northeastern New York walked a forest trail twice—once in person and once through a VR simulation that depicted various future ecological changes, such as shifts in plant and animal species. (Immersive Learning News, 2024)

The study, published in *The Adirondack Journal of Environmental Studies*, found that engaging with the VR simulation significantly enhanced participants' sense of place. Additionally, it contributed to a deeper understanding of climate change science and fostered a greater appreciation for its impact. The report defines a sense of place as the way individuals form connections and develop perspectives on issues affecting a particular location. Through focus groups, researchers discovered that VR technology helped participants better grasp the significant environmental impact of even slight temperature changes. Students also expressed a preference for this immersive learning method over traditional climate change lessons they had previously experienced. The research team, consisting of student Stephanie Tyski and professor Joe Henderson, emphasizes that VR-based educational experiences can enhance how environmental and climate change educators convey future ecological shifts due to global warming. (Jack, 2024)



Findings suggest that such programs could “open new doors” by allowing students to explore places they might never have the chance to visit in person. The study also highlights the potential for virtual field trips to reinforce learning by enabling students to revisit locations, explore topics further, and deepen their understanding of lesson material. The study concludes that VR is no longer just a novelty in experiential education but is becoming a valuable tool for teaching climate change and environmental issues. Participants showed increased interest in climate science and were more motivated to adopt eco-friendly behaviors. (Jack, 2024)

In 2017, WWF, in partnership with Lenovo and Google, launched an innovative project that blends virtual and real-world experiences to raise awareness and inspire real action. Through the VR game *Into the Wild*, players not only engage in a digital conservation experience but also contribute to tangible environmental efforts. For instance, when players plant trees within the game, a real tree is planted in the physical world, bridging the gap between virtual engagement and real-world impact. (Inglobe Technologies, 2022)

#### 4.2. Interactive Digital Tools and Apps for Environmental Awareness

As digital technology continues to evolve, a growing number of educational apps and interactive tools have been developed to enhance climate literacy and environmental awareness. These apps provide engaging, immersive, and interactive experiences that help students understand complex environmental issues such as climate change, biodiversity loss, and sustainable practices. Some notable examples can be listed as below;

- **Earth Hero** – Helps users track their carbon footprint and suggests sustainable lifestyle changes. (Earth Hero , 2025)
- **WWF Together** – Features interactive storytelling and augmented reality experiences to explore endangered species and conservation efforts. (WWF, 2025)
- **EcoChallenge** – Encourages users to participate in daily sustainable actions and track their environmental impact. (ecochallenge, 2025)
- **JouleBug** – Gamifies sustainability by rewarding users for making eco-friendly choices in daily life. (JouleBug, 2025)
- **NASA Earth Now** – Provides real-time satellite data on global climate indicators such as temperature, carbon dioxide levels, and ice mass. (NASA, 2025)
- **Project Drawdown's Climate Solutions 101** – Offers educational videos and interactive content on climate solutions. (Project Drawdown, 2025)
- **iNaturalist** – A citizen science app that allows students to document biodiversity and contribute to research projects. (iNaturalist, 2025)

Teachers can effectively incorporate digital tools through gamification, real-time data analysis, virtual field trips, climate action projects, interdisciplinary learning and discussions into their curriculum to enhance environmental education and engage students in climate literacy. By leveraging these interactive digital tools, educators can make environmental awareness more engaging and impactful, fostering a generation of students who are informed and motivated to contribute to sustainability efforts.



### 4.3. Online Platforms for Collaborative Climate Change Projects

As climate change is a global challenge, online platforms provide excellent opportunities for students and educators worldwide to collaborate on environmental projects. These platforms facilitate knowledge sharing, research, and collective action, helping students engage with global sustainability initiatives. These platforms enable users to connect with like-minded individuals, collaborate on environmental challenges, and take meaningful action for a sustainable future.

Global partnerships in environmental education offer numerous advantages, fostering collaboration and innovation among students worldwide.

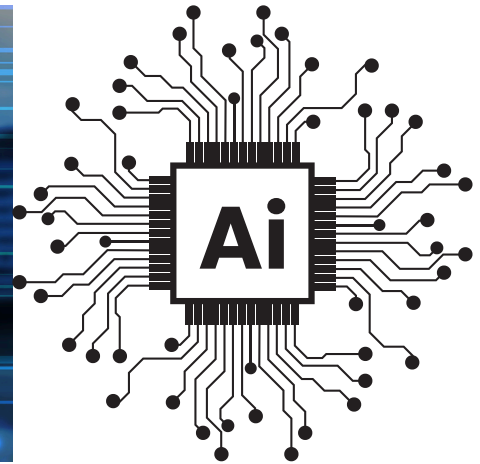
- **Expanding Knowledge and Perspectives:** Students gain insights from diverse cultural perspectives on climate change and engage with global case studies and real-world sustainability challenges.
- **Enhancing Research and Data Sharing:** Access to global climate datasets allows for better analysis, while collaboration on research projects leads to innovative solutions.
- **Encouraging Active Participation:** These partnerships inspire students to take part in real-world climate advocacy and engage in hands-on environmental projects at both local and global levels.
- **Strengthening STEM and Digital Skills:** Students develop expertise in digital tools for climate modeling and analysis, improving skills in AI, GIS mapping, and data visualization.
- **Creating Long-Term Sustainable Impact:** By initiating eco-friendly projects in their schools and communities, students contribute to sustainability while building networks of future climate leaders.

These benefits collectively empower students to become proactive agents of change in the fight against climate change.



#### 4.4. The Role of Artificial Intelligence (AI) in Personalized Learning

Artificial Intelligence (AI) is revolutionizing education by providing personalized learning experiences tailored to individual student needs. Additionally, AI enhances environmental education by analyzing complex data for student-led sustainability projects. AI-driven learning systems adapt to students' abilities, learning styles, and progress, making education more effective and engaging. AI plays a crucial role in environmental education by enabling students to analyze complex climate and sustainability data. AI processes large environmental datasets, helping students study climate change patterns and ecological trends. Also, AI assists students in tracking real-time data such as pollution levels, deforestation and weather changes. AI models potential environmental impacts of human actions, allowing students to develop data-driven solutions for sustainability. Interactive simulations created by AI help students to understand the effects of policy decisions on environmental challenges.



## CHAPTER 5: Best Practices from the World

To enhance the effectiveness of climate change education, best practices must be rooted in research-backed methodologies that foster engagement, critical thinking, and real-world application.

Climate change is a multifaceted issue requiring knowledge from various disciplines, including science, geography, economics, and social studies. Interdisciplinary curricula help students understand the interconnectedness of environmental, social, and economic factors (OECD, 2021).

Hands-on learning experiences, such as fieldwork, laboratory experiments, and community-based projects, improve knowledge retention and student engagement. Studies show that experiential learning significantly enhances students' understanding of climate science and encourages pro-environmental behavior (Mansfield, 2023).

Incorporating technology, such as artificial intelligence (AI), augmented reality (AR), and gamification, into climate education makes learning more interactive and impactful. AI-driven adaptive learning platforms personalize content, while AR/VR simulations provide immersive experiences of environmental changes (Emirates Scholar, 2024).

Collaborations with local governments, NGOs, and businesses provide students with real-world applications of their knowledge. Community projects enable students to take active roles in local environmental solutions, fostering a sense of responsibility (Cordero, Centeno, & Todd, 2020).

Adapting content to different learning styles enhances accessibility and inclusivity. Differentiated instruction—where students engage with materials in diverse formats such as videos, interactive exercises, and self-paced modules—improves comprehension and retention (Labster, 2024).

There are many successful applications for climate change education in the world. Those can be listed as;

### **Finland's Sustainability Education Model:**

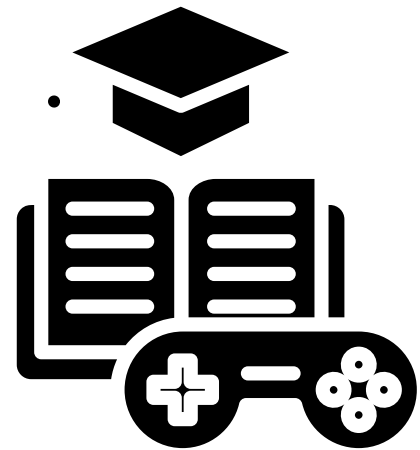
Finland integrates environmental education across subjects, ensuring that students learn sustainability concepts from an early age. The Finnish curriculum emphasizes inquiry-based learning, where students analyze environmental problems and propose solutions (OECD, 2021). Finland's basic education core curriculum highlights everyone's ability to contribute to a sustainable future, focusing on four key elements: participation, systems thinking, sufficiency, and responsibility. (Europass Teacher Academy, 2025)



**UN Climate Change Education Initiatives:** The United Nations has developed educational frameworks, such as the Education for Sustainable Development (ESD) initiative, which provides guidelines and resources for climate education worldwide. This program promotes active student participation in sustainability projects (UN, 2023). UNESCO's ESD for 2030 program generates and disseminates knowledge, provides policy guidance and technical support to countries, and carries out on-the-ground projects. It promotes peer learning and innovation through information sharing, networks, and partnerships.



**Gamification in Education Climate Interactive:** The Climate Interactive initiative uses simulations and role-playing games like World Climate and Climate Action Simulation to teach students about international climate negotiations and policy-making. Research suggests that these games improve students' understanding of policy complexities and enhance critical thinking skills (Climate Interactive, 2023).



**Climate Reality Project (Global):** The Climate Reality Project is a global climate education and advocacy initiative founded by former U.S. Vice President Al Gore. It focuses on Training individuals to understand and communicate the urgency of climate change, empowering people to push for just and effective climate policies, promoting a rapid shift to renewable energy and sustainable solutions. It operates through **training programs, campaigns, and partnerships**, engaging a global network of activists, scientists, and leaders to push for systemic change. (Climate Reality Project, 2025)





**Green School Initiative (United States):** The Green Schools Initiative was established in 2004 by environmentally conscious parents who were alarmed by the lack of sustainability in their children's schools. Motivated to improve the environmental health and ecological responsibility of educational institutions across the U.S., the initiative seeks to safeguard children's well-being—both within schools and beyond—by inspiring and supporting environmental actions among students, educators, parents, and policymakers. Its primary objectives include: Eliminating toxic substances, promoting sustainable resource use, developing eco-friendly schoolyards and buildings, providing nutritious meals, and enhancing environmental literacy and stewardship. The Green Schools Initiative is dedicated to transforming schools into sustainability models for their communities. By engaging students in hands-on, inquiry-driven learning, it fosters environmental responsibility while enhancing the health and sustainability of school operations. The initiative advocates for policies, action plans, and professional development that promote high-performing, cost-effective, and academically enriching schools. (Green Schools Initiative, 2025)





**Outdoor Education (Denmark & Norway):** The Scandinavian concept of udeskole (meaning “outdoor school”) is an innovative educational approach that encourages learning outside the traditional classroom setting. It has been explored in various Nordic countries, each adapting it to their local context. In Norway udeskole is an approach to education that emphasizes outdoor activities and direct engagement with nature, offering a more holistic form of learning. Udeskole in Sweden, where it is incorporated into the curriculum to help students develop a stronger connection to the environment and foster practical learning skills. The Danish implementation of udeskole, where outdoor education is structured as part of the regular school schedule and emphasizes physical activity, environmental awareness, and social development. Udeskole targets children aged 7-16 and is characterized by regularly scheduled educational activities held outdoors, typically once a week or every other week. This model aims to make learning more engaging by immersing students in real-world contexts, encouraging them to explore and learn about nature, sustainability, and practical problem-solving in a hands-on way.



The success of these programs stems from their strong connection to policy and practice. Effective collaboration with governments and educational institutions is crucial for their success. These programs focus on training educators to enhance teaching quality and create better learning opportunities. Well-trained educators, backed by strong policy support, have the power to elevate climate education beyond its current boundaries, fostering deeper awareness and meaningful action. (Children and Nature Network, 2025)



**The European Green Deal's Education Initiatives:** As the EU and its Member States make significant investments in green technologies and infrastructure, it is imperative to address the human element of this transition. This initiative aims to support educational institutions—such as schools, high schools, universities, and parent associations—by facilitating the adaptation of existing curricula and the development of new subjects focused on the green transition. The goal is to empower students and educators with the knowledge, skills, and mindset needed to actively participate in the sustainable transformation of society. By facilitating the creation of a green education ecosystem, this initiative would contribute to shaping a generation of students who are not only aware of climate challenges but also equipped with the skills to drive change. (European Commission, 2024)



## CHAPTER 6: Conclusion

Climate change is one of the most significant challenges of our time, requiring urgent and collective action. Education plays a fundamental role in equipping future generations with the knowledge, skills, and motivation needed to address this global crisis. However, traditional climate change education often fails to engage students effectively, relying on outdated methods that do not foster critical thinking, problem-solving, or real-world application.

Climate change education varies across Iceland, Denmark, Türkiye, Spain, and Germany, with each country incorporating sustainability and environmental awareness into its national curriculum. Iceland places a strong emphasis on sustainability, integrating climate education into its curriculum with a focus on renewable energy, particularly geothermal and hydro power, alongside environmental responsibility. Schools emphasize experiential learning, encouraging students to study glaciers, volcanoes, and ecosystems affected by climate change. Denmark introduces climate education early, embedding sustainability topics into subjects like science, geography, and ethics. Project-based learning is a key approach, with students engaging in initiatives like energy efficiency programs and urban gardening. The government actively promotes environmental education through initiatives such as "Climate Partnerships," which foster critical thinking about green transitions. Türkiye has recently updated its curriculum to give greater importance to climate change education, particularly within science and social studies. Given the country's vulnerability to droughts, wildfires, and extreme weather, schools place emphasis on climate resilience. Non-governmental organizations, including the TEMA Foundation and WWF Türkiye, play a crucial role in supporting environmental education through workshops and projects. Spain has made climate education mandatory, requiring schools to incorporate climate change topics across various subjects. Regional differences exist with autonomous regions like Catalonia and the Basque Country implementing advanced sustainability programs. Additionally, youth activism, exemplified by movements such as Fridays for Future Spain, significantly influences climate discussions in schools. Germany integrates climate change education extensively within STEM subjects, geography, and ethics. The country follows a national strategy known as "Education for Sustainable Development" (ESD), ensuring that sustainability is embedded across all levels of education. Vocational training institutions and universities also offer specialized courses on green technology and climate-related disciplines. Overall, each country adapts its approach to climate education based on its environmental priorities and educational policies, fostering awareness and engagement among students. (Belma & Barbaros, 2020), (ECCC, 2022)



This report has explored **innovative educational approaches**, such as **gamification**, **project-based learning**, **experiential education**, and **blended learning**, that can enhance the effectiveness of climate change education. These strategies not only make learning more engaging and interactive but also ensure that students develop a deeper understanding of climate science and sustainability principles.

Key takeaways from this report include:

- **The Need for Innovation:** Traditional teaching methods must be complemented with interactive, student-centered approaches that encourage active participation and critical thinking.
- **The Role of Technology:** AI, AR/VR, and online learning tools offer new ways to enhance climate education, making complex concepts more accessible and engaging.
- **The Importance of Experiential Learning:** Outdoor education, hands-on projects, and real-world applications are essential for reinforcing climate knowledge and fostering environmental stewardship.
- **The Power of Interdisciplinary Learning:** Climate change is a multifaceted issue that requires collaboration across scientific, economic, and social disciplines. A holistic approach to education can better prepare students to understand and address environmental challenges.

RECOMMENDED



### Recommendations for Future Action

1. **Integrating Climate Education into Curricula:** Policymakers should ensure that climate change is embedded into national and school-level curricula with a focus on interactive and interdisciplinary learning.
2. **Providing Professional Development for Educators:** Teachers must be equipped with the necessary knowledge, training, and tools to implement innovative teaching strategies effectively.
3. **Leveraging Digital and Technological Tools:** Schools should invest in AI-driven learning platforms, simulations, and gamified educational experiences to enhance student engagement.
4. **Encouraging Community and Real-World Engagement:** Schools should promote environmental projects, partnerships with local organizations, and student-led initiatives to reinforce learning through action.
5. **Ongoing Research and Evaluation:** Further studies should assess the impact of innovative educational approaches to refine and improve climate change education strategies continuously.



CLIMATE CHALLENGE  
*Adventure*



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By embracing modern, student-centered learning approaches, educators and policymakers can ensure that climate change education is not only informative but also empowering and action oriented. Equipping young learners with the right tools and knowledge will enable them to make informed decisions and contribute to a more sustainable future.





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