

Hazard Literacy Center

Hazard Literacy Education Program

Hazard Literacy Center

The 1.5°C Promise: Designing the Future with AI and Climate Engineering



1. Program Overview

"The 1.5°C Promise: Designing the Future with AI and Climate Engineering" is an inquiry-based program in which students design and build their own climate change simulators using generative AI–based Vibe Coding. Participants first envision a future climate scenario for 2100 and then engage in a backcasting process, working backward to identify warning signs in 2050 and design response strategies for the present. They also explore climate change and climate engineering technologies and connect environmental, social, and economic variables to understand the complex interactions within the climate crisis.
Students then collaborate with generative AI to build climate change simulators using natural-language prompts. They evaluate and revise AI-generated models based on scientific evidence, progressively refining their simulations. This approach allows students to focus on scientific modeling and systems thinking rather than coding syntax, while critically examining the benefits, limitations, and trade-offs of climate engineering technologies. Through this process, students develop scientific decision-making skills for addressing challenges facing future societies. In particular, the program provides a new learning experience in which AI is used not merely as a tool but as a co-designer (AI co-engineering) for exploring and solving future-oriented problems.

Grade Level	High school students (Grades 10–11 recommended; approximately 20–30 students)	Instructional Methods	Generative AI–based Vibe Coding, project-based inquiry
Learning Environment	Computer lab or a regular classroom equipped with laptops	Duration	2 sessions (100 minutes total; 50 minutes per session)
Required Materials	Laptop or PC, internet access, access to a generative AI platform (e.g., ChatGPT), worksheets, and writing materials		

2. Learning Objectives (Hazard Literacy Framework)

① Understand the principles and characteristics of the climate crisis and climate engineering technologies, and scientifically explain various risk factors and their social and environmental impacts.
② Design and refine a climate change simulator using generative AI–based Vibe Coding, analyze causal relationships and systemic interactions among variables, and explore strategies for responding to future climate challenges.
③ Comprehensively evaluate the benefits and limitations of climate engineering technologies and propose responsible decisions and actions for a sustainable society.

Learning Objectives	Knowledge & Understanding		Reasoning & Skills					Values & Attitudes			Psychology & Emotion			Behavioral & Practical Engagement		
	A1	A2	B1	B2	B3	B4	B5	C1	C2	C3	D1	D2	D3	E1	E2	E3
Objective ①	O	O	O													
Objective ②			O	O	O	O			O					O		
Objective ③				O		O	O	O	O				O	O	O	O

3. Key Concepts

- Climate Change and Earth System Interactions
- Principles and Impacts of Climate Engineering Technologies
- Systems Thinking and Causal Modeling
- Future Scenarios and Backcasting
- Sustainable Climate Decision-Making

4. Program Sequence

Session	Title	Activities
1	A Warning from 2100: Diagnosing the Future and Designing Solutions	① Understanding the Climate Crisis: Explore the principles and examples of climate change and climate engineering technologies. ② Developing Future Scenarios: Analyze possible climate crisis scenarios for 2100 and select a social message or issue to address. ③ Backcasting: Work backward from the desired future in 2100 to identify warning signs in 2050 and design present-day policy and technological response strategies. ④ Designing a System Model: Select key variables, such as global mean temperature, CO_2 concentration, food production, economic costs, and social inequality, and design causal relationships and feedback structures among them.
2	The 1.5°C Promise with AI: Building a Climate Change Simulator	① AI-Based Vibe Coding: Build a climate change simulator in colla boration with generative AI using natural-language prompts. ② AI Co-engineering: Evaluate the AI-generated model based on scientific evidence and refine it by adding or removing variables, revising causal relationships, and adjusting parameters. ③ Running and Analyzing Simulations: Apply different climate engineering technologies and policies, compare the outcomes, and analyze their benefits and limitations. ④ Sharing and Reflection: Compare the models before and after revision and discuss sustainable climate response strategies based on systems thinking and scientific decision-making.

5. Theoretical Background and Activity Design for Disaster Education

The climate crisis is a "complex hazard" arising from interactions among natural, social, and economic systems. Addressing such complexity requires "systems thinking", which goes beyond understanding individual phenomena to comprehensively examining interactions and feedback among multiple components (Meadows, 2008; Sterman, 2000). In addition, the international community has increasingly emphasized the importance of "backcasting" in responding to the climate crisis: rather than simply predicting future risks, backcasting involves envisioning a desirable future and working backward to identify the actions needed in the present to achieve it (Robinson, 1990; Wiek & Iwaniec, 2014). Accordingly, this program is designed for students to first construct a future climate scenario for 2100 and then work backward to identify warning signs in 2050 and develop present-day policy and technological response strategies.

Based on future climate scenarios presented by the IPCC (IPCC, 2023), students analyze the potential impacts of the climate crisis, investigate the benefits and limitations of climate engineering technologies, and then develop their own climate change simulators using generative AI–based "Vibe Coding". Rather than serving merely as a tool that performs coding tasks, generative AI provides an "AI co-engineering environment" in which students collaboratively design and refine models with AI (Mollick, 2024). Through iterative evaluation and revision of AI-generated models based on scientific evidence, students examine causal relationships and feedback structures among variables and engage in scientific decision-making. These activities incorporate the core processes of "Model-Based Inquiry—model construction, evaluation, and revision"(Gilbert, 2004; Schwarz et al., 2009)—and are designed to foster both "hazard literacy and systems thinking" in the context of the climate crisis.



Figure 1. Vibe Coding-Based Climate Crisis System Development Outcome

6. Instructional Considerations

Students should be guided to critically evaluate and revise the outputs generated by AI based on scientific evidence rather than accepting them without question. They should also consider not only the potential benefits of climate engineering technologies but also their limitations and risks, including termination shock and broader environmental and social impacts. Students should be encouraged to connect future scenarios for 2100 with present-day response strategies, focusing on causal relationships among variables and systemic interactions. During discussions, instructors should promote respect for diverse perspectives and guide students toward sustainable solutions through evidence-based decision-making.

7. References

- Lee, H. J., Shin, D. H., Shin, E. H., Choi, Y. J., Lee, J. H., Shim, M. K., Moon, S. Y., & Moon, M. K. (2025). Hazard literacy as a future citizenship competency: Development of a multidimensional conceptual framework. Journal of the Korean Association for Science Education, 45(3), 337–351.
- Choi, Y. J., Lee, H. J., & Shin, D. H. (2025). Analysis of disaster education content in the 2022 revised national curriculum. The Journal of Curriculum Studies, 43(4), 53–78.
- Oh, H. S., & Lee, H. N. (2021). Levels and characteristics of middle and high school students' systems thinking about material cycles in the Earth system. Journal of Science Education, 45(3), 275–291.
- Park, W., Lee, H., Ko, Y., & Lee, H. (2023). "Safety" and "integration": Examining the introduction of disaster into the science curriculum in South Korea. Journal of Curriculum Studies, 55(5), 580–597.
- United Nations Disaster Relief Organization. (1980). Natural disasters and vulnerability analysis. United Nations.

The 1.5°C Promise: Designing the Future with AI and Climate Engineering

Topic	A Warning from 2100: Diagnosing the Future and Designing Solutions
What Will We Learn?	• Understand the principles of climate change and climate engineering • Analyze future scenarios for 2100 and early warning signs in 2050 • Design solution strategies using backcasting

1 Exploring Climate Crisis Variables

① Identify and list as many phenomena as possible that change as a result of global warming (rising temperatures). You may include variables related not only to natural phenomena but also to society, health, and the economy.

② **Variable Investigation**

No.	Variable (Phenomenon)	Detailed Description of the Direction of Change and Its Impacts (Do not simply write "increases")	Source / Evidence
1			
2			

2 Envisioning the Worst: Case Future in 2100

Based on the three future scenarios reported in the Korea Meteorological Administration's scenario analysis, choose one "worst-case future" that your group must prevent. (Choose one.)

[1] Choosing the Worst-Case Future in 2100

[ ]	Scenario A. Food System Collapse: An imbalance between rising temperatures and precipitation intensifies drought in agricultural areas, causing rice production to plummet by 40% and eliminating suitable regions for fruit cultivation.
[ ]	Scenario B. Urban Flooding: The frequency of localized extreme rainfall events increases dramatically during summer, causing urban rivers to overflow frequently and low-lying areas to experience chronic flooding.
[ ]	Scenario C. Ecosystem Stress: Climate stress destroys the habitats of native plants and animals, while invasive species and pests rapidly spread.

[2] Selecting Key Variables for the Worst-Case Future in 2100

☐ Increase in Average Temperature (related to food system collapse and ecosystem degradation)

☐ Annual Number of Extreme Rainfall Days (related to urban flooding)

☐ Number of Consecutive Summer Heatwave Days (related to ecosystem stress and drought)

[3] Writing the 2100 Investigation Report

✓ Due to global warming, our selected key indicator, [choose one specific variable from Section 2], has (increased / decreased) by as much as (_____ °C / _____ days) compared with the 2026 baseline.

✓ This rapid change caused physical environmental impacts, such as [e.g., drying out soil moisture in farmland / causing urban drainage systems to overflow], which ultimately triggered the catastrophic event we observed: [Event: _____].

[4] Identifying Warning Signs in 2050: Signals During the Golden Window

Let's turn back the clock to 2050, halfway to the catastrophic future of 2100. The disaster of 2100 did not happen overnight. What warning signs were already appearing in the 2050 data?

- ✓ Looking at the data from the 2050s, our selected key indicator had already changed by (_____% / _____ units) compared with the present, indicating that it had entered a dangerous trajectory.

- ✓ **If you had to summarize in one sentence the warning humanity should have recognized from this data, what would it be?**

(Example: "By 2050, the number of extreme rainfall days had already doubled compared with today, signaling the catastrophe to come.")

- ✓ **Investigator's One-Line Assessment:**

[5] Choosing a Solution to Change the Past—and Its Trade-offs

If humanity had recognized the warning signs in 2050, what intervention should it have taken? Choose a solution while considering not only its benefits but also its potential trade-offs.

Our Chosen Solution for 2050 (Choose One):

☐ echnological Intervention (e.g., SAI): Release artificial particles into the atmosphere to intentionally lower global temperatures.

(Trade-off: Reduced sunlight may negatively affect crop yields.)

☐ Policy Intervention (e.g., Carbon Tax): Impose substantial financial penalties on carbon dioxide emissions.

(Trade-off: Businesses may face severe financial difficulties, and consumer prices may rise sharply.)

☐ Citizen-Level Regulation (e.g., Energy Rationing): Mandate limits on individuals' fossil fuel use.

(Trade-off: Restrictions on freedom of movement and a potential decline in quality of life.)

- ✓ **Example:** We decided to implement [chosen solution] in 2050 to bring down [key variable from Section 2-1], which had already reached a dangerous level. Although this intervention comes with the trade-off of [side effect of the chosen solution], we concluded that it was the best option for preventing an even greater catastrophe in 2100.

- ✓ **My Backcasting Conclusion:**

3 Climate Engineering Investigation

Choose one of the four climate engineering technologies below and investigate it using at least two different sources (e.g., textbooks, news articles, academic papers, or reports from governments or international organizations).

① Stratospheric Aerosol Injection (SAI)
② Marine Cloud Brightening (MCB)
③ Large-Scale Afforestation
④ Space-Based Mirrors

My Chosen Technology 1: ( )

Principle / How It Works	
Expected Effects (Benefits)	
Side Effects, Risks, and Limitations	
References / Sources (at least 2, including AI)	

4 Building My Own Climate Crisis Simulator

1) Choose One Social Message You Want to Communicate Through Your Simulator.

Select one of the five options below and explain why you chose it.

- ☐ **Climate Dilemma Warning:** Warn that technology can solve one problem while creating new risks.
- ☐ **Climate Inequality:** Highlight that the impacts of the climate crisis and climate technologies disproportionately affect vulnerable populations.
- ☐ **Cost-Effectiveness:** Critically evaluate the effectiveness of climate solutions in relation to their actual costs and available budgets.
- ☐ **Call for Public Action:** Emphasize that changes in individual behavior are more important than relying solely on technology.
- ☐ **Warning Letter to the Present:** Write from the perspective of future generations to warn people today about the consequences of their choices.
- ☐ Other:

▶ **Why did you choose this message? What dependent variable do you want to focus on? What is the purpose of this simulation?**

Category	My Choice and Description
Selected Message Type	
Reason for My Choice	
Final Purpose of the Simulation (e.g., development purpose)	

▶ **What Are the Main Features and Interaction Flow of Your Simulation?**

(What elements can users manipulate, and what changes or outcomes should result from their actions?)

Associated Side Effects (Variables · Direction / Magnitude)	How Does This Design Communicate Your Message?

User-Controlled Elements (Buttons / Sliders)	Immediate Changes (Variables · Direction / Magnitude)

5 Reflection

What Chain of Consequences Did a Single Choice Create in Your Simulation?
(Explain how the variables were connected and what changes resulted, including both the expected effects and unintended side effects. Based on your findings, describe your thoughts on how advances in science and technology are connected to social choices and ethical dilemmas.)

What risk was your simulation designed to reduce?
What new risks or limitations emerged in the process?