

Hazard Literacy Center

Hazard Literacy Education Program

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How Should Our School Respond to Fine Dust? Exploring Solutions with NetLogo



1. Program Overview

This program was designed to help students investigate the effectiveness of different school response strategies under high fine dust conditions through simulation and use the results as evidence to propose appropriate guidelines for their school and local community. Building on their understanding of fine dust and previous exploration of real air quality data, students focus on responding to fine dust and making evidence-based decisions.

First, students learn the basic principles of NetLogo, an environment for Agent-Based Modeling (ABM), and explore a fine dust exposure simulation representing a simplified school setting. Students may be located inside the school or outside on the playground, and their exposure to fine dust accumulates over time. Under high fine dust conditions, students change school response strategies and observe how these changes affect exposure. Strategies include reducing outdoor activity time, wearing masks, switching from outdoor to indoor activities, and providing additional protection for students who are sensitive to fine dust.

Students evaluate each strategy using two indicators: Average Exposure and the Number of Highly Exposed Students. Through this comparison, they recognize that reducing overall exposure and protecting students at high risk may represent different criteria for evaluating a response strategy. They also compare applying the same measures to all students with providing additional protection based on individual vulnerability.

Next, students consider the limitations of the simulation and propose ways to better represent real-life conditions at their school. They suggest additional factors affecting fine dust exposure, such as rain, classroom ventilation, or air purifiers, and design how these could be incorporated into the model. With the support of generative AI, students then attempt to modify the NetLogo model accordingly. Through this activity, students learn that models are simplified representations of reality that can be revised depending on their purpose.

Finally, students examine the Seasonal Fine Dust Management Program as a real-world example and use both simulation results and actual response measures to propose fine dust response guidelines for their school or local community. They identify the target and recommended measures and justify their proposals using scientific reasoning and simulation evidence. In this way, the program develops students' ability to use models and data to evaluate responses to environmental hazards and connect their findings to decision-making in their school and community.

Grade Level	Grades 4-6	Instructional Methods	Simulation-Based Inquiry, Discussion, Problem Solving, and Use of Generative AI
Learning Environment	Classroom or Computer Lab	Duration	45 minutes
Required Materials	Laptop, NetLogo Software, and Fine Dust Worksheet		

2. Learning Objectives (Hazards Literacy Framework)

① Students can use a NetLogo simulation to compare and analyze students' exposure under different school response strategies for fine dust.

② Students can evaluate the effectiveness of fine dust response strategies based on average exposure and the number of highly exposed students and determine appropriate strategies while considering vulnerable students.

③ Students can propose fine dust response strategies applicable to their school and local community by considering the limitations of the simulation and real-world response measures.

Learning Objectives	Knowledge & Understanding		Reasoning & Skills					Values & Attitudes			Psychology & Emotion			Behavioral & Practical Enagement		
	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									
Objective ③		O					O									O

3. Key Concpets

· Agent-Based Modeling and NetLogo Simulation

· Fine Dust Exposure and School Response Strategies

· Evaluating Response Effectiveness Using Average Exposure and the Number of Highly Exposed Students

· Model Limitations and Improvement

· Fine Dust Responses at the School and Community Levels

4. Program Sequence

Learning Activities	
Introduction	·Recall possible school responses on days with high fine dust levels. ·Introduce the question: "How should our school respond to fine dust?"
Inquiry1	·Understand the basic principles of NetLogo and Agent-Based Modeling (ABM). ·Run the fine dust simulation and examine average exposure and the number of highly exposed students.
Inquiry2	·Change response strategies such as reducing outdoor activities, wearing masks, switching to indoor activities, and protecting vulnerable students. ·Compare the results and determine which strategies are effective. ·Discuss whether vulnerable students need additional protection.
Inquiry3	·Identify limitations of the model by considering real school situations. ·Propose new elements such as rain, open windows, or air purifiers and improve the model using generative AI.
Wrap-up	·Examine real-world responses such as the Seasonal Fine Dust Management Program. ·Use simulation results as evidence to propose a fine dust response strategy for the school or local community.

5. Theoretical Background and Activity Design for Disaster Education

Fine dust is an environmental hazard that can affect students' health and school activities. However, its risk depends not only on outdoor fine dust concentrations but also on students' exposure and vulnerability. For example, exposure may vary depending on whether students are indoors or outdoors, wear masks, or participate in outdoor activities, while students sensitive to fine dust may require additional protection. Therefore, responding to fine dust requires consideration of hazard, exposure, vulnerability, and response. To explore these factors, students use NetLogo, an environment for Agent-Based Modeling (ABM). In the simulation, individual students are represented as agents located inside the school or outside on the playground, and their fine dust exposure accumulates over time. Students manipulate response strategies, such as reducing outdoor activity, wearing masks, switching to indoor activities, and providing additional protection for vulnerable students, and examine how these changes affect exposure.

Students evaluate the strategies using two indicators: Average Exposure and the Number of Highly Exposed Students. By comparing these outcomes, they consider both reducing overall exposure and protecting students at greater risk. They also compare uniform measures for all students with differentiated protection for vulnerable students, recognizing that effective responses should account for differences in vulnerability. Students then examine the limitations of the simulation as a simplified representation of reality. They identify additional factors, such as rain, classroom ventilation, or air purifiers, and, with the support of generative AI, attempt to incorporate these factors into the model. This process helps students understand that models can be revised and improved depending on their purpose. Finally, students connect their simulation-based inquiry to real-world responses, such as the Seasonal Fine Dust Management Program. Using simulation results and actual response measures as evidence, they propose fine dust response guidelines for their school or local community. Through this process, students move from understanding environmental hazards to evidence-based decision-making that considers exposure, vulnerability, and appropriate responses.

6. Instructional Considerations

It is important to ensure that students do not interpret simulation results as absolute predictions of what will occur in an actual school. The NetLogo model represents only selected factors affecting fine dust exposure, so a strategy that appears most effective in the simulation may not always produce the same results in every situation. Students should therefore consider both the results and the conditions and assumptions under which they were produced.

Students should also evaluate response strategies using more than one indicator. Rather than focusing only on average exposure, they should also consider the number of highly exposed students and whether vulnerable students are sufficiently protected. When comparing strategies, students should change one condition at a time whenever possible so that the effects of each response can be clearly identified.

Care should be taken when discussing students who are sensitive to fine dust. They should be described as students who may require additional protection because of their health conditions, rather than as “weak students.” Students should also consider why providing the same response to everyone may not always be appropriate.

During the model improvement activity, students should explain why a new element should be added, how it would operate in the model, and how it might affect the results. Code suggested by generative AI should not be accepted automatically; students should examine whether it appropriately represents the intended variable and produces scientifically reasonable outcomes.

Finally, students should not directly translate the best-performing simulation strategy into school policy. When proposing responses for their school or local community, they should also consider feasibility, the needs of different students, the school environment, and available resources. The simulation should therefore be used as one form of evidence to support real-world decision-making rather than as a tool that provides a single correct answer.

7. References

- Kim, G., & Lee, H. (2017). Effects of community-based SSI programs on promoting middle school students’ understanding of issues and character and values as citizens: Focused on fine dust issues. Journal of the Korean Association for Science Education, 37(6), 911–920.
- Kim, G., & Lee, H. (2017). Perceptions of teachers, program instructors, and local experts on implementing community-based socioscientific issues programs. Journal of the Korean Association for Science Education, 37(3), 453–464.

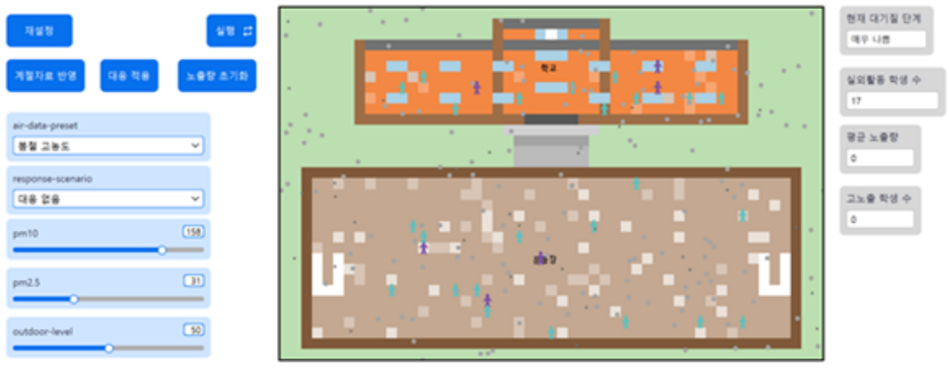
How Should Our School Respond to Fine Dust? Exploring Solutions with NetLogo

Topic	Designing Fine Dust Response Strategies for Our School
What Will We Learn?	① We can use a simulation to compare the effects of different strategies for responding to fine dust. ② We can use data to select and explain appropriate fine dust response strategies for our school. ③ We can propose fine dust response guidelines that can be applied to our school and local community.

1 Responding to Fine Dust with a Simulation

- Download the provided NetLogo simulation and explore how students' exposure to fine dust changes depending on the school's response strategies.

This simulation allows you to investigate how students' exposure to fine dust changes depending on the school's response strategies on a day with high fine dust levels. Students may be inside the school or on the playground, and their exposure to fine dust accumulates over time. Students may be exposed to more fine dust when they are outside on the playground than when they are inside the school. Change response strategies such as wearing masks, switching to indoor activities, and applying protective measures for vulnerable students, and examine which strategies are effective in reducing students' exposure.



1) Check the results for a situation with high fine dust levels (e.g., winter).

Fine Dust Levels (X)		Simulation Results (Y)	
PM-10	μg/m³	Average Exposure	
PM-2.5	μg/m³	Number of Highly Exposed Students	

2) Change the school's response strategies and compare the results.

Response Strategy	What Did You Change?	Result (Average Exposure)	Result (Number of Highly Exposed Students)
Reduce Outdoor Activity Time	____ → ____		
Wear Masks	No Response → Wear Masks		
Switch to Indoor Activities	Outdoor Activities → Indoor Activities		
Apply Protective Measures for Vulnerable Students	No Protection → Apply Protection		

3) Analyze the Results.
※ Students sensitive to fine dust: Students with underlying health conditions such as asthma, allergies, respiratory diseases, or cardiovascular diseases

3-1) Considering the two results together—average exposure and number of highly exposed students—which response strategy was the most effective?

3-3) Which do you think is more appropriate: applying the same response measures to all students or providing additional protective measures for students who are sensitive to fine dust? Explain your reasoning.

3-4) Suggest Ideas to Improve the Model

- What new elements would you like to add to this simulation to better represent real-life situations at your school?
- With the help of generative AI (ChatGPT, Gemini), try adding your proposed idea to the NetLogo model.

① What element would you like to add? Examples: Rain, opening classroom windows, installing air purifiers, etc.	
② How would you control this element?	☐ On/Off button ☐ Slider to adjust a numerical value ☐ Menu to select a condition (e.g., "High Fine Dust Level") ☐ Other: _____
③ Why do you think this element should be added?	

Reference: Learning About NetLogo Simulations

After accessing the link below, select the appropriate file for your computer and install it.
▶ Download link: https://www.netlogo.org/downloads/archive/7.0.2/

1) What Is NetLogo?

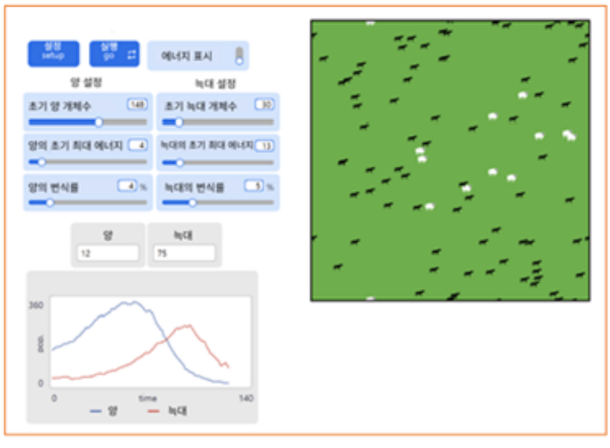
- NetLogo is a program that allows you to simulate real-world phenomena on a computer.
- You can change different conditions, observe how the results change, and explore questions such as, “What would happen under these conditions?”

2) What Types of Agents Are There in NetLogo?

Observer	Starts and manages the entire simulation
Turtles	Agents that move around, such as people, animals, and cars
Patches	Small squares that make up the world and represent environments such as forests, oceans, and roads

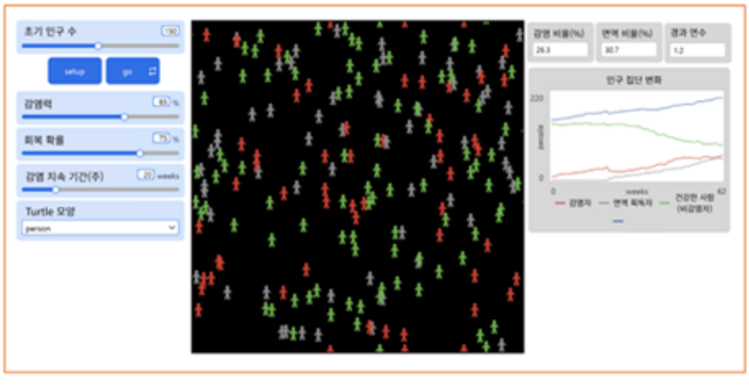
Example 1. Wolf-Sheep Model

- A simulation showing how sheep and wolves interact and how their populations change over time.
- By changing different conditions, you can explore changes in population and the balance of an ecosystem.



Example 2. Disease Spread Model

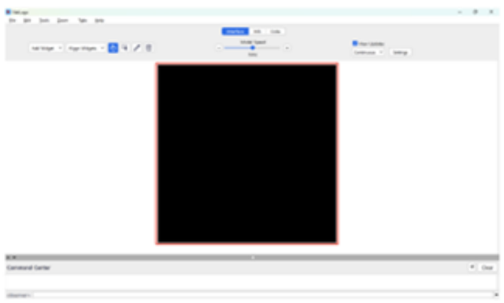
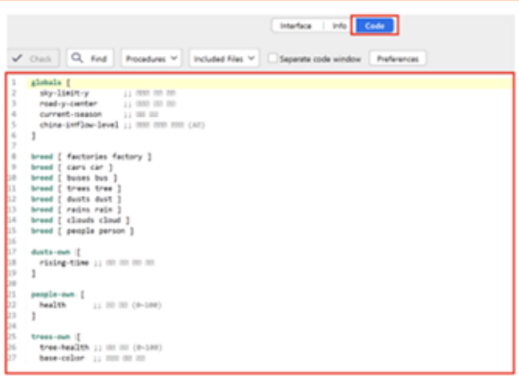
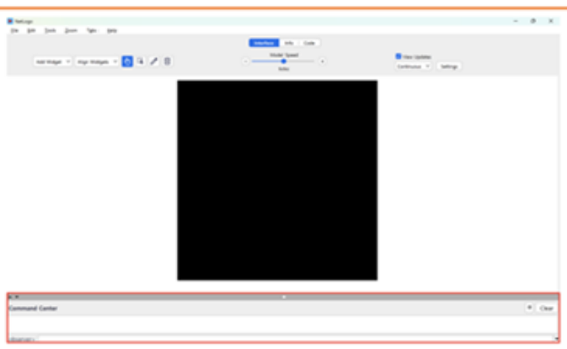
- A simulation showing how an infectious disease spreads and people recover within a population.
- You can explore how the spread of disease changes depending on factors such as the infection rate, recovery rate, and infection duration.



3) How Does NetLogo Work?

- In NetLogo, objects that can move or act on their own—such as people, animals, cars, and viruses—are called agents.
- Each agent can be given simple rules, such as “move,” “eat,” or “gain energy.”
- When many agents interact with one another, various outcomes can emerge. This is called an Agent-Based Model (ABM).
- You can explore how the results change by adjusting conditions using sliders and buttons.

4) How Is the NetLogo Screen Organized?

World : The space where agents move and interact	
Interface : The screen where you can run the simulation and change conditions using buttons and sliders	
Code : The space where you create rules that determine how agents behave	
Command Center : The space where you can enter and immediately run simple commands	

3 Creating Fine Dust Response Guidelines

1) Learning About the Seasonal Fine Dust Management Program

〈Examples〉

Restrictions on Grade 5 vehicles / Suspension of coal-fired power plants /
Enhanced road cleaning / Inspection of facilities used by vulnerable groups /
Distribution of masks to low-income groups and outdoor workers

The Seasonal Fine Dust Management Program is a system that implements stronger fine dust reduction and management measures than usual from _____ to _____, when fine dust concentrations are high.

2) Developing Our School's Response Guidelines
Write one fine dust response measure that you would like to propose to your school or local community.

Who are you proposing it to?	☐ School ☐ Local Community ☐ Students ☐ Parents
What response measure do you propose?	
Why do you think this measure is necessary?	

4 Wrap-Up

- What is something new you learned from today's lesson?

- Why do you think it is important to make decisions based on real air quality data?

- What actions can you take when fine dust levels are high?