

Hazard Literacy Center

Hazard Literacy Education Program

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Secrets Beneath the Ground: Exploring the Principles of Sinkholes



1. Program Overview

This hands-on science program explores the question, "Why do sinkholes suddenly occur?" Students build underground layer models using materials such as sand, water, cotton candy, sugar, and bendable straws to investigate how sinkholes form. By changing experimental conditions and observing differences in the size and timing of sinkhole formation, they identify the factors that influence the process. The program includes exploring real-world sinkhole cases, simulating underground pipe leakage, comparing experimental results, and discussing prevention strategies. Through these inquiry-based activities, students connect scientific concepts to real-world issues while developing scientific inquiry and problem-solving skills.

Grade Level	Grades 4-6 (Elementary School)	Instructional Methods	Lecture, Discussion, Hands-on Experiment
Learning Environment	Classroom or Science Laboratory	Duration	110 minutes (55 minutes × 2 class periods)
Required Materials	Water, colored sand, transparent container with holes, sugar, cotton candy, bendable straws, disposable spoons, colored pens, scissors, and craft materials		

2. Learning Objectives (Hazards Literacy Framework)

① Explain how underground cavities are formed through the movement of water beneath the ground.
② Understand sinkhole formation as the result of multiple interacting factors, including ground conditions, changes in water content, and structural influences, rather than a single cause.
③ Use scientific evidence to identify potential sinkhole hazards in everyday life and propose appropriate prevention strategies.

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													
Objective ②		O	O						O							
Objective ③					O				O					O		

3. Key Concpets

· Underground Structure and Ground Stability

· Groundwater Flow and Cavity Formation

· Load and Collapse Conditions

· Cause–Process–Outcome Relationships in Hazard Events

4. Program Sequence

Learning Activities	
Introduction	·Develop initial hypotheses about "Why do sinkholes suddenly occur?" ·Predict the process of sinkhole formation using a diagram of underground layers
Inquiry 1	·Build an underground layer model in a transparent container ·Represent different soil layers using cotton candy or sugar (soluble layer) and colored sand (stable layer) ·Pour water with a dropper and observe changes inside the model ·Record and explain the process of ground collapse
Inquiry 2	·Identify variables (e.g., amount of water, type of material, layering method) ·Control variables by changing only one factor at a time ·Compare the size and timing of sinkhole formation and analyze the results
Conclusion	·Discuss factors that increase the risk of sinkholes ·Examine real-world examples of urban sinkhole management ·Investigate sinkhole-related issues in the local community ·Propose and share ideas for sinkhole prevention

5. Theoretical Background and Activity Design for Disaster Education

Recent years have seen a steady increase in sinkhole incidents, with groundwater leakage recognized as one of the major causes. According to the Ministry of Trade, Industry and Energy(MOTIE), groundwater leakage in Korea increased by approximately 54.6% between 2020 and 2023, while Seoul recorded an increase of 88.9% during the same period.

As groundwater flows away, soil particles are carried with it, creating underground voids (cavities). Over time, these cavities weaken the ground until it can no longer support the surface load, resulting in sudden ground collapse. Aging underground pipes and excavation associated with urban development also contribute to sinkhole formation. Therefore, sinkholes should be understood not as isolated natural events but as hazards resulting from the interaction of groundwater flow, subsurface structure, and human activities.

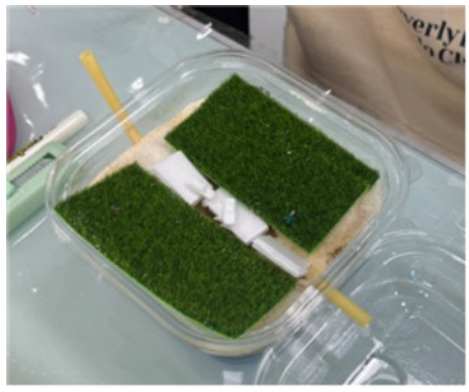

Figure 1. Underground layer model demonstrating cavity formation and ground collapse caused by groundwater leakage.

The model experiment (Figure 1) simplifies and demonstrates this process. The sand layers in the transparent container represent natural soil and subsurface strata, while the central structure and pipe model represent urban underground infrastructure. Water is introduced through a side tube to simulate groundwater leakage, allowing students to observe how water flow alters the underground layers and creates cavities. Through this activity, students understand how invisible subsurface changes gradually lead to ground collapse over time, recognizing sinkholes not as sudden events but as hazards resulting from a connected sequence of cause, process, and outcome.

6. Instructional Considerations

Students should be guided to understand that sinkholes result from the interaction of multiple factors—including groundwater flow, soil properties, and aging underground pipes—rather than a single cause. Teachers should discourage oversimplified explanations such as "sinkholes occur because there is too much water." Since the activity involves water and scissors, appropriate safety instructions should be provided in advance, and the teacher should actively supervise the experiment.

Throughout the inquiry, teachers should use open-ended questions (e.g., "Why does the ground collapse more deeply when cotton candy is placed around the straw?" or "How are underground cavities formed?") to encourage students to explain their observations and reasoning. The activity should conclude with a discussion connecting scientific concepts to real-world infrastructure management and disaster prevention, helping students recognize how scientific knowledge contributes to public safety.

7. References

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- Jeong, S., Jeong, Y., & Kim, D. S. (2017). Trend of Physical Modelling For Ground Subsidence And Study of Its Application. *Journal of Korean Society of Disaster and Security, 10*(1), 1-10.
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Lesson 1: Exploring Sinkholes

Theme	Why Does the Ground Suddenly Collapse?
What Will We Learn?	① Learn about the various causes of sinkholes through real-world examples. ② Investigate the process of sinkhole formation by creating a hands-on model using water, sand, and cotton candy. ③ Predict methods for preventing sinkholes based on scientific principles and compare how different conditions affect sinkhole formation through experiment.

1 Let's Think!

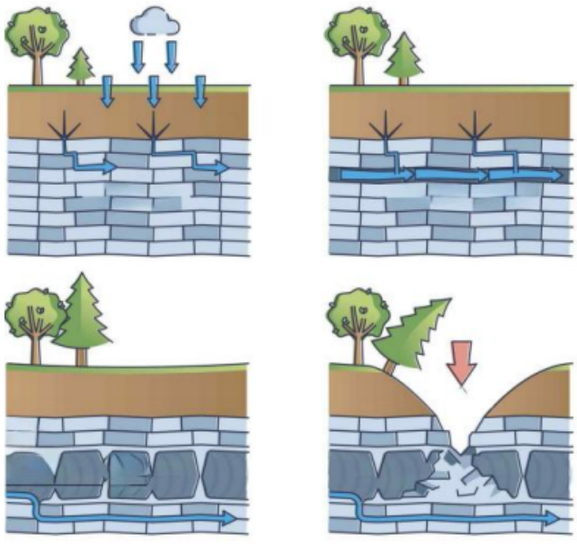
- Have you ever seen a sinkhole (ground subsidence) in real life or on the news? Why do you think the ground suddenly collapses?



2 Let's Think Ahead

- What is a sinkhole (ground subsidence), and why does it occur? Let's find out!

1.





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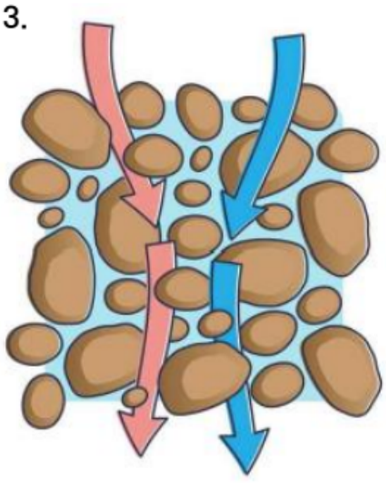

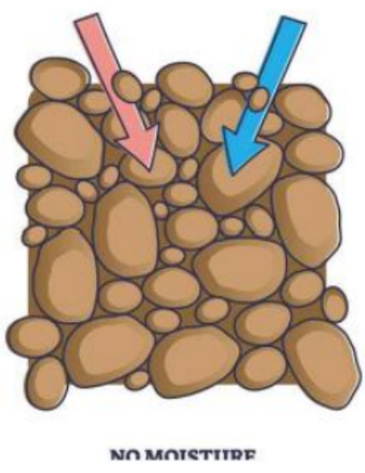

NO MOISTURE

3 Let's Explore

- Activity 1. How Does a Sinkhole Form Due to a Leaking Underground Water Pipe?



- Materials:

Water, colored sand, a transparent square container, sugar, cotton candy, bendable straws, disposable spoons, colored pens, scissors, and craft materials

- Procedure

1. Draw measurement marks on the transparent container with a colored pen and label each underground layer.
2. Fill the container with colored sand to create the underground layers, then place sugar and cotton candy in the middle layer.
3. Insert the bendable straw to represent an underground pipe, and decorate the model to resemble a real road.
4. Slowly pour water through the bendable straw using a disposable spoon and observe the changes inside the container.

- Record Your Observations: What changes did you observe inside the container when water was poured through the disposable spoon?

- Explain the main cause of the sinkhole by relating it to the role of the straw.

Think About It:What do you think will happen to the sinkhole if you change the materials or the way they are stacked?

Activity 2. Make the Sinkhole Smaller Using Different Materials

- Materials:

Water, colored sand, a transparent rectangular container, sugar, cotton candy, a flexible bendy straw, disposable plastic pipettes, colored markers, scissors, and decorative materials.

- Procedure

1. How can you change the materials, the order of the layers, or the way they are stacked to reduce the size of a sinkhole?

What will you change?	How will you change it?	What do you predict will happen?

2. Make another layered earth cup using the condition from Step 1, with all other conditions kept the same.
3. Use a disposable dropper to drip water into the flexible straw and observe what happens.

- Did your prediction match the actual result? If not, what do you think caused the difference?

- How did the size of the sinkhole or the speed at which it formed change because of the condition you changed??

〈Think About It〉 How can we prevent sinkholes in real life?

Activity 3. How Can We Prevent Sinkholes?

- What factors can make sinkholes worse?

- What methods are used in real life to prevent damage caused by sinkholes?



4 Wrap-Up

- What is the empty space that forms underground before a sinkhole appears called?

- Why do sinkholes form? Think back to the experiment and today's lesson, and explain your answer using the word “cavity"

- Scan the QR codes below to find places where sinkholes have occurred in your neighborhood. Then write what you should do if you notice signs of a sinkhole.

Seoul Safety Nuri
Ground Subsidence Map

Nationwide Sinkhole Map

- Write one new thing you learned or something you found interesting in today's lesson.