

Hazard Literacy Center

Hazard Literacy Education Program

Hazard Literacy Center

Why Does the Damage Keep Growing When a City Shakes?



1. Program Overview

This program is designed to help students explore urban disasters caused by earthquakes from a systems perspective. Students begin by comparing earthquake damage in Japan and Türkiye, where earthquakes of similar magnitudes resulted in different levels of damage. Through this comparison, they explore how the severity of earthquake damage is shaped not only by the magnitude of the earthquake itself, but also by the various elements that make up a city and the ways these elements are interconnected.

Next, students predict how changes and disruptions may spread throughout a city following the collapse of buildings. They identify and categorize key elements of an urban system according to their roles, including the natural environment, built environment, urban infrastructure, people and society, disaster response, and disaster impacts. Students then create an urban system map by connecting these elements with arrows. Through this mapping process, they examine how a change in one element can affect others and how earthquake damage can spread and intensify through interconnected parts of the city.

Finally, based on the understanding that earthquakes cannot be predicted with certainty, students take on the role of an urban safety design team. Working within a limited budget, they decide which element of the urban system should be improved first and justify their decision using evidence from their system map. They also predict how improving the selected element could lead to changes across the wider urban system. By comparing their system maps and proposed solutions with those of other groups, students recognize that the same problem can lead to different solutions depending on how the system and its relationships are interpreted.

Through these activities, students develop an understanding that earthquake damage does not simply end with the collapse of buildings. Rather, damage can spread and intensify through interactions among multiple interconnected elements of a city. Ultimately, students explore effective strategies for disaster preparedness, prevention, and response by considering the urban system as a whole.

Grade Level	Grades 6	Instructional Methods	System mapping, discussion, and presentation
Learning Environment	A classroom suitable for group activities and presentations	Duration	80 minutes total (40 minutes × 2 class session)
Required Materials	Worksheets, colored pens (or highlighters), writing tools		

2. Learning Objectives (Hazards Literacy Framework)

① Students will be able to systematically understand how earthquake damage spreads through interactions among various elements of an urban system.

② Students will be able to analyze the connections among elements of an urban system and use a system map to explain how earthquake damage can spread through a chain of interconnected changes.

③ Students will be able to identify priority areas for improvement to reduce earthquake damage, justify their choices based on the urban system, and predict the changes that may result from their proposed improvements.

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	O				O								
Objective ②			O	O			O								O	
Objective ③		O	O			O	O		O	O		O		O	O	O

3. Key Concpets

· Earthquakes and Urban Systems

· Interconnectedness of Urban Elements and Cascading Damage

· Systems Thinking and Leverage Points (Effective Points for Intervention)

4. Program Sequence

Learning Activities	
Introduction	·Compare earthquake cases in Japan and Türkiye and explore differences in the extent of damage. ·Consider why earthquakes of similar magnitudes can result in different levels of damage. ·Introduce the idea that earthquake damage does not end with building collapse.
Activity 1	·Predict cascading changes that may occur throughout a city following building collapse. ·Classify the elements of an urban system into six categories: natural environment, built environment, infrastructure, people and society, disaster response, and disaster impacts.
Activity 2	·Create a system map by connecting urban elements with arrows to represent their influences on one another. ·Analyze key connections within each group's system map and examine how earthquake damage can spread and intensify through the urban system.
Activity 3	·Identify a leverage point—an element that should be improved first—under a limited budget. ·Use the system map to justify the choice and explain the cascading changes expected from the proposed improvement. ·Compare system maps and proposed improvements across groups and explore multiple possible solutions.
Wrap-up	·Summarize how interactions within an urban system can amplify earthquake damage. ·Reflect on earthquake preparedness strategies and areas for improvement in the local community.

5. Theoretical Background and Activity Design for Disaster Education

Earthquakes are a major type of natural hazard, but the extent of actual damage is not determined by earthquake magnitude alone. Various factors—including the safety of buildings, urban infrastructure such as roads and communication networks, disaster response systems, and citizens' level of preparedness—interact with one another to increase or reduce the extent of damage. Therefore, understanding earthquake damage requires an approach that views the city as a system rather than examining individual elements in isolation, with particular attention to the interactions among elements and the cascading changes that may occur throughout the system.

This program is designed to help students understand, through real-world cases, that earthquakes of similar magnitudes can result in different levels of damage depending on a city's structure and disaster response system. Students then classify the elements that make up an urban system according to their roles and represent the connections among these elements using a system map. Through this process, they explore how a change in one element can influence other parts of the system. Finally, within the constraint of a limited budget, students select an element that they believe could most effectively improve urban safety. Using their system maps as evidence, they justify their choice and predict the changes that could result from the proposed improvement, thereby identifying potential leverage points for reducing damage across the urban system.

Through these activities, students develop an understanding that earthquake damage does not simply end with building collapse but can spread and intensify through interactions within an urban system. The program thus provides students with opportunities to analyze hazards and disasters from a systems perspective and to explore possible strategies for reducing disaster risk.

6. Instructional Considerations

Teachers should guide students to understand earthquake damage not as the result of a single factor, but as an outcome of interactions among multiple interconnected elements within an urban system. When students create their system maps, teachers should emphasize that all groups do not need to produce identical maps and that there may be multiple reasonable ways to interpret the connections among urban elements.
Rather than simply listing or connecting elements, students should be encouraged to continually extend their thinking by asking questions such as, “Why are these elements connected?” and “How might this change affect other elements in the system?” During the urban improvement activity, teachers should emphasize that the goal is not to find a single correct answer, but to identify potentially effective points of intervention by considering the urban system as a whole.

Different groups may select different elements as priorities for improvement. Teachers should help students recognize that these differences may arise from how each group interprets the system and which connections they consider most important. During presentations and discussions, students should be encouraged to support their claims with evidence from their system maps and activity results, while respectfully considering and comparing alternative solutions proposed by other groups.

Finally, teachers should emphasize that the exact timing of an earthquake cannot be predicted with certainty. Students should understand that disaster risk reduction involves not only responding after an earthquake occurs, but also strengthening and improving urban systems in advance to prevent or reduce potential damage.

7. References

- Yoo, J. K., Kang, J. D., & Park, S. H. (2021). A preliminary study on the development of educational materials and a training system for earthquake disaster prevention experts in Seoul [In Korean]. The Seoul Institute.
- Mambrey, S., Timm, J., Landskron, J. J., & Schmiemann, P. (2020). The impact of system specifics on systems thinking. Journal of Research in Science Teaching, 57(10), 1632-1651.

When Cities Shake: Why Does the Damage Keep Growing?

Topic	Exploring Earthquake Damage as an Urban System
What Will We Learn?	① Explain how an earthquake can affect various parts of a city, such as buildings, roads, hospitals, and communication systems, in a chain reaction. ② Represent how different elements of a city are interconnected as a system. ③ Identify which elements can be improved most effectively to reduce earthquake damage in a city and explain why.

1 Think About It

- Both countries experienced major earthquakes, but the scale of the damage was different. Why do you think this difference occurred?



Earthquake in Japan

- Some buildings were damaged, but many remained structurally intact.
- Roads and railways were damaged, but infrastructure was restored relatively quickly.
- Many buildings were designed with earthquake-resistant structures.
- Tsunami damage was extremely severe. (Great East Japan Earthquake)

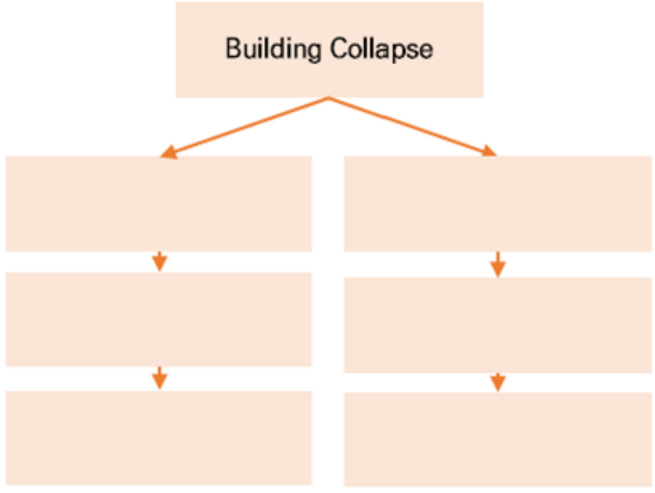


Earthquake in Türkiye

- Many apartment buildings collapsed floor by floor.
- Widespread destruction occurred across entire cities.
- Many older buildings did not meet earthquake-resistant construction standards.
- Building collapse was a major cause of casualties.

2 What Happens to a City After an Earthquake?

- If buildings collapse, what other problems might follow?



3 What Is Connected in a City?

Earthquake damage can become more severe as different elements affect one another.
First, classify the elements that make up a city into the categories below. In the next activity, you will create a system map showing how these elements are connected to one another.

- Classify the elements below according to the role they play.

〈Examples〉

Earthquake / Aftershocks / Old Buildings / Earthquake-Resistant Design / Building Collapse / Roads / Bridges / Electricity / Water Supply / Communication / Fire / Hospitals / Rescue Teams / Shelters / Disaster Preparedness Education / Population Density / Injured People / Rescue Time / Scale of Damage / Recovery Time

Natural Environment (Factors related to the earthquake itself)	Built Environment (Condition and safety of buildings)
Urban Infrastructure (Facilities and systems that keep the city functioning)	People and Society (People living in the city and their level of preparedness)
Disaster Response (Resources used to reduce damage)	Damage Outcomes (Changes that occur after an earthquake)

- Using the city elements you classified above, connect elements that influence one another with arrows (→).
- Work with your group members to complete your city system map.As you make connections, think about “How does one element affect another?”

[Connection Rules]

1. Draw each arrow in the direction of influence.
2. Connect at least two or more elements in a chain.Include and connect elements from all six categories: Natural Environment, Built Environment, Urban Infrastructure, People and Society, Disaster Response, and Damage Outcomes.
3. Use thicker lines or colored markers to indicate the connections you think are most important.

[Think About It]

- Why did the damage continue to grow after the buildings collapsed?

4 How Can We Make the City Safer?

From the city system map you created earlier, you can see that one element can continue to affect other elements.
If so, which element should we improve first to make the city safer? Using the system map you created, identify the most effective way to improve the city.

〈Scenario〉

We cannot predict exactly when an earthquake will occur. Therefore, it is important to make the city safer before an earthquake happens.From now on, you are members of a city safety planning team. However, because the budget is limited, you cannot improve every part of the city at once.

Using the city system map you created earlier, choose one element that should be improved first and explain why.

1) Which element does your group want to improve first?

- ☐ Earthquake-resistant design
- ☐ Roads and bridges
- ☐ Hospitals
- ☐ Communication systems
- ☐ Rescue teams
- ☐ Disaster preparedness education
- ☐ Other: _____

2) Using your system map, explain why you selected this element.
What other elements would be affected if this element were improved?

3) What changes would occur in the city if this element were improved?

※ When describing the expected changes, try using expressions such as: increase / decrease / shorten / extend / improve / reduce / expand / shrink / enhance / worsen

Expected Change	Explain Specifically Using Your System Map

[Think About It]

- How was your group's improvement plan different from those of other groups? Why do you think these differences occurred?

5 Wrap-Up

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

- Which element do you think had the greatest influence in the system map you created today?

- What do you think should be improved first in our school or community to reduce earthquake damage?