Formative Assessment Exemplar - 7.2.3

Introduction:

The following formative assessment exemplar was created by a team of Utah educators to be used as a resource in the classroom. It was reviewed for appropriateness by a Bias and Sensitivity/Special Education team and by state science leaders. While no assessment is perfect, it is intended to be used as a formative tool that enables teachers to obtain evidence of student learning, identify gaps in that learning, and adjust instruction for all three dimensions (i.e., Science and Engineering Practices, Crosscutting Concepts, Disciplinary Core Ideas) included in a specific Science and Engineering Education (SEEd) Standard.

In order to fully assess students' understanding of all three dimensions of a SEEd standard, the assessment is written in a format called a cluster. Each cluster starts with a phenomenon, provides a task statement, necessary supporting information, and a sequenced list of questions using the gather, reason, and communicate model (Moulding et al., 2021) as a way to scaffold student sensemaking. The phenomenon used in an assessment exemplar is an analogous phenomenon (one that should not have been taught during instruction) to assess how well students can transfer and apply their learning in a novel situation. The cluster provides an example of the expected rigor of student learning for all three dimensions of a specific standard. In order to serve this purpose, this assessment is NOT INTENDED TO BE USED AS CURRICULUM.

Because this assessment exemplar is a resource, teachers can choose to use it however they want for formative assessment purposes. It can be adjusted and formatted to fit a teacher's instructional needs. For example, teachers can choose to delete questions, add questions, edit questions, or break the tasks into smaller segments to be given to students over multiple days.

General Format:

Each formative assessment exemplar contains the following components:

1. Teacher Facing Information: This provides teachers with the full cluster as well as additional information including the question types, alignment to three dimensions, and answer key. Additionally, an example of a proficient student answer and a proficiency scale for all three dimensions are included to support the evaluation of the last item of the assessment.
2. Students Facing Assessment: This is what the student may see. It is in a form that can be printed or uploaded to a learning platform. (Exception: Questions including simulations will need technology to utilize during assessment.)

Accommodation Considerations:

Teachers should consider possible common ways to provide accommodations for students with disabilities, English language learners, students with diverse needs or students from different cultural backgrounds. For example, these accommodations may include: Providing academic language supports, presenting sentence stems, or reading aloud to students. All students should be allowed access to a dictionary.

References:

Moulding, B., Huff, K., & Van der Veen, W. (2021). *Engaging Students in Science Investigation Using GRC*. Ogden, UT: ELM Tree Publishing.

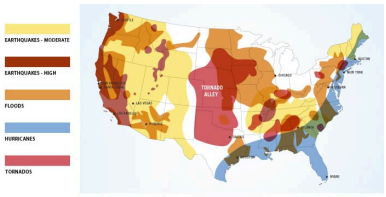
Teacher Facing Information

Standard: 7.2.3

Ask questions to *identify constraints* of specific geologic hazards and *evaluate competing design solutions* for maintaining the stability of human-engineered structures such as homes, roads and bridges. Examples of geologic hazards could include earthquakes, landslides, or floods. (ESS3.B, ETS1.A, ETS1.B, ETS1.C)

Assessment Format: Printable or Online Format (Does not require students to have online access)

<table>
<tr><th colspan="2">Phenomenon</th></tr>
<tr><td>Natural disasters are universal. People everywhere design structures to cope with these disasters.

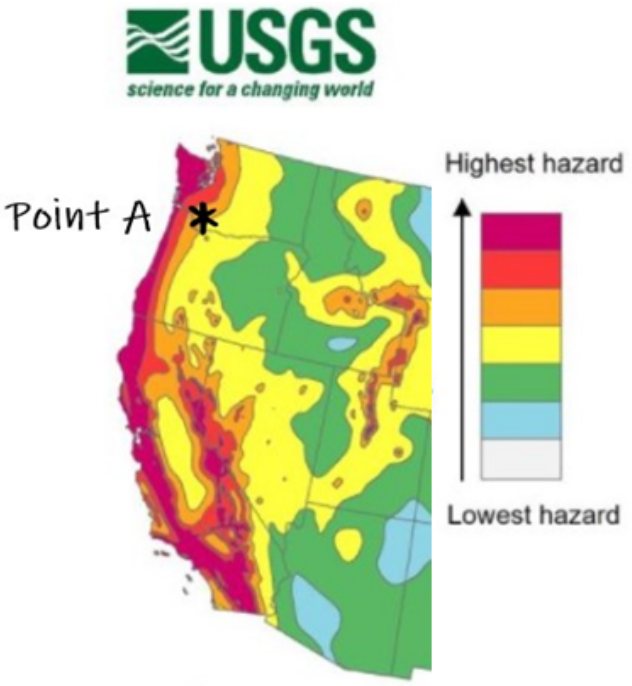
Figure 1 - Natural Hazards of the United States
 

This map shows the areas where different types of natural hazards are more common.</td><td>Proficient Student Explanation of Phenomenon:

Not every solution works for every hazard. Design solutions are unique and specific to the hazard they address. Buildings are designed to handle the hazards most common to where they are located.

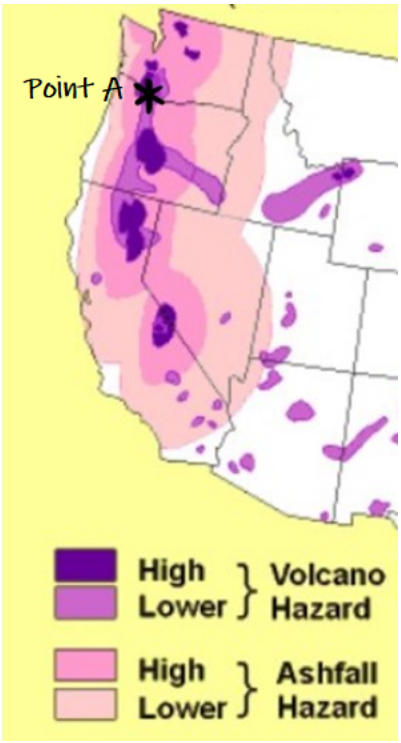
Design solutions for Earthquakes need to handle shaking- base isolators, reinforced concrete
Design solutions for Tsunamis would raise structures off the ground with stilts, cross braces, reinforced concrete
Design solutions for volcanoes- evacuate! ,reinforced metal roof for ash</td></tr>
<tr><th colspan="2">Cluster Task Statement</th></tr>
<tr><td colspan="2">(Represents the ultimate way the phenomenon will be explained or the design problem will be addressed)

In the questions that follow, you will identify appropriate solutions for specific geologic hazards common in Washington State (point A). Your task will be to choose appropriate design solutions for keeping buildings stable during the geologic hazards for a location.</td></tr>
<tr><th colspan="2">Supporting Information</th></tr>
<tr><td colspan="2">Figure 2 - Western US Earthquake Hazard Map</td></tr>
</table>



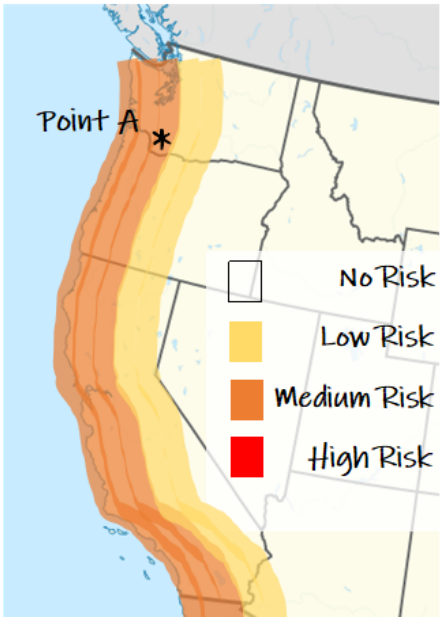
This map shows a ranking of the severity of earthquakes in the Western United States.

Figure 3 - Western US Volcano Hazard Map



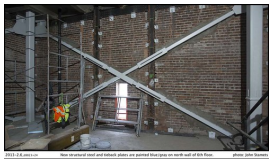
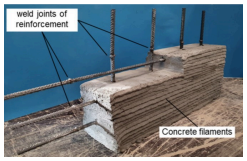
This map shows a ranking of the possibility of volcanoes in the Western United States.

Figure 4 - Western US Tsunami Hazard Map



This map shows a ranking of the risk of Tsunamis in the western United States.

Table 1: Hazard Design Strategies for Stable Structures

Build Strategy	Image	Description
Base Isolators		A collection of a building's structural elements resting on its foundation to provide partial separation of the building from shaking ground.
Stilts		Poles, posts or pillars that lift a building to keep it a safe distance above the ground or water.
Cross-bracing		Two metal supports placed diagonally between two walls to form an X-shape.
Reinforced Concrete		Concrete that has metal rods placed inside it to increase its strength and stability.
Steep-sloped, Metal Roof		Material slides off steep, sturdy surface of roof instead of forming heavy piles.

Cluster Questions

Gather:
Cluster Question #___1___
Question Type: Table Match
Addresses:
__x__ DCI: ESS3.B
__X__ SEP: analyzing and interpreting data
__x__ CCC: Patterns
Answer:

Hazard	Looking at point A, select the level of risk for each hazard.		
	No to Low risk	Low to Medium risk	Medium to High risk
Earthquake Figure 1			x
Volcano Figure 2			X
Tsunami Figure 3		X	

Question 1:

Please locate point A on the maps in Figures 2-4 (marked with a black asterix). How severe is the risk for each hazard in this location?

Hazard	Looking at point A, select the level of risk for each hazard.		
	No to Low risk	Low to Medium risk	Medium to High risk
Earthquake Figure 1			
Volcano Figure 2			
Tsunami Figure 3			

Gather:
Cluster Question #___2___
Question Type: Table Match
Addresses:
__x__ DCI: ESS3.B
__x__ SEP: Analyze and Interpret data

Question 2:

Based on the information in Table 1, stilts would be helpful to protect a house from which of the following hazards?

a) Water
b) Lava
c) Earthquakes

____ CCC:
Answer: a) water

d) Wind

Gather:
Cluster Question #___3___
Question Type: Table Match
Addresses:
__x__ DCI: ESS3.B
__x__ SEP: Analyze and Interpret data
__x__ CCC: Patterns
Answer:

Hazard	Hazards affecting Point A		
	Volcano	Earthquake	Tsunami
Base Isolators		X	
Stilts			x
Cross-bracing		x	x
Reinforced Concrete Structure	x	x	X
Steep-sloped, Metal Roof	x		

Question 3:

Based on Table 1 - Hazard Design Strategies select any design strategies that would be helpful for each hazard. (Select as many as apply for each hazard.)

Design Strategy	Hazards affecting Point A		
	Volcano	Earthquake	Tsunami
Base isolators			
Stilts			
Cross-bracing			
Reinforced Concrete structure			
Steep-sloped, Metal Roof			

Reasoning:
Cluster Question #___4___
Question Type: Long Answer

Question 4:

Pick the two hazards affecting Point A that are the biggest problem

Addresses: __x__ DCI: ESS3.B __x__ SEP: Analyzing and interpreting data __x__ CCC: Size and Scale Answer: Earthquakes and volcanoes are the two most dangerous hazards at point A. This is because (*answers will vary*).	for the stability of buildings. Explain what makes these two hazards the most dangerous in two to three complete sentences.
Reasoning: Cluster Question #___5___ Question Type: Long Answer Addresses: __x__ DCI: ESS3.B __x__ SEP: Asking Questions ____ CCC Answer: Answers may vary. Students should ask questions that correlate with the hazards they selected in #4.	Question 5: The design strategies listed in Table 1 are expensive. For a building to be affordable, only some can be used. What additional information would you want to know about these strategies to help you decide which ones to use for the two natural hazards you selected in question 4? Please list 2-3 things you would want to know before you decide. 1. 2. 3.
Communicate: Cluster Question #___6___ Question Type: Long Answer Addresses: __x__ DCI: ESS3.B __x__ SEP: Designing solutions __s__ CCC: Stability and change Answer: Answers may vary. Students should choose strategies that correlate with the hazards they selected in #4.	Question 6: Which **two** strategies would you use to protect the stability of your building? Please explain why you picked those strategies in 2-3 complete sentences. 1. I would use _____ in my building because _____ _____ _____ _____ _____ 2. I would use _____ in my building because _____ _____ _____ _____ _____
Communicate:	Question 7:

Cluster Question #___7___ Question Type: Long Answer Addresses: __x__ DCI: ESS3.B __x__ SEP: Designing solutions __x__ CCC: Stability and change Answer: Answers will vary. Students should identify weaknesses in the strategies or reasons why they don't relate to the hazards they selected in #4.	Of the three strategies you decided you wouldn't use in your building, please explain the reasons why you decided **not** to use those strategies. 1. I decided not to use _____ because_____ _____ 2. I decided not to use _____ because _____ _____ 3. I decided not to use _____ because _____ _____

Proficiency Scale

Proficient Student Explanation:

I would use reinforced concrete in my design. It protects against all three types of hazards and increases the stability of the design. I would not use stilts, because they would not protect against earthquakes or volcanoes.

Level 1 - Emerging	Level 2 - Partially Proficient	Level 3 - Proficient	Level 4 - Extending
SEP: Does not meet the minimum standard to receive a 2.	**SEP:** Ask questions about what would happen if a variable is changed. Identify scientific (testable) and non-scientific	**SEP:** Ask questions that arise from careful observation of phenomena, models, or unexpected results, to clarify and/or seek additional information. Ask questions to identify and/or clarify evidence and/or the premise(s) of an argument. Ask questions to determine relationships between	**SEP:** Extends beyond proficient in any way.

	(non-testable) questions. Ask questions that can be investigated and predict reasonable outcomes based on patterns such as cause and effect relationships. Use prior knowledge to describe problems that can be solved. Define a simple design problem that can be solved through the development of an object, tool, process, or system and includes several criteria for success and constraints on	independent and dependent variables and relationships in models. Ask questions to clarify and/or refine a model, an explanation, or an engineering problem. Ask questions that require sufficient and appropriate empirical evidence to answer. Ask questions that can be investigated within the scope of the classroom, outdoor environment, and museums and other public facilities with available resources and, when appropriate, frame a hypothesis based on observations and scientific principles. Ask questions that challenge the premise(s) of an argument or the interpretation of a data set. Define a design problem that can be solved through the development of an object, tool, process or system and includes multiple criteria and constraints, including	

	materials, time, or cost	scientific knowledge that may limit possible solutions.	
CCC: Does not meet the minimum standard to receive a 2.	**CCC:** Identifies change is measured in terms of differences over time and may occur at different rates. Recognizes some systems appear stable, but over long periods of time will eventually change.	**CCC:** Explains how stability and change can be constructed in natural or designed systems and examines the changes over time and forces at different scales, including the atomic scale. Understands how small changes in one part of a system might cause large changes in another part. Recognizes that stability might be disturbed either by sudden events or gradual changes that accumulate over time. Recognizes that systems in dynamic equilibrium are stable due to a balance of feedback mechanisms.	**CCC:** Extends beyond proficient in any way.
DCI: Does not meet the minimum standard to receive a 2.	**DCI:** The locations of mountain ranges, deep ocean trenches, ocean floor structures, earthquakes, and volcanoes occur in	**DCI:** Maps of ancient land and water patterns, based on investigations of rocks and fossils, make clear	**DCI:** Extends beyond proficient in any way.

	patterns. Most earthquakes and volcanoes occur in bands that are often along the boundaries between continents and oceans. Major mountain chains form inside continents or near their edges. Maps can help locate the different land and water features areas of Earth.	how Earth's plates have moved great distances, collided, and spread apart.	

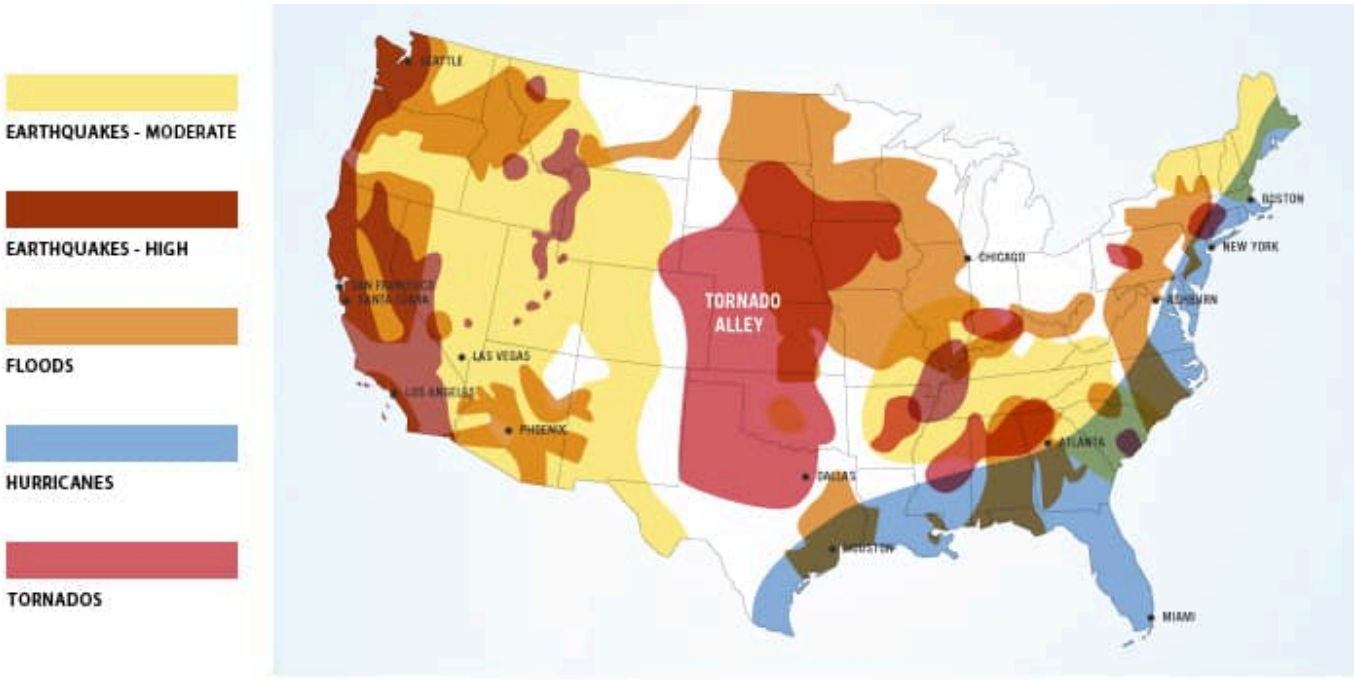
(Student Facing Format on following page)

Name: _____ Date: _____

Stimulus

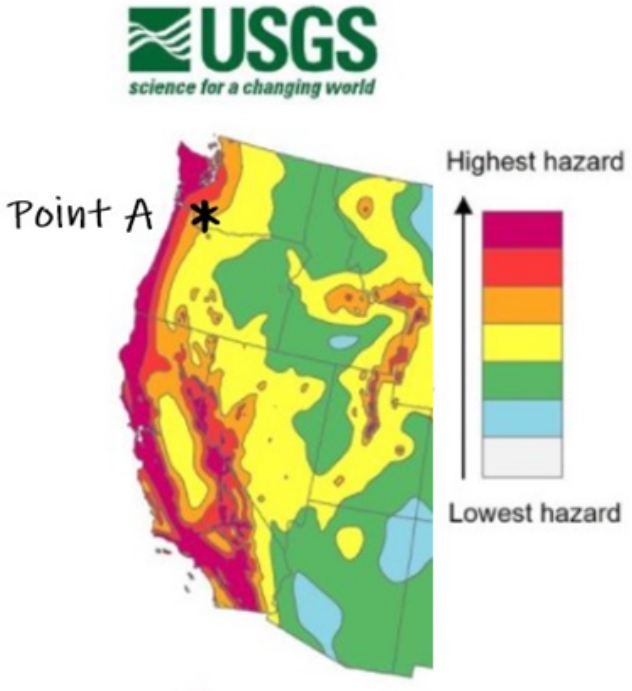
Natural disasters are universal. People everywhere design structures to cope with these disasters.

Figure 1 - Natural Hazards of the United States



This map shows the areas where different types of natural hazards are more common.

Figure 2 - Western US Earthquake Hazard Map

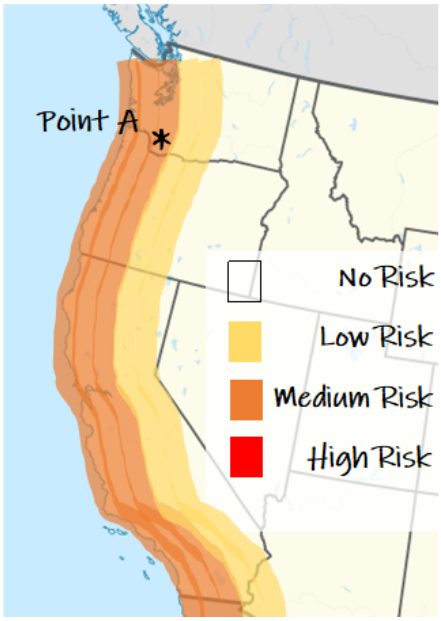


This map shows a ranking of the severity of earthquakes in the Western United States.

Figure 3 - Western US Volcano Hazard Map

This map shows a ranking of the possibility of volcanoes in the Western United States.

Figure 4 - Western US Tsunami Hazard Map



This map shows a ranking of the risk of Tsunamis in the western United States.

Table 1: Hazard Design Strategies for Stable Structures

Build Strategy	Image	Description
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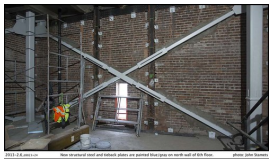
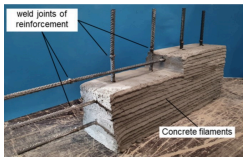
Cross-bracing		Two metal supports placed diagonally between two walls to form an X-shape.
Reinforced Concrete		Concrete that has metal rods placed inside it to increase its strength and stability.
Steep-sloped, Metal Roof		Material slides off steep, sturdy surface of roof instead of forming heavy piles.

Your Task

In the questions that follow, you will identify appropriate solutions for specific geologic hazards common in Washington State (point A). Your task will be to choose appropriate design solutions for keeping buildings stable during the geologic hazards for a location.

Question 1

Please locate point A on the maps in **Figures 2-4** (marked with a black asterix). How severe is the risk for each hazard in this location?

Hazard	Looking at point A, select the level of risk for each hazard.		
	No to Low risk	Low to Medium risk	Medium to High risk
Earthquake, Figure 2			
Volcano, Figure 3			
Tsunami, Figure 4			

Question 2

Based on the information in Table 1, stilts would be helpful to protect a house from which of the following hazards?

A. Water

B. Lava

C. Earthquakes

D. Wind

Question 3

Based on **Table 1 - Hazard Design Strategie**s select any design strategies that would be helpful for each hazard. (Select as many as apply for each hazard.)

Design Strategy	**Hazards affecting Point A**		
	Volcano	Earthquake	Tsunami
Base isolators			
Stilts			
Cross-bracing			
Reinforced Concrete structure			
Steep-sloped, Metal Roof			

Question 4

Pick the two hazards affecting Point A that are the biggest problem for the stability of buildings. Explain what makes these two hazards the most dangerous in two to three complete sentences.

_____

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Question 5

The design strategies listed in Table 1 are expensive. For a building to be affordable, only some can be used. What three pieces of additional information would you want to know about these strategies to help you decide which ones to use for the two natural hazards you selected in question 4?

1._____

2._____

3._____

Question 6

Which two strategies would you use to protect the stability of your building? Please explain why you picked those strategies in 2-3 complete sentences.

I would use _____ in my building because _____

_____

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I would use _____ in my building because _____

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Question 7

Of the three strategies you decided you wouldn't use in your building, please explain the reasons why you decided **not** to use those strategies.

I decided not to use _____ in my building because _____

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I decided not to use _____ in my building because _____

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I decided not to use _____ in my building because _____

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