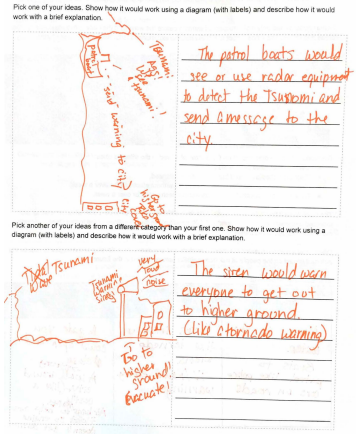
UNIT STORYLINE

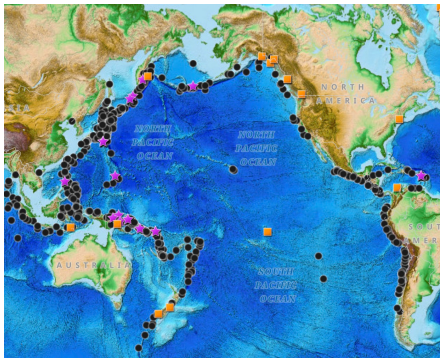
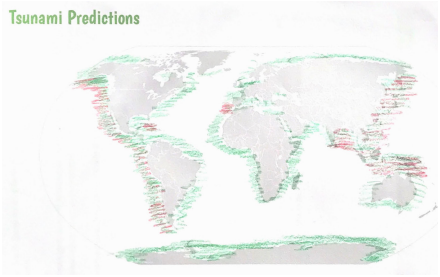
How students will engage with each of the phenomena

HANDS-ON/ LAB ACTIVITIES | VIDEOS OR IMAGES | DATA SETS | READINGS | COMPUTER INTERACTIVES

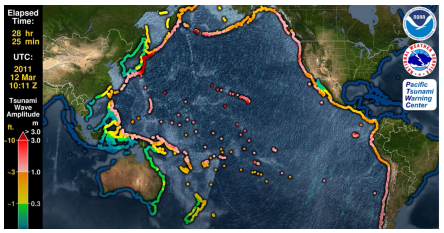
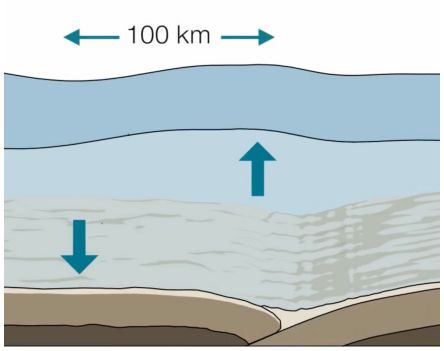
Unit Question: Where do natural hazards happen and how do we prepare for them?

Lesson Question	Phenomena or Design Problem	What we do and figure out	How we represent it
LESSON 1 3 days **What happens to a community when a tsunami occurs?** Anchoring Phenomenon	 *Triggered by a strong earthquake in the Pacific Ocean in 2011, a massive tsunami caused loss of life and damage to structures along Japan's entire east coast.*	We read about and watch the 2011 tsunami triggered by an earthquake off the eastern coast of Japan, causing devastating loss of life and structural damage. We develop initial engineering ideas intended to detect tsunamis, provide warning of their approach, and reduce their impact. We think about what makes some engineering ideas more promising or challenging than others. We brainstorm related natural hazards and ask questions to generate a list of data and information we need to better understand where these hazards occur and how we can prepare for them. We figure out: • A tsunami is a large wave that results from movement of the ocean floor. • Tsunamis cause major flooding that damages homes and property and harms people in the community. • Proposed solutions include a system of detection sensors, warning plans, and design solutions to reduce damage.	

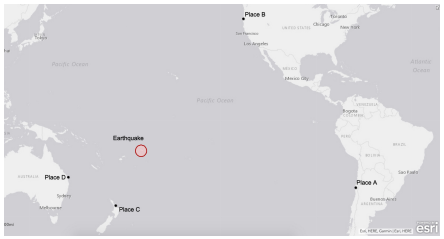
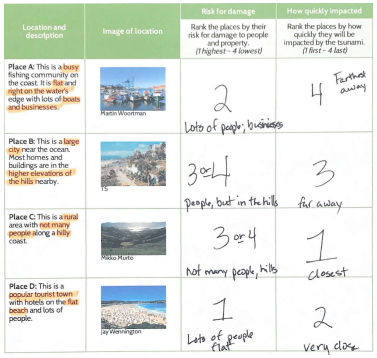
⇓ **Navigation to Next Lesson:** We are wondering where tsunamis happen in the world, because knowing this can help us understand how those communities can prepare for them.

LESSON 2 2 days **Where do tsunamis happen and what causes them?** Investigation	 *Data reveal patterns in the locations and causes of tsunamis.*	We investigate historical tsunami data and figure out spatial patterns for where tsunamis occur and that most are caused by earthquakes. We use digital tools, analyze maps and graphs, and notice that only certain types of earthquakes cause tsunamis. We establish a cause-and-effect relationship between types of earthquakes and tsunami formation. We use this relationship to forecast the locations that may be at risk for future tsunamis. We figure out these things: • Tsunamis form as a result of earthquakes, volcanic eruptions, and landslides. • Stronger, shallow earthquakes tend to be most related to tsunami formation. • Almost all tsunamis occur along plate boundaries where the plates are colliding. • Data about where tsunamis have occurred in the past help to forecast where they might happen in the future.	

⇓ **Navigation to Next Lesson:** We figured out that most tsunamis form because of strong, shallow earthquakes along colliding plate boundaries, but we wonder how these types of earthquakes form a tsunami.

Lesson Question	Phenomena or Design Problem	What we do and figure out	How we represent it
LESSON 3 3 days **What causes a tsunami to form and move?** Investigation	 *Analyze and evaluate different wave models.*	We analyze three wave models to make sense of how an earthquake-driven tsunami forms and moves to shore. We use different perspectives to understand various aspects of the phenomena, and then we identify benefits and limitations of each model. We figure out these things: • Physical waves form from a single point of movement, and then move outward in a circular pattern. • The bigger the movement of the ocean floor, the greater the movement of the water above it. • When a wave approaches shore, it gets taller until it reaches the shore, where it collapses and flows, or runs up onto the shore. • The bigger the wave is when it reaches shore, the farther onto the land the water will flow. • As waves move and interact with surrounding land at the shore and in the ocean, they transfer energy to the land and reflect off its surface. As this continues, the waves get smaller and smaller due to losing energy that has been transferred to their surroundings.	 *Commonwealth of Australia (Geoscience Australia).*

⇓ **Navigation to Next Lesson:** We want to know what happens to communities as a tsunami meets the shore so we can find ways to protect them.

LESSON 4 1 day **How can we forecast where and when tsunamis will happen and which communities are at risk?** Putting Pieces Together	 *An earthquake occurs that could affect communities around the Pacific Ocean.*	Using the Tsunami Chain of Events poster as evidence from previous lessons, we construct an explanation that describes the geologic changes that cause a tsunami. Then we use what we know about tsunamis--where they happen and what causes them--to consider how to protect people and property from their effects. We revisit the DQB to determine which questions we are now able to answer and document responses for each question. We figure out these things: • Places with more people, closer to water, or at low elevations have greater risk for a tsunami to cause damage. • We can use science ideas to forecast tsunamis and predict which areas will experience damage to people and property.	

⇓ **Navigation to Next Lesson:** Now that we understand what causes tsunamis, where they happen, how they move, and how they impact coastal communities, we are wondering about solutions to protect communities.

Lesson Question	Phenomena or Design Problem	What we do and figure out	How we represent it

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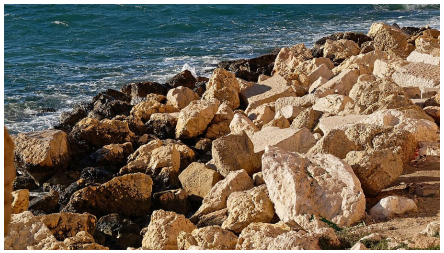
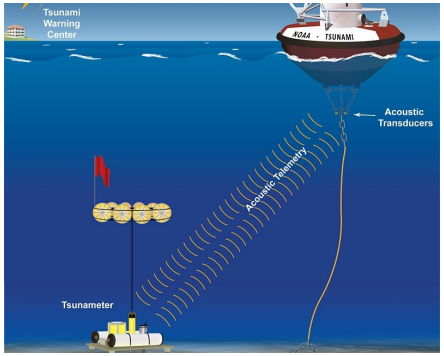
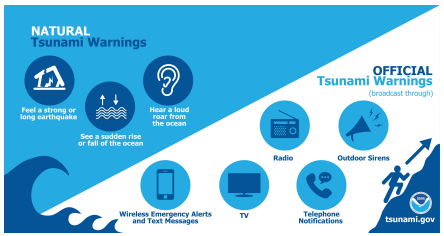
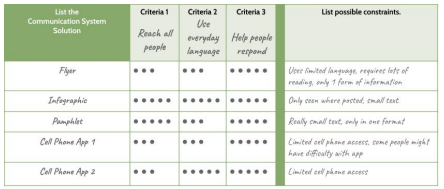
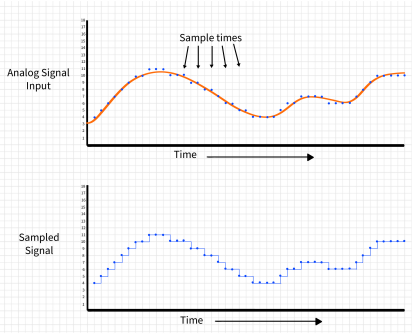
LESSON 5 3 days **How can we reduce damage from a tsunami wave?** Investigation	 *Many design solutions exist to reduce the damage from tsunami waves.*	We revisit the coastal communities of Japan that were affected by the 2011 tsunami to evaluate existing solutions. We define our problem, identify criteria and constraints, and evaluate each solution using a systematic process. We consider what it means for a solution to be promising for one community versus another. We figure out: • Engineers account for relevant scientific principles and potential impacts on people and the natural environment when designing and evaluating solutions. • Clearly identifying the design problem, criteria, and constraints allows for the evaluation of solutions and increases the likelihood that a solution will meet the needs of communities at risk. • Effective solutions to reduce damage from tsunamis need to not only dissipate the energy of the wave and deflect the water, but also meet the needs of communities at risk.	
⇓ **Navigation to Next Lesson:** Sometimes tsunami solutions fail, so we are wondering what else we can do to protect communities when a tsunami happens.			
LESSON 6 1 day **How are tsunamis detected and warning signals sent?** Investigation	 *A complex system exists to detect and warn people of tsunamis.*	We read about how tsunamis are detected using a complex system of instruments set up on land (seismometers), on the ocean surface (surface buoys), on the ocean floor (tsunameters), and in space (satellites). We read that tsunami warnings are sent only when specific sets of criteria are met, first regarding the location, strength, and depth of the earthquake that is detected, and then regarding whether the tsunami is expected to reach land. We figure out these things: • Tsunamis happen suddenly and can travel at high speeds over great distances. Depending on where the tsunami forms, communities have more or less time to respond. • To help prevent or reduce loss of life, we need to detect a tsunami quickly and accurately in order to provide timely information to an at-risk community. • Criteria and constraints for a tsunami detection system must consider the available scientific information (earthquake data) and design limitations (signal transmission through air and water).	*A complex system with many parts (some on land, some in space, and some on the ocean surface and ocean floor) is designed to detect tsunamis, predict whether they will reach land, and then send a warning.*
⇓ **Navigation to Next Lesson:** We are wondering what people do when a tsunami is detected and the warning signal is sent. How do they respond?			

Lesson Question	Phenomena or Design Problem	What we do and figure out	How we represent it
LESSON 7 2 days **What are ways we can communicate with people before and during a tsunami?** Investigation	 *Communication systems warn people to respond when a tsunami approaches.*	We listen to a tsunami warning signal and read accounts of tsunami survivors from Japan. We identify stakeholders who the warning signal must work for, and then develop criteria and constraints for tsunami communication. We evaluate different communication options based on stakeholder needs. From this we learn that there are many ways to communicate with different stakeholders before and during a tsunami event. We figure out the following: • Groups of people can be affected by hazards in different ways. People particularly at-risk during a hazard are older people, children, people who speak a different language, and those who are sick or need assistance. • Effective plans account for the people living in a place and the resources communities have to respond. • A variety of communication strategies and modalities are necessary to ensure that all people at risk receive the warning. • Communication strategies include educating the community before a natural hazard happens.	
⇓ **Navigation to Next Lesson:** All the coastal towns in Japan had different systems in place. We are wondering how they all work together to protect communities.			
LESSON 8 1 day **Which emergency communication systems are the most reliable in a hazard?** Investigation	 *Different communication systems and signals have advantages and disadvantages in how they alert people.*	We consider the ways in which people are alerted during a hazard and what would make a warning system reliable. We read about analog and digital signals and discuss what forms of communication best meet the needs and are most reliable for multiple stakeholder groups. We figure out: • Communication technologies use different equipment and signals to transmit and receive information during a hazard. • Digital signals use technology that makes them more reliable means of communication than analog signals. • A combination of communication technologies are important to use during a hazard to ensure as many people receive the warning messages as possible.	
⇓ **Navigation to Next Lesson:** We figured out that we need a combination of communication technologies to warn people during a hazard, but how does this system of communication work within the larger hazard response system?			

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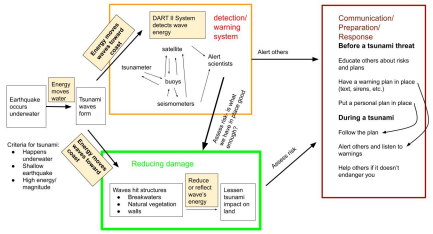
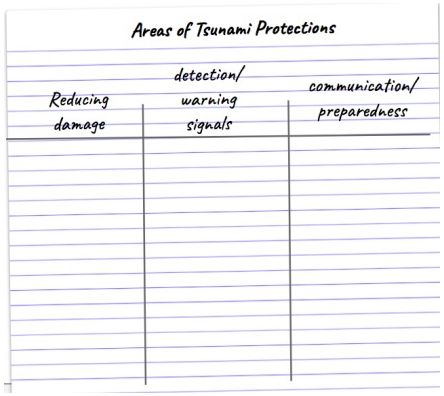
LESSON 9 1 day **How can we model the systems put into place to protect communities?** Putting Pieces Together	 *Tsunami systems consist of many subsystems working together to meet the overall criteria of the community.*	We develop a tsunami system model. We analyze the model to determine the importance and interactions of the various subsystems. We develop a process engineers use to solve problems and determine we can use our ideas to prepare for a hazard that is important to us. We figure out the following: • Engineers can design a system for responding to hazards that includes design solutions to forecast, detect, warn and communicate with people, and reduce damage. • Each part of the system is dependent on another part of the system; subsystems work together to meet the criteria for the overall system. • Engineers engage in a generalized process to define problems, develop solutions, and optimize those solutions.	
⇓ **Navigation to Next Lesson:** We have learned about systems in place to protect against tsunamis. Can we use this same approach to prepare for a natural hazard important to us?			
LESSON 10 4 days **How can we effectively prepare our communities for a natural hazard?** Putting Pieces Together	 *Local communities are at risk of other types of natural hazards.*	We investigate the general patterns of risk of other natural hazards in the United States and determine our local level of risk for each hazard. We choose a natural hazard, gather information, and plan for communication to an identified stakeholder community at risk for the hazard. We evaluate our final plans and products using constraints and criteria for effective communication with our stakeholder groups. We figure out: • All communities are impacted by natural hazards with different levels of risk, and these hazards often require different ways to detect risk, warn people, and reduce damage. • Knowledge about hazards (the causes of the hazard, locations at greater or lesser risk, how to design solutions, and how to respond when it happens) can empower us and others to design solutions to save lives. • Effective communication and response plans account for the needs of people living in a place and the available resources to respond. • Communication strategies include educating the community before a natural hazard happens and alerting people when the hazard is happening.	 *Copyright 2022 Oregon Department of Emergency Management and Dark Horse Comics.*

LESSONS 1-10
21 days total