UNIT OVERVIEW Mitigating the Effects of Natural Hazards

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Anchoring Phenomenon: Worldwide, between 1970-1979, there were 711 climate-related natural hazards and between 2010-2022 there were 3,165 climate-related natural hazards. (Source: World Meteorological Organization and Our World in Data)

Design Problem: How can we design early warning systems to increase community resilience and mitigate the effects of natural hazards caused by climate change?

Lesson Title and Question	Lesson Snapshot	What Students will Figure Out
LESSON ONE **Define the Problem** *How has the impact of natural hazards on human populations changed between 1970 - 2022?* **1 45-minute class period** 	Students are introduced to the problem of natural hazards increasing worldwide over time due to climate change. Students analyze data to figure out that increased temperatures lead to increased evaporation rates and increased water vapor in the air. Students develop an understanding of how each natural hazard connects to climate change and then consider how Early Warning Systems can protect people from natural hazards. Students generate questions about how early warning systems work and consider obstacles to access.	**Students figure out:** ● Increased temperatures lead to increased evaporation rates and more water vapor in the atmosphere. ● Evaporation happens in all areas, but more moist conditions have higher evaporation rates than drier conditions. ● In dry areas without rain, increased evaporation leads to droughts and wildfires. ● In wet areas with rain, increased evaporation leads to more rain and floods. ● An Early Warning System (EWS) is a type of technology that can help protect people and save lives by mitigating the effect of natural disasters. ● Currently, not everyone has equal access to early warning systems

<table>
<tr><td colspan="3">Navigation to Lesson 2: We have a lot of questions about the parts of an EWS. Let’s take a look at some existing solutions to learn more about them.</td></tr>
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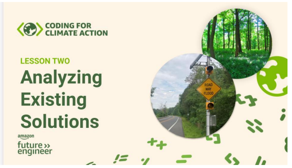
<td>LESSON TWO
Analyzing Existing Solutions

What types of Early Warning Systems already exist?

1 45-minute class period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<td>In this lesson, students will be introduced to computational thinking and the engineering design process. Both will be used to help guide our research, design, build, testing, and sharing the results of our Early Warning Systems design solutions. Students will spend this entire lesson in their Computational Thinking and Engineering Journals as the teacher presents information on three existing Early Warning Systems. Students will analyze the information presented and models provided to determine the common parts and functions of all Early Warning Systems. This will begin our research phase of the engineering design process while also using the computational thinking concepts of evaluation and looking for patterns.</td>
<td>Students figure out:
● Understanding more about Early Warning Systems (EWSs) will help us design a solution to help protect everyone in a community.
● EWSs have similar parts and functions including sensors to sense the danger, a way to send/process data (cloud computing, sent over Internet), and a way to send communication to the end user (phones, loud speakers).
● EWSs require computer programmers and engineers to build the system.
● EWSs can be improved to help even more people.
● We can use computational thinking concepts to analyze Early Warning Systems.</td>
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<tr><td colspan="3">Navigation to Lesson 3: Many of the questions and ideas you shared are related to the inputs and outputs of an early warning system so let’s explore that next!</td></tr>
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<td>LESSON THREE
Researching micro:bit Inputs and Outputs

How could we use the micro:bit to design an early warning system and increase accessibility?

2 45-minute class periods


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<td>Students will be provided a real world example of a warning sign that uses flashing lights to help warn people that a road is flooded. This leads into a three part design challenge where students will learn the basic logic and structure of creating code sequences for the micro:bit to create a flashing sign. Students will learn the difference between hardware and software and will test their code (software) by downloading to the micro:bit (hardware). They will experience the efficiency of using loops to repeat code. Students will also learn how to add music to increase accessibility and code button inputs to display LED lights and sound outputs. Students will then reflect in their journals on the pros and cons (regarding accessibility) of different outputs and on the computational thinking skills used in this lesson.</td>
<td>Students figure out:
● Computer science will help us design our early warning system.
● Outputs such as LED lights and sound can be used as an alert system.
● Using more than one type of output will increase the accessibility of the EWS.</td>
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Navigation to Lesson 4: We have just begun to learn how to code the micro:bit. Looking back at our questions, it seems like we might want to learn more about different sensors that we could use to design our early warning system.

LESSON FOUR **Researching micro:bit Sensors** *How can we build a system that continually monitors the environment to detect danger and warn communities?* **2 45-minute class periods**  	In part 1, students learn how to fix the problem experienced with the code in Lesson 4. They will begin by creating and setting variables to store information that changes in an algorithm. In this case, they are setting the variable to Danger = 1 when danger is detected and setting the variable to Danger = 0 when no danger is detected. They will also learn how to use conditional blocks to detect the danger and trigger the variable to run the code using the input buttons. In part 2, students will learn to use the logic comparison blocks with sensors to tell the computer to check for a certain condition. They also learn how to write comments to help explain the function for each set of code. A jigsaw activity is used to help students write code and test different sensors. These directions will become a useful resource when students design and build their own system in Lesson 8.	**Students figure out:** ● Sensors measure inputs (signals) from the environment (light energy, gravitational pull, temperature) and convert into data for the computer to read. ● Computers use data to trigger outputs when conditions are met. ● Sensors are useful to help us design an Early Warning System in order to measure changes in the environment related to natural hazards.

Navigation to Lesson 5: *After reflection, students determine they need a way to detect flooding and droughts. How could microbit to monitor those hazards?*

LESSON FIVE **Researching micro:bit Pins** *How can we measure water levels in the environment using micro:bits?* **2 45-minute class periods**  	Students read about a real world example of an Early Warning System that monitors water levels called StormSense. Students will then learn how to use the input pins on the micro:bit to measure when electricity completes an electric circuit using the pin pressed blocks of code. Students will create a conductivity tester to figure out whether certain materials are conductors or insulators. They will then build a program to use the pins to measure water levels through the detection of an electric circuit. A teacher demonstration may be done with water to show how water acts as a conductor to transfer electricity. Students build the program to measure water levels but use aluminum foil to represent water as the conductor. If time provides, students engage in the extension activity that asks them to build a program to measure more than one water level using a multi-tiered system.	**Students figure out:** ● Pins can be used to trigger an event through the detection of a closed circuit. ● Computer science is powered by electricity. ● We can use circuits to sense things in our environment.

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<tr><td colspan="3">Navigation to Lesson 6: We have figured out how to use sensors to monitor different types of natural hazards and send warnings using the micro:bit, but we still need the micro:bit to be able to send messages to other devices. How could we use the micro:bit to use live data to trigger an alert and then communicate with the community that a hazard is coming?</td></tr>
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<td>LESSON SIX
Researching micro:bit Radios
How can we use live data to trigger an alert and then communicate with the community that a hazard is coming?

1 45-minute class period

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<td>In this lesson, students will be divided into groups that will be used for the rest of this unit as they design and build an Early Warning System. Each group needs to have at least two people with two micro:bits, although groups of 4 are suggested. Each group will be divided into two, with a Sending micro:bit and a Receiving micro:bit. Students will code their micro:bit to either send or receive a message using radio signals. Students will learn how the micro:bit uses the antenna to send radio signals and how each group must be set to the same radio channel frequency in order to communicate.</td>
<td>Students figure out:
Cloud computing and radio waves allow us to build devices that can collect data from remote locations, process it on a cloud (aka server), and send alerts to people.
Radio channels are used to transmit information on different frequencies between devices.
Micro:bits must be set to the same radio channel to send and receive messages.</td>
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<tr><td colspan="3">Navigation to Lesson 7: We now know how to monitor different types of natural hazards and communicate warnings. Could we put this all together to make an EWS?</td></tr>
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<td>LESSON SEVEN
Researching a Location for Your EWS
What is the history of natural hazards in the area chosen for the EWS design solution?

1 45-minute class period

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<td>In this lesson, students will think back to the prior lessons researching micro:bits and take a look at their initial questions to determine that they are now ready to begin designing their EWS. Students will be introduced to the final project and the rubric that will be used to assess their work as they design, build, test, and share the results of their EWS design solutions. Students will use several data sets provided through visual representations related to precipitation and heat waves to predict the natural hazards for the different locations. Then, students will decide as a group on the location for their EWS design and research that location, including the history of natural hazards in that area.</td>
<td>Students figure out:
Some climate change-related natural hazards are preceded by phenomena that allow for reliable predictions (ex: hurricanes)
Some climate change-related natural hazards are more difficult to predict (ex: wildfires). However, understanding the risk factors for these hazards can be used to determine which areas are most at risk for this type of hazard.
Understanding the characteristics of an area (populations, geography) helps to determine the cause of human vulnerability to natural hazards in an area and will help us design an EWS solution.</td>
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Navigation to Lesson 8: *We've chosen an area to focus on and figured out which type of natural hazard is most likely to happen there. What sensors could you use to monitor natural hazards in the area you chose?*		
LESSON EIGHT **Design and Build Your EWS** *How can we use computational thinking approaches to help build our EWS design solution?* **2 45-minute class periods** 	In this lesson, students will spend two days designing and building their Early Warning System design solutions. On Day 1 (Part 1), students will brainstorm design decisions as a group and draw a model for the type of system they decide to build. On Day 2 (Part 2), groups of students will divide themselves to split up the roles of software developers and engineers. The software developers will write the code, test with the simulator, and download to the micro:bit. The engineers will build the physical prototypes using the micro:bit kits and any consumables provided. Together they will test and troubleshoot their design solutions and document them in their journals.	**Students figure out:** ● Developing a model helps plan for the hardware components (inputs and outputs) and code (information flow) that will be needed to build the Early Warning System design solution. ● Building and testing a prototype of a design solution helps to identify issues with the hardware or software. ● Computational thinking approaches help to iteratively design, test, and improve a design solution.
Navigation to Lesson 9: *We've designed an EWS; how could we explain how it works to our class?*		
LESSON NINE **Sharing Your Design Solution** *How will you present your design solution to the class?* **1 45-minute class period** 	In this lesson, students will prepare to share their final design solutions with the class. They will review the EWS rubric as a class and add any final images to the Design Solution Slideshow or other methods for sharing their design solutions with the class. Students will then present their design solutions as a team while the other students in the class take notes in their Computational Thinking and Engineering Journals of the ideas that they think the team did well. Students will share what they think each team did well and will answer the final question in their journal, explaining any improvements they would make to their design after listening to the other presentations.	**Students figure out:** ● Computational thinking approaches help to iteratively design, test, and improve a design solution. ● For an early warning system to be effective/adopted, a team needs to accurately explain their design solution including how the software (inputs, outputs, information flow) and hardware components (sensors, micro:bit, speakers) function together in the system.

Standards

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<tr><th>Next Generation Science Standards</th><th>CSTA Computer Science Standards</th></tr>
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Disciplinary Core Ideas
ESS3.B Natural Hazards
Mapping the history of natural hazards in a region, <s>combined with an understanding of related geologic forces </s>can help forecast the locations and likelihoods of future events
DCI- ESS3.D Global Climate Change
Prior Knowledge Applied
Human activities, such as the release of greenhouse gases from burning of fossil fuels are major factors in the current rise in Earth's mean surface temperature (global warming). Reducing the level of climate change and
Element focused on in this unit
Reducing human vulnerability to whatever climate changes do occur depends on the understanding of climate science, engineering capabilities, and other kinds of knowledge such as understanding of human behavior and on applying that knowledge wisely in decision and activity.
ETS1.B: Developing Possible Solutions
Sometimes parts of different solutions can be combined to create a solution that is better than any of its predecessors. (MS-ETS1-3)
These lessons could be part of a series of lessons building toward the following Performance Expectation
MS-ESS3-2. Analyze and interpret data on natural hazards to forecast future catastrophic events and inform the development of technologies to mitigate their effects.
[Clarification Statement: Emphasis is on how some natural hazards, such as volcanic eruptions and severe weather, are preceded by phenomena that allow for reliable predictions, but others, such as earthquakes, occur suddenly and with no notice, and thus are not yet predictable. Examples of natural hazards can be taken from interior processes (such as earthquakes and volcanic eruptions), surface processes (such as mass wasting and tsunamis), or severe weather events (such as hurricanes, tornadoes, and floods). Examples of data can include the locations, magnitudes, and frequencies of the natural hazards. Examples of technologies can be global (such as satellite systems to monitor hurricanes or forest fires) or local (such as building basements in tornado prone regions or reservoirs to mitigate droughts).]
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2-CS-02 Design projects that combine hardware and software components to collect and exchange data.

2-CS-01 Recommend improvements to the design of computing devices, based on an analysis of how users interact with the devices.

2-CS-03 Systematically identify and fix problems with computing devices and their components.

2-AP-11 Create clearly named variables that represent different data types and perform operations on their values.

2-AP-12 Design and iteratively develop programs that combine control structures, including nested loops and compound conditionals.

2-IC-21 Discuss issues of bias and accessibility in the design of existing technologies.
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