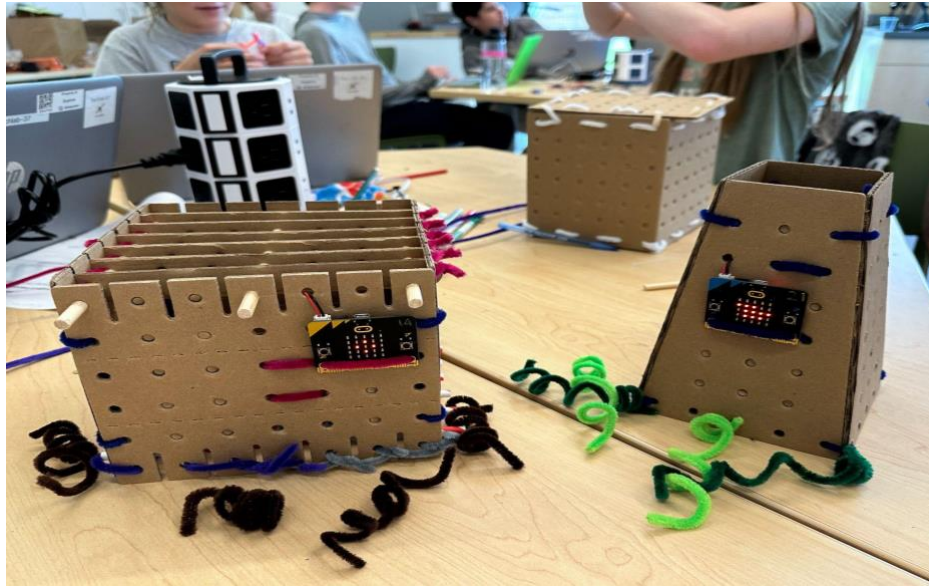**FACILITATOR GUIDE**

Capstone Design Radio Project

Learning Objectives

1. Apply ideas about radio communications and coding skills to plan and make a prototype of a radio communication design solution to help those affected by a natural disaster.

2. Receive and give peer feedback to refine and improve our radio communication design solution.

Activity Goals

- Help learners understand the role of radio communication in their lives to meet societal demands

- Learners see themselves as capable of learning how to use new tools through collaboration to solve problems.

Handouts

- Project Planning Worksheet
- Make a Pressure Sensor

● Make a Switch

Materials per group

- 2 computers
- 2-3 BBC micro:bits
- Sticky notes for presentation feedback
- KitCo Design classroom kit [URL: kitco.design]
- Pencils and color markers
- Optional: Craft materials to enhance design
- Optional: Servos motors (for groups adding mechanical outputs to their design solutions)

Advance Preparation

- Set out all the materials learners will use for their design solution project. Determine a process for managing the distribution of materials in an orderly fashion.

- Create an example of a radio communication design solution to motivate ideas.

- Make a 3-column chart titled, *Natural Disasters, Problems, and Solutions Chart*. Label the first column "Natural Disasters", the second column "Issue or Problem", and the third column "Who or What is Affected".

- Print enough copies of the *Project Planning Worksheet*

- Consider using short videos or the **Whispers in the Wind** app to help motivate ideas for designing radio communication solutions for natural disasters. The app features Hurricane Maria, and its impact on radio communication and the people of Puerto Rico. Science ideas related to radio communication are explored along with potential radio devices to help those affected.

- Review and practice programming the micro:bit sensors available to use as a part of learners design solution: light, motion, sound, pressure, and movement of a motor 180 degrees. Also review the handouts "Make a Pressure Sensor" and "Make a Switch" and have available for learners

Activity Procedure

Setup the context to motivate this activity:

- Ask learners to raise your hand if you have been in a bad storm.

- Explain that some storms like hurricanes are so bad, they are considered natural disasters. Tell learners we are going to talk about natural disasters in our community, the problems they can occur, and design radio communication solutions to help those affected by the natural disaster.

Step 1: Brainstorm local natural disasters and their impact on our community:

1. Share the chart titled, Natural Disasters, Problems, and Solutions Chart.
2. Ask learners, what is a **natural disaster** in your community that could happen? Have learners turn and talk to their partner and discuss for one minute.
3. Call on a volunteer to share one idea that was discussed. Write that idea in the first column.
4. Repeat by calling on more volunteers to generate a list of natural disasters that can occur in their local community.
5. Once all the ideas are elicited, explain that these natural disasters can cause problems within our community. Tell partners to choose one natural and discuss issues or problems that can result from this natural disaster. Encourage partners to come up with two or more issues or problems that might result from the disaster.
6. Allow 2 minutes for partners to respond to the second question.
7. Call on volunteers to share their ideas.
   a. State the natural disaster and a problem that can result
   b. Record the problems shared for the given natural disaster
   c. Repeat for the other natural disasters listed.
8. Then say, *We know that these problems that can result affect humans and non-humans. Let's consider **who or what is affected** by the problems caused by storms or natural disasters that can happen in our area*.

Step 2: Who or What is Affected by the Natural Disaster

9. **Note to the presenter:** The purpose of this next section is to have learners consider the impact of these natural disasters on people, other living things, and/or the environment. This is why we ask them to consider **who or what is affected**. If learners only focus on people, motivate the idea that other things besides people are affected. Also, encourage learners to be specific. If they say a person, ask them if there is a specific person or people that they think will be affected. For example, they can say that an elderly man living on the third floor of an apartment building is affected.
10. Introduce the word "stakeholder" to match the handout.
    a. Who = people
    b. What = non-humans
11. Ask learners to consider who or what is affected by the problems that can result.
12. Write learners ideas on chart paper.
13. Use follow up questions that can press learners to be more specific.

14. Transition by saying, "*Knowing who or what is affected by the problem caused by the natural disaster can help us design solutions to help those affected.*"

Sample Natural Disasters, Problems, and Solutions Chart

Natural Disasters	Issue or Problem
Earthquakes	• Building collapses • People can get trapped
Droughts	• Lose lots of life (plants/fish) • Food on farms get ruined.
Tornado	
Flash flood	• Houses flood and get ruined
Dust Storms	• Dust can cover cars
Wild fires	• The town Rio Doso burned down
Hail storm	• People can get a concussion.

Who or What is Affected?
- The building; people and animals ↳ they get stuck
- Georgy is affected (by the drought) because wheat crumbles in his hand which means he cannot eat.
- People by rivers or bodies of water ↳ their houses will be flooded
- Dust storms affect how plants grow. They also affect cars (how they run)
- Grandmothers, older people, disabled affected 🔵 in Rio Doso.

Step 3: Identifying a Radio Communication Solution

Option A: The "Terrible Ideas" Design Process

This activity is based on the **Wrong Theory Protocol**. We have modified the activity and the prompts to be more kid-friendly. While the original protocol calls for designers to consider "harm and humiliation" to generate ideas, this may be triggering for young learners. Our goal for the "Terrible Ideas" design process is to support learners to take risks and reframe the problem they are designing for in order to better understand the range of design possibilities before finding a solution. Here, learners are asked to come up with the *worst possible design*, one that violates constraints and does not address needs. **This is to be done prior to generating good ideas for solutions that will help those affected**. Skip this section, and go to **Option B** if you decide not to use the "Terrible Ideas" Design Process.

1. Explain that sometimes people get stuck coming up with new and good ideas for a solution. Say, Today we are going to try a technique.
2. Have learners silently think about the following: What would be a terrible, the worst possible way to solve this problem and help those affected by the natural disaster?

3. Say, It might seem a little silly or wrong at first, but that's okay. The purpose of the activity is to help you really understand the problem and to see it from a different point of view.
   a. Try to be as creative as possible
   b. Try to Jot ideas down
   c. Speak your ideas out loud
4. Emphasize that by thinking about terrible ideas first, it can help us be creative in designing true solutions to the problems we have identified. Have fun, but not cruel!!
5. Remind learners to use the ideas learned about radio communication.
6. In their table groups, have the learners have a discussion related to the following questions and be prepared to share with the whole group.
   a. How does your idea make things worse?
   b. How does your idea create some harm to people in our community?
   c. Is everyone in our community equally affected by this idea?
   d. Is it worse than having no solution?
7. After 5 mins, call on a person from each table to summarize what their table group discussed
8. Say, now that you know how our designs will not work as solutions for the people affected by a problem, it is time to come up with beneficial ideas!
9. Explain that we had a chance to consider very bad ideas. Now we want to think of the opposite to those ideas.
10. With their table group, have learners follow the instructions below. If needed, provide an example of an idea that was "bad" and a potential "opposite" idea to that bad idea.
    a. Think about your bad ideas. What are the opposites?
    b. Use words and/or drawings to draft your ideas. Try to come up with different ways to meet the needs you identified, not just minor variations of the same solution.
    c. Try role playing: Imagine you are the stakeholder. What do you want?
    d. Don't discount or eliminate any ideas at this point!
11. Allow groups to share out.
12. Next, have learners brainstorm what are the **constraints** to our problem? By **constraints** we mean *limitations*
13. For example,
    a. Environment: a limited amount of water to generate power for a telephone station.

b. Economic: it could be too expensive to make or create.
c. Other Examples:
    i. Personal or cultural constraints
14. Explain that we are going to use our ideas to design a solution for the radio communication problem.
15. Distribute the *Project Planning Worksheet* to each camper (or to partners)
16. Allow learners the choice to work individually, with a partner, or within their small group.
17. Review and ask learners to complete questions 1 and 2 of the handout.
18. Emphasize they must consider what radio-communication technology or system they could design to help those affected.

Option B: Designing Your Radio Communication Solution
1. Tell learners that they are design engineers hired to help those affected by the natural disaster.
2. Explain that they will consider the following questions:
    a. What could be a solution to help those affected by that natural disaster?
    b. What radio-communication technology or system (using micro:bits) could you design to help those affected?
3. Distribute *Project Planning Worksheet*.
    a. Allow learners the choice to work individually, with a partner, or within their small group.
    b. Review and ask learners to complete questions 1 and 2 of the handout.
    c. Emphasize they must consider what **radio-communication technology or system** they could design to help those affected.

MAKING WAVES
with radio

Name: _____

Date: _____

Brainstorming and Project Planning

1. What **problem** are you addressing? Write + sketch.

2. **Stakeholder: Who or what** is impacted by the problem?

3. What could be a solution to help those affected by that natural disaster?

4. What radio-communication technology or system (using micro:bits) could you design to help those affected? Write + sketch.

5. What will be your micro:bit **INPUT**?
____ Button Press (A or B)
____ Shake/motion (accelerometer)
____ Temperature
____ Light
____ Incoming message (string/number)
____ Sound
____ Touch
____ Other:_____

6. What will be your micro:bit **OUTPUT**?
____ A radio signal (string or number) sent to another device
____ Turn LEDs on/off
____ Play a sound/song

4. Review the design requirements. Your radio solution should:
   a. Connect to at least one other radio device
   b. Send and/or receive messages
   c. Have an input
   d. Have outputs (an action from the input)
5. Clarify any questions they may have.
6. You get to come up with a radio communication technology solution (using micro:bits as a model) that can help those affected by natural disaster

7. Tell learners their solution can be BEFORE/DURING/AFTER the disaster. Prevention, early detection, during the disaster, or even afterwards.
8. Emphasize that the micro:bit is not working by itself. It is working with other devices as a part of a radio communication system. The design must show how the micro:bit and other devices work together to help those affected.
   a. **For example**: A radio sensor system that monitors humidity, can send a message to the fire department when the hills are dry before a fire starts.

Using the sensors: Coding inputs and outputs
9. Tell the learners, before going any further, it is important to clarify which inputs and outputs they plan to use in their design. Remind them that inputs and outputs can be the messages being sent by radio communications. Explain we will go over the different sensors on the micro:bit that you might decide to use as a part of your design solution. Find instructions on using different sensor inputs https://makecode.microbit.org/reference/input

10. Remind learners of the kinds of materials available for use as a part of their design solution. Explain that all designs must be approved before they are allowed to start building their design solution. Review the process for getting materials and clarify any questions. (See: *Note to the Presenter above*)

11. Ask learners to complete questions 3 - 6 of their handout. Walk around the room to clarify any questions.

12. Once they are ready and designs have been approved, provide them with a laptop and two micro:bits, and follow the agreed upon process for getting materials to work on their design.

Note: Adjust as necessary to allow learners time to work on their design solutions. Also, if necessary, allow learners to review any related video or the ***Whispers in the Wind*** app to get ideas about devices they can design.

Notes to the Presenter

Facilitating whole group discussion: Offering learners the opportunity to share with the peers before whole group discussion gives them the chance to practice and clarify their ideas in their own ways of expression before the large group discussion. To make the whole group discussion equitable, it is important to elicit ideas from different learners, validate their ideas, and allow the use of gestures to show agreement or disagreement. Use the prompts as a guide to facilitate the discussion. However, be ready to have

learners clarify their thinking by asking, "Can you tell me more about…?" Or, "What do you mean when you say…?"

Working with individuals/small groups: In this activity, it will be important that learners use ideas about radio communication in their design solution. As you rotate around to different groups, be sure to ask questions about how their devices work to help those affected by the natural disaster.

Managing Materials: To reduce the disorderly movement of learners, it is important to determine where materials will be set up and how learners will gather them for their projects. We suggest designating areas or stations for the different kinds of materials: cardboard pieces at one table/ location, string, yarn, etc. at a different table/ location. Ideally, the materials will be away from where the learners are building their designs. It might also be useful to create a protocol for a maximum number of learners gathering materials from a given station at a time: For example, "No more than 3-4 people gathering materials from the cardboard station at a time."

Extension: Adding a switch or a motor to their design is optional. However, this provides an opportunity to apply their understanding of coding to program their micro:bits and think creatively about how to include a switch or a motor as a part of their design.

Supporting Equitable Participation

- **Extended Time:** Provide extended time for learners who may need it. Equitable participation includes accommodating different learning paces.

- **Visual Aids:** Use visual aids, such as diagrams or charts, to complement verbal instructions. Visual cues, such as gestures, can be particularly helpful for visual learners and those who may have difficulty with language processing.

- **Mixed-Ability Pairing:** When organizing learners in pairs, try to create mixed-ability pairs. If you don't know your group well enough, you can ask: Who feels very confident about programming their radio devices. It may also be necessary to allow learners who speak the same language to work together to ensure they successfully meet the design challenge.

Conversational Prompts

Use these prompts as part of the group discussion to elicit ideas. Consider any follow-up questions that will help clarify thinking or make connections to their experiences and ideas about radio communication.

- What is a natural disaster in your community you think could happen?
- What issues or problems can result from this natural disaster?
- Thinking about those natural disasters and issues or problems that can result, who or what is affected?
- Consider one natural disaster that could impact your friends, family, or others in our community.
  - What could be a solution to help those affected by that natural disaster?
  - What radio-communication technology or system (using micro:bits) could you design to help those affected?

Content Background

In this lesson, we introduce an engineering design challenge that requires thinking about how to design and test a solution that helps people in their community. Here, we identify natural disasters that can affect people in our community and potential issues/ problems that can result. We work collaboratively with a partner to plan a radio communication design solution to help those affected by the natural disaster that meet the design requirements. We use materials to test our design solutions with the micro:bit while identifying ways to improve the design for the community. Using the results from the tests, final revisions are made to ensure the design solution addresses the identified communication issue in the community.

Through this process, learners figure out that radio technologies can be used to protect our community from natural disasters by letting us share information that can help us make critical decisions during an emergency. We also learn that when we connect sensors to radios, they can sense things like changes in weather or motion and send that information to us. This helps us know when something bad might happen and respond quickly, making it easier to stay safe during emergencies.

List of Terms Related to this Activity

Design problem: a challenge or a need that you want to solve by creating something, using your imagination and available materials. In this activity, learners will identify a problem caused by a natural disaster.

Design constraints: the limitations on a design or solution. This includes the amount and type of materials available to use, or the amount of time to complete the task.

Design solution: a creative way to solve a problem or make something better for a particular person, stakeholder or community.

Stakeholder: someone who has a special interest or is affected by something. The stakeholders in this project are the people, animals, other living things who are impacted by the problem caused by the natural disaster