

Focus: Defining the Problem

Grade Level: 7-12

Session Length: One or two sessions of 45-60 minutes

Driving Questions

- How can we use coding skills to transform our data?

NGSS Links

- Analyzing and Interpreting Data
- Using Mathematics and Computational Thinking

Systems Thinking Characteristics

- Identifying System Components & Processes
- Identifying Simple Relationships Between System Components
- Organizing System Components & Processes within a Framework of Relationships
- Identifying Hidden Dimensions of the System

In the sixth session of the Coastal Dynamics Program, students project teams take a closer look at the data they collected through the virtual data collection exploration in Session 5, and use sand height measurement data to create three-dimensional beach profiles using a program called GNU Octave

During the first part of the session, students reflect on how they can use the sand height measurements to create a visualization that will let them visually see how the North Beach is changing over time. Next, students work through four coding steps in GNU Octave to create three-dimensional beach profiles of the North Beach and use them to compare how the beach looks at different times of year. Lastly, they reflect on how they could use this data, along with wave dynamic data that was collected in Session 5, to determine how the beach is changing over time and test the assumptions in their model.

Learning Outcomes & Assessments

<i>By the end of this module, students will be able to...</i>	<i>You can assess this using...</i>
1. Use GNU Octave to create a three dimensional visualization of a beach profile.	Updated team models
2. Compare two or more beach profiles to visually assess how the beach is different at different times of year.	Class discussion; Field notebooks
3. Generate ideas about how to quantify the change in North Beach sand volume between different data collection dates.	Class discussion
4. Reflect on how we can use the data to validate the assumptions in our model.	Field notebook reflection

Session Overview

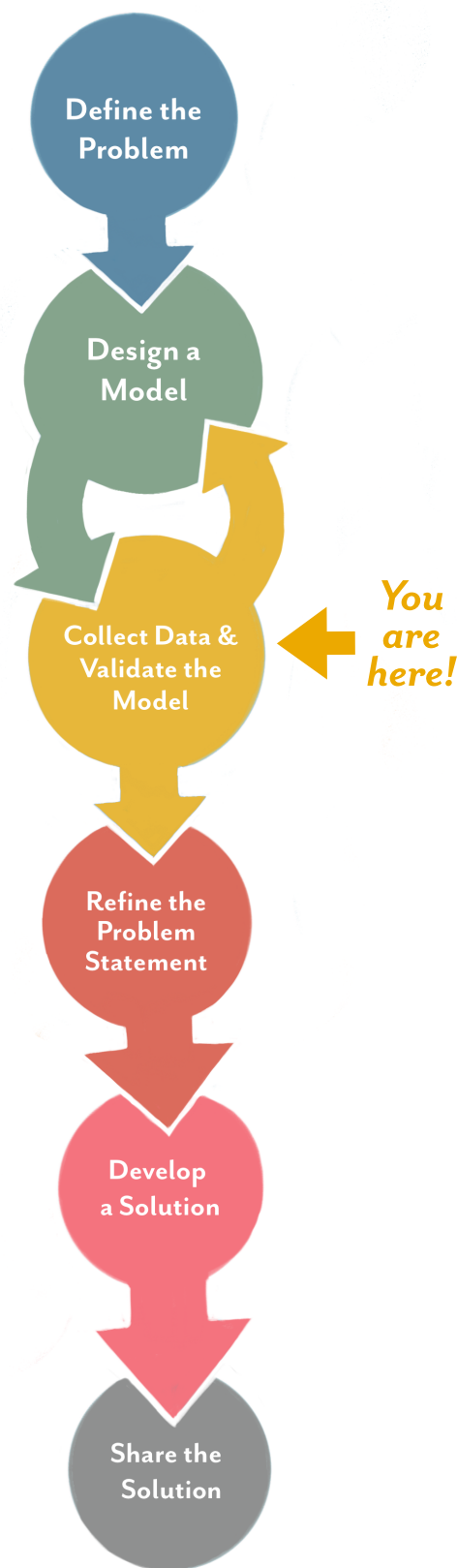
Section	Description	Length	Format
Launch	Erick welcomes the students to Session 6 and prompts them to think about how they can transform the data collected to create data visualizations that will help them identify patterns in our data.	5 minutes	Whole class
Explore	<p>Erick introduces students to GNU Octave, a free open source version of MatLab that is used by engineers and scientists to analyze data and create data visualizations</p> <p>Students are introduced to four coding concepts. They follow along with Erick as he introduces the coding concept in a video and demonstrates how to use it in a screencast. Then they use GNU Octave to modify the script provided to create their own data visualizations. Lastly, they jot down any observations they make through each skill within their field notebooks.</p>	40-45 minutes	Individual
Share	Students debrief on their experiences manipulating code on GNU Octave to create data visualizations.	5-10 minutes	Whole class or project teams
Reflect	Students reflect on their experience during Session 6.	5 minutes	Individual

The Environmental Engineering Process: Validate the Model

In Session 6, students begin analyzing the beach profile data that they collected. As they do so, they start to consider how they might use that data to validate the assumptions in their model in order to see if their predictions about how the beach system works are accurate or not.

This is an important step in the environmental engineering process because it positions students to start using data as evidence to support their claims. By using a computer program to create three-dimensional representations of the beach shape, they can visually compare how the shape of the beach changes from season to season. This will prepare them to look for mathematical patterns in Session 7 when they graph data over time.

Throughout Session 6, remind students that the reason we are collecting data is to validate the models that we created earlier. The patterns that they find in their data will become evidence to support the claims in their model about how different factors affect beach sand over time.



Virtual Materials

- Session 6 Google Slides Presentation: <https://bit.ly/3vrEwPD>
 - How to Get Started with GNU Octave VoiceThread: <https://bit.ly/3vvkzay>
 - GNU Octave Files (Dropbox): <https://bit.ly/3sZAHQ7>
- Session 6 Written Instructions for GNU Octave: <https://bit.ly/3t68Yx3>
- Session 6 Field Notebook Template (optional): <https://bit.ly/2PuXTrI>

Each student will need...

- A device with internet access (a computer, smartphone, or tablet will all work!)
- GNU Octave:
 - Downloaded and installed on their computers
 - Data files can be found within the [Dropbox link](#)
- Field notebook and pencil

Advanced Preparation

The session involves the use of a coding program called GNU Octave and data files downloaded through Crystal Cove's Dropbox. The files and instructions to download and install GNU Octave and the data files can be found within our [VoiceThread](#).

NOTE: GNU Octave is compatible with most computer operating systems but it is **NOT** compatible with Chrome OS, the operating system that is used by Chromebooks. If you happen to have this operating system, you will not be able to download or install GNU Octave.

Before You Start Teaching

- Copy over the [Session 6 Slideshow](#) to your own Google Drive account. Test to make sure that the videos work. (If not, you may have to check the permissions on the Crystal Cove Conservancy Youtube Account.)
- Decide how long to give students for this session. If they have not coded before, you may want to plan for two class sessions so that they have more time to work through the process.
- Ideally, you'll want to download GNU Octave and install it on student computers before the session begins. You may need to talk to the tech coordinator at your school to get help or to make sure you have the necessary permissions to install a new program. More directions on setting up GNU Octave are located in the [Installation VoiceThread](#).
- Take a few minutes to go through the download and installation process on our VoiceThread and familiarize yourself with GNU Octave using the screencasts provided within the Google Slides. Most of the session should be self-guided for students, but you can check to see if there are any parts where you may need to offer specific assistance.
- Consider whether you want students to work independently or in groups for this session. It may be helpful to have students work in pairs if possible. This will allow them to actually manipulate the computer instead of simply watching, but will also give them a buddy to help support them if they struggle with coding.

Learning Sequence

Launch

Getting Started (10 minutes)

1. Open the [Session 6 Slideshow](#) and play the video on [Slide 2](#) for your class. In this video, Erick will introduce the idea of creating data visualizations with the sand height measurements collected in Session 5.
2. After watching the video, advance to [Slide 3](#), where you will find a graphic of the environmental engineering process with a marker pointing at “Collect Data & Validate Model.” Tell students that today, they will continue on this step within the Environmental Engineering Process to start analyzing the data that they collected so that they can use it to validate the assumptions in their model.
3. Once you’ve gone over this step in the engineering design process, advance to [Slide 4](#) to give students an overview of what they will do and learn during Session 6.

Explore

Part 1: Virtual Field Expedition

1. Advance to [Slide 5](#) and play the video. Here, Erick will introduce students to the idea of creating data visualizations using the sand height measurements that they collected in Session 5.
2. Once you are done watching the video, move on over to [Slide 6](#). In this slide, students will see an example of what the raw sand height measurement data looks like. Ask students to brainstorm how they might use that data to create some sort of graph, model, or other visualization that will help them to visualize what the North Beach looks like at different times of year. You can have this discussion as a whole class or ask students to talk in their project teams.
3. After students have brainstormed their ideas, advance to [Slide 7](#) and play the video. Erick will go through how we can use GNU Octave, a free open source version of MatLab, to create three-dimensional data visualizations that show a snapshot of what the beach in front of the North Beach looked like on a specific day! Students will be invited to work alongside Erick and produce their own three-dimensional data visualizations using GNU Octave.

4. Once the video is done, move on to [Slide 8](#) and play the video on the slide. In this video, Erick will describe what the process of coding on GNU Octave looks like.

During the rest of the session, students will be introduced to four different coding skills within GNU Octave. Erick will first explain the skill being practiced in a video and then demonstrate it on GNU Octave using a screencast. Then, students will then get the opportunity to try the skills themselves. Lastly, students will record their observations in their field notebooks as they go.

The four skills include:

1. Setting Up Your Directory
2. Creating a Three-Dimensional Data Visualization
3. Creating Multiple Three-Dimensional Data Visualizations
4. Calculating Sand Volume (optional; if time allows)

5. Divide students into pairs (or whatever group you want them to work in) and assign them to a computer. If you haven't already installed GNU Octave on the computers, give students access to the [Installation VoiceThread](#) so they can get set up.

You may also decide to print and distribute the written instructions for using GNU Octave.

Part 2: Setting Up Your Directory

1. Advance to [Slide 9](#), where Erick will introduce the first skill students will need to know to code in GNU Octave, setting up their directory. A directory is a region on our computer that you want Octave to read its files from, this could be a file or specific folder.

2. Once you're done watching the introduction video, move on to [Slide 10](#), where Erick will demonstrate to students how to set up their directory within GNU Octave within a screencast. It is important to note that each student will have a different directory that is unique to them and the location in which their files are saved.

3. Once students finish watching the screencast, advance to [Slide 11](#). Here, students will have written instructions that will help them follow the skill that was demonstrated on the screencast.

Give students time to set up their directory in the GNU Octave editor. This is a good time to check in with each group of students to make sure they understand how to edit the text in the editor window.

Part 3: Creating a Single Three-Dimensional Data Visualization

1. After students are done setting up their directory, they are ready to move onto the next step, creating a Single three-dimensional data visualization. Advance to [Slide 12](#) and play the video to watch Erick introduce this new skill: Creating a Three-Dimensional Data Visualization.
2. Afterwards, advance to [Slide 13](#) where Erick will demonstrate how to create a single three-dimensional data visualization using GNU Octave.
3. When students have finished watching the screencast and are ready to try creating their own three-dimensional data visualization, advance to [Slide 14](#). Here, students will have written instructions that will help them follow the skill that was demonstrated on the screencast.

You can decide whether you would like them to create the same three-dimensional data visualization as they see on their screencast (which might be easier for students that have not coded before -- and will be easier for you to check to make sure everyone has done it correctly) or choose their own date from the list provided on [line 17](#) of the GNU Octave script (recommended for more advanced students or teachers who are comfortable with coding).

Give students instructions out loud on what you would like them to do.

4. As students begin creating their own three-dimensional visualizations, move between the groups to make sure that they are doing so correctly. If they struggle, direct them towards the GNU Octave written instructions, which will give them step-by-step instructions on how to complete this task and run the code.
5. Once their three-dimensional data visualizations are created, advance to [Slide 15](#) and play the video. In this video, Erick will demonstrate to students how they can interpret the data visualization they just created.

The video will introduce the idea that the top of each graph corresponds to the area along the boardwalk starting with transect A on the right hand side. Moving towards the bottom of the graph, the measurements get closer to the waterline of the beach. The lighter colors on the color bar and our graph indicate the higher points of elevation during our data collection, while the darker colors indicate the lower points of elevation.

6. Once students are done watching the video, move along to [Slide 16](#). Inform students that they will now interpret the data visualization they created by answering the questions provided on the slide.

7. Give students time to reflect on their three-dimensional graph and record their observations in their field notebook. If there is time, you can invite different teams to share their observations and three-dimensional graphs out loud to the whole class.

Part 4: Creating Multiple Three-Dimensional Data Visualization

1. After students have interpreted their data visualization, it is time to move on to the third skill: Creating multiple three-dimensional data visualizations at once!

Advance to [Slide 17](#) and play the video. Erick will describe the importance of why creating multiple data visualizations can be helpful in comparing changes that are happening at different times of the year and how they could use GNU Octave to create multiple three-dimensional data visualizations at the same time.

2. When students are ready, advance to [Slide 18](#), to watch a screencast on the process of creating multiple three-dimensional data visualizations at once. In this screencast, students will learn how to manipulate the code to choose multiple dates of interest, remove the color bar to allow for more space, and change the spacing within our data visualization window.

Like before, before students try this skill on their own, decide on whether you would like them to create the same three-dimensional data visualizations as they see on their screencast or choose a different one from the dates provided on [line 17](#) of the GNU Octave script.

3. Once students are ready to create multiple three-dimensional data visualizations, advance to [Slide 19](#). Here, students will have written instructions that will help them follow the skill that was demonstrated on the screencast.

Give them time to work and create the two visualizations.

4. After they have created multiple three-dimensional data visualizations, move on to [Slide 20](#). Using the data visualizations they created, have students answer the questions provided in the slide in their field notebook, and if time allows, have them share their responses with their project teams!

Part 5: Calculating Sand Volume (Optional)

1. When students are ready, and if time allows, continue on to *Slide 21* and play the video.

Here students will be introduced to the fourth and final skill, calculating the sand volume of their data visualization using GNU Octave.

2. Next, after they have finished watching the introduction video, advance over to *Slide 22* and play the video screencast. In this screencast, Erick will demonstrate how they could use GNU Octave to calculate the sand volume of a chosen date using skills they had practiced along the way, as well as how to use basic mathematical functions within Octave to calculate the change in sand volume between two different beach profile dates.

3. When students are ready, advance over to *Slide 23*. Here, students will have written instructions that will help them follow the skill that was demonstrated on the screencast.

If you would like (and if time allows), have students calculate the sand volume of a couple of dates within GNU Octave and jot down the values within their field notebooks. Then, have students determine the change in sand volume between the dates they gathered data for.



Share

Sharing Our Monitoring Projects (5-10 minutes)

1. Ask students to regroup back with the remainder of the class and advance to *Slide 24*. Either with the sand volume values they calculated or with the observations they made within their field notebook, have students discuss the questions on the slide with their project team.

2. If there is time, bring the whole class back together. Ask students to briefly recap their experience on creating three-dimensional data visualizations on GNU Octave.

3. Finally, remind students that our goal is to understand how the sand volume on the beach in front of Crystal Cove's North Beach is changing over time. Invite students to share their thoughts on possible next steps and how they could further analyze the data they collected or test the assumptions in their model.

Elevate ideas that today's data is only one type of data -- we'll have to look at the extended data set, including data from wave dynamics, to really see if our assumptions about how one factor might affect another factor are correct so that we can make predictions about how Crystal Cove's North Beach is changing over time. We can then use that further analysis on the data to test the assumptions in our models.



Reflect

Reflecting on Session 6 (5 minutes)

1. At the end of the discussion, advance to *Slide 25* in the slideshow and play the video, where Erick will recap the experience today and ask students to spend a few minutes reflecting.
2. Move on to *Slide 26*, which will share reflection questions. Ask students to spend five minutes reflecting on their experiences today in their field notebook.
3. Finally, thank the class for their time today. Tell them that when you gather again, they will get a chance to analyze the full data sets to determine how Crystal Cove's North Beach is changing over time!