

Session 6: North Beach Boardwalk

Focus: Coastal Engineering

Grade Level: 6-12

Session Length: 3-5 hours (Sessions can be done in class or assigned as homework)

Driving Questions

- How can we design a boardwalk at the Historic District's North Beach that will provide public access to the area and withstand the beach's environmental conditions?

NGSS Links

- Constructing Explanations and Designing Solutions
- Engaging in Argument from Evidence
- Obtaining, Evaluating, and Communicating Information
- Engineering Design

Computer Science Standards Links

- Data and Analysis

In this Environmental Challenge, students are introduced to the design challenges faced by coastal engineers as they restore the area surrounding the historic cottages on the North Beach in Crystal Cove State Park's Historic District. They will create a design for a boardwalk and build and test a prototype of their design.

For the past few years, Crystal Cove Conservancy has been hard at work thinking about best practices to restore the remaining 17 unrestored cottages at the Historic District's North Beach. With restoration of these cottages and the infrastructure surrounding them comes many issues due to the environmental factors that the cottages face. As sea levels begin to rise and storms become more frequent, Crystal Cove Conservancy faces the challenge of not only restoring the cottages, but designing a boardwalk. This boardwalk will be able to withstand the changing ocean and beach conditions without limiting accessibility to the public, including guests with limited mobility, and support the weight of emergency vehicles. This boardwalk will be the key to ensuring that the cottages are not only protected today, but also well into the future.

During the environmental challenge, students will...

1. **Learn** about the environmental factors that Crystal Cove's North Beach faces.
2. **Research** designs and solutions that have been implemented in the past to address beach erosion, including the results of those designs or solutions.
3. **Submit** a a design brief explaining the North Beach's environmental problem they will address and how they plan to solve it.
4. **Develop** a preliminary design for a boardwalk using Tinkercad.
5. **Build** and test a prototype of their solution.
6. **Share** their recommendations and designs with their classmates and Crystal Cove State Park.
7. **Reflect** on the experience of developing designs, solutions, and prototypes.
8. **Connect** with STEM professionals and like-minded peers to explore STEM content and careers in more depth.

Session Overview

<i>By the end of this module, students will be able to...</i>	<i>You can assess this using...</i>
1. Explain the environmental factors that occur along the coast and how they impact structures built close to the shore.	Student notebook page; class discussions
2. Use knowledge of environmental factors to create a solution to a coastal engineering challenge.	Student notebook page
3. Use a 3D design application (e.g., Tinkercad) to develop a design of a structure that meets the requirements of an engineering challenge.	Design saved in Tinkercad; Student notebook page
4. Build , test, optimize, and re-test a prototype of a coastal engineering solution.	Student notebook page; class discussions
5. Provide results of prototype testing and recommendations to land managers.	Student notebook page
6. Participate in class discussions and discover shared areas of interest with classmates and explore those areas of interest together.	Class discussions
7. Connect with other students who are interested in coastal engineering.	Questions and comments posted to Padlet
9. Connect with STEM professionals during and/or after the environmental challenge to learn more about STEM disciplines and careers.	Questions posted to Padlet

Learning Outcomes and Assessments

<i>Section</i>	<i>Description</i>	<i>Length</i>	<i>Format</i>
Launch	Students learn about butterflies and the monitoring project at The Bowl through a slideshow and online resources. They develop two hypotheses about whether the abundance and diversity of the population is changing over time .	10 minutes	Individual or Whole class
Explore	Students progress through the engineering design process.	3-5 hours	Individual or small group
Share	Students share their solutions with Crystal Cove State Park through Google Forms and with their classmates through a class discussion.	15-45 minutes	Individual and Whole Class
Reflect	In their student notebook, students reflect on whether they think it is important to protect the cottages at Crystal Cove State Park. Students also reflect on their thoughts about designing and testing a coastal engineering solution.	10 minutes	Individual and Whole Class

Virtual Materials

- Online Environmental Challenge from Crystal Cove Conservancy's website: <https://bit.ly/3j9geXf>
- Introduction to the North Beach Boardwalk Environmental Challenge Voicethread Presentation: <https://bit.ly/3kfDimQ>
- Website pages includes links to the following:
 - Sand Movement: <https://bit.ly/3gqrXiH>
 - Coastal Erosion: <https://bit.ly/3B5maGX>
 - Studying Beach Dynamics: <https://bit.ly/3sODr4w>
 - Sea Level Rise Information: <https://bit.ly/2Wawejn>
 - How Sea Level Rise and Ocean Waves Shape Beaches: <https://bit.ly/3sEpG8q>
 - Coastal Armoring in California: <https://bit.ly/2Wg7HsH>
 - Tinkercad Crash Course YouTube Video: <https://bit.ly/2Wk1WKP>
 - Examples of Designs and Solutions Implemented for Shoreline Protection:
 - Broad Beach, Malibu: <https://lat.ms/389JLd8>
 - Capistrano Beach, Dana Point: <https://bit.ly/3B62umy>
 - Surfer's Point, Ventura: <https://bit.ly/3zbvpVy>
- North Beach Boardwalk Question Board: <https://bit.ly/3ybN4uU>
- Google Form for Design Brief: <https://bit.ly/3j8vgwE>
- Google Form for Building and Testing Your Design: <https://bit.ly/3zbtw7>
- Google Form for Sharing Findings: <https://bit.ly/3B7pOLO>
- Video for Reflection Section: <https://bit.ly/389w2mA>
- Student notebook pages: <https://bit.ly/3B62SS2>

Each student will need...

- A device with internet access (a computer, smartphone, or tablet will all work!)
- Supplies to build and test their boardwalk prototype. Below are some examples of supplies, but students can use any everyday materials that they think will work.
 - Glue gun
 - Tape
 - Popsicle sticks
 - Cardboard or paper
 - Aluminum foil
 - Toothpicks
 - Straws
 - Pencils
 - Cotton swabs
 - Pasta
 - Sterilite container or other container that holds water for testing
 - One-liter water bottle

Before You Start Teaching

- Decide if you want your students to use the student notebook pages. This can be a good option if you want to collect student's work at the end of the project.
- Decide if you want to do the challenge during class time, assign it as homework, or a combination of both.
- Decide if you want students to work individually or in small groups.
- Become familiar with Tinkercad if you haven't used it before by going through the crash course YouTube video.
- If you will be doing the challenge during class time, make arrangements for the materials that will be needed for students to build and test prototypes. You may decide to ask students to bring in materials from home or you may have items in your classroom that students can utilize.
- This challenge can be done during class as a whole group or it can be assigned for students to work on independently in class or at home. The following instructions in the Learning Sequence describe how to lead students through the challenge as an in-class activity.

Learning Sequence

Launch

Getting Started (15-30 minutes)

1. Open the **Introductory Voicethread Slideshow** and play the video on **Slide 2** for your class. In this video, students will meet Kaitlin and Erick, who will introduce you to Crystal Cove historic cottages and the North Beach Boardwalk Challenge.
2. Give students time to answer the questions about the North Beach Boardwalk project in their student notebooks.
3. After you've finished the video, continue to advance through Slides 3 and 4 so students can learn more about the challenge and the engineering design process.
4. After students have answered the questions in their notebooks, facilitate a short class discussion so students can share with you their understanding of the challenge so you can confirm that they know that your class has been asked to help protect the historic cottages on the North Beach by designing a boardwalk and sharing their recommendations with Crystal Cove State Park.

Explore

Progressing Through the Engineering Design Process (3-5 hours)

1. Students progress through the steps of the engineering design process by starting with **Step 1: Investigate the Environmental Challenge** on the website. In this step, students will learn about the environmental factors that affect beaches through a slideshow and websites.
2. Play the introductory video on **Slide 2** for the class to introduce them to the challenge of building a boardwalk on sand. After watching the video together, ask students to go through the rest of the slides on their own to learn more about the challenges that come with building structures on the coast.
 - A. **Slide 3** gives information about tides.
 - B. **Slide 4** provides information about waves.
 - C. **Slide 5 and 6** provide information about seasonal changes.
 - D. **Slide 7** provides information about storm events.
 - E. **Slide 8** provides information about sea level rise.

- F. *Slide 9* provides information about erosion caused by armoring.
- G. *Slide 10* provides students with the opportunity to reflect on the environmental factors they just learned about and how they will play a role in the design of there boardwalk.
- H. *Slide 11* provides links to additional resources to learn more about the environmental factors.

3. After students have viewed each slide, provide them with additional time to investigate the links on *Slide 11* and ask them to answer the questions for Step 1 in their student notebooks.

4. Before moving on to Step 2, facilitate a discussion with the class to allow them to share what they have learned about the environmental factors during Step 1 and give them the opportunity to share their initial thoughts on how those environmental factors will affect the design of their boardwalk.

5. In *Step 2: Define the Problem*, students will learn about the design criteria and design constraints for the boardwalk through a YouTube video and then submit a design brief through a Google Form. Play the short video of Erick describing design criteria and constraints for the class or ask students to watch it on their own.

6. After students have watched the video, ask them to work on completing the design brief individually or in their small groups. They can submit their design brief through the Google Form and/or in their student notebook. As students work on their design brief, walk around the room to check on their progress and answer any questions.

7. Once students have finished their design briefs, facilitate a discussion with the class so students can share their ideas from their design briefs and learn about the similarities and differences between ideas.

8. In *Step 3: Research Possible Ideas*, students will learn about examples of designs and solutions that have been implemented for shoreline protection in the past through websites. Ask students to explore the websites that describe designs and solutions and to search for other examples. They can record information they find by answering the questions in their student notebooks.

9. After students have had time to explore the examples and answer the questions in the student notebooks, facilitate a discussion so that students can share their thoughts and share any examples they learned about that aren't from the websites that Crystal Cove Conservancy provided. Make sure to ask them to discuss their thoughts on how what they learned from the examples relates to the boardwalk challenge.

10. In *Step 4: Design your Solution*, students will use a 3-D modeling tool, called Tinkercad, to create a design. If students aren't familiar with Tinkercad, watch the crash course video together as a class or have students watch individually.

11. Give students time to use Tinkercad to design their solution. Walk around the room to check on progress and answer questions. Remind them to save their designs to share with Crystal Cove State Park and/or share with you in their student notebook.

12. In *Step 5: Build and Test your Prototype Boardwalk*, students use everyday, household materials to bring their design to life and test it to see if it can withstand weight and waves. Give students access to the supplies they need to build and test their prototypes. You may want them to work outside if you think that testing will lead to water spills. If students work outside, make sure to provide them with guidelines for behavior and boundaries while working outside of the classroom. Walk around the room to monitor progress and answer questions.

13. After testing is complete, remind students to answer the questions in their student notebooks and/or submit their results in the Google Form. Facilitate a discussion so students can share the results of their testing and give each other feedback on the design and suggestions for improvements.

14. In *Step 6: Optimize and Retest your Design*, students make modifications to their model based on their observations during the test and retest it to see if it can withstand the weight and waves. Give students time to incorporate feedback and their own ideas into optimizing their design and then retest their prototype. Give students access to the supplies they need to build and retest their prototypes. Ask students to record their notes from the retesting in their student notebooks. You may want them to work outside if you think that testing will lead to water spills. If students work outside, make sure to provide them with guidelines for behavior and boundaries while working outside of the classroom. Walk around the room to monitor progress and answer questions.

Share

Share Your Findings (15 minutes)

1. After the students have have retested their model, they will move to **Step 7: Share Your Results and Make a Recommendation** and share their findings with Crystal Cove State Park through the Google Form on the website. If possible, facilitate a class discussion about their designs and models before students submit their results and recommendation to Crystal Cove State Park. A class discussion will give students an opportunity to explain their designs and solutions and make any necessary revisions based on new information that comes to light during the discussion.
2. If you had students use the student notebook page, remind them to record their observations of their model testing on the student notebook page and return it to you at the end of the project if you wish to see their work.
3. If students are interested in communicating with other students who have analyzed the data, they can submit thoughts, comments, and questions to the **Padlet**.

Reflect

Reflecting on North Beach Boardwalk Challenge (10 minutes)

1. Tell students that they have one last task. Remind them that it's important for scientists to take time to reflect on how our thinking is changing. Show the **video** on the website page of Kaitlin talking about reflection and about the North Beach Boardwalk Challenge.
2. Ask students to spend five to ten minutes reflecting on their experiences by answering the following questions in their student notebook or in another document if you aren't using the student notebooks. If possible, facilitate a class discussion to allow students to share their thoughts with each other.
 - A. What did you do during this environmental challenge?
 - B. What did you learn? How did your thinking change?
 - C. Do you think it is important to protect the historic cottages on the North Beach?
 - D. Did you enjoy designing a solution and building and testing a model? What did or didn't you like about the experience?
 - E. Would you like to learn more about coastal engineering? If so, what topics interest you? Do you have ideas of how you could learn more about them?

3. If students are interested in exploring coastal engineering and other marine science careers, encourage them to explore these links that are on the website.

- A. *Marinecareers.net*
 - I. *Ocean Engineering*
- B. *Job Profile: Coastal Engineer*