Crystal Cove® CONSERVANCY

Session 2: Designing a Model

Focus: Designing a Model
Grade Level: 7-12
Session Length: Two sessions of 45-60 minutes

Driving Questions

- How can we define the system that we want to study?
- How can we create a model that shows how natural and anthropogenic factors impact sand volume on Crystal Cove's North Beach?

NGSS Links

- Designing and Using Models
- Using Mathematics and Computational Thinking
- HS-ESS3-6

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 second session of the Coastal Dynamics Program, students collaborate with their project teams to design a model that shows their initial ideas about what might affect the amount of sand on Crystal Cove's North Beach.

During the first half of the session, students reflect on how to define the system that we want to study to address our problem statement. They then work in their project teams to brainstorm a list of environmental factors and anthropogenic factors that might impact the sand volume on the North Beach. During the second half of the session, project teams use an online platform to collaboratively design a model showing how different factors within their system interact and influence one another. Lastly, they begin identifying any questions they have about their model to investigate further in Session 3.

Learning Outcomes & Assessments

By the end of this module, students will be able to...	***You can assess this using...***
1. ***Create*** a model that shows how environmental factors and anthropogenic factors might affect sand volume on the North Beach.	Project team models
2. ***Use*** their model to predict how changes to the environment will impact the amount of sand on the North Beach.	Field notebook entry; Whole class discussion
3. ***Reflect*** their model to predict how changes to the environment will impact the amount of sand on the North Beach.	Field notebook reflection

Session Overview

Section	Description	Length	Format
Launch	Students watch a video that introduces them to the idea of defining a system to study.	5 minutes	Whole class
Explore	Project teams discuss how to put boundaries on the system that they want to study, and then generate a list of factors that might affect the sand volume on the North Beach.	20-25 minutes	Project teams
	Project teams use their list to create a collaborative model using Padlet, SageModeler, or another online platform of the teacher's choice.	40-50 minutes	Project teams
	Optionally, project teams can also use their models to make predictions about how changes to the beach will affect the sand volume.	15 minutes	Project teams
	Finally, project teams identify what questions they still have about their model.	5 minutes	Project teams
Share	If there is time, students share their models with the whole class.	10-15 minutes	Whole class
Reflect	In their field notebook, students reflect on what they've learned from their model and what their next steps might be.	5 minutes	Individual

The Environmental Engineering Process: Designing a Model

During Session 2, students reflect on how they could clearly define the system that they want to study, and then collaborate with their project teams to design a computational model. This model is intended to show students' initial ideas about how different factors might affect the sand volume on Crystal Cove's North Beach.

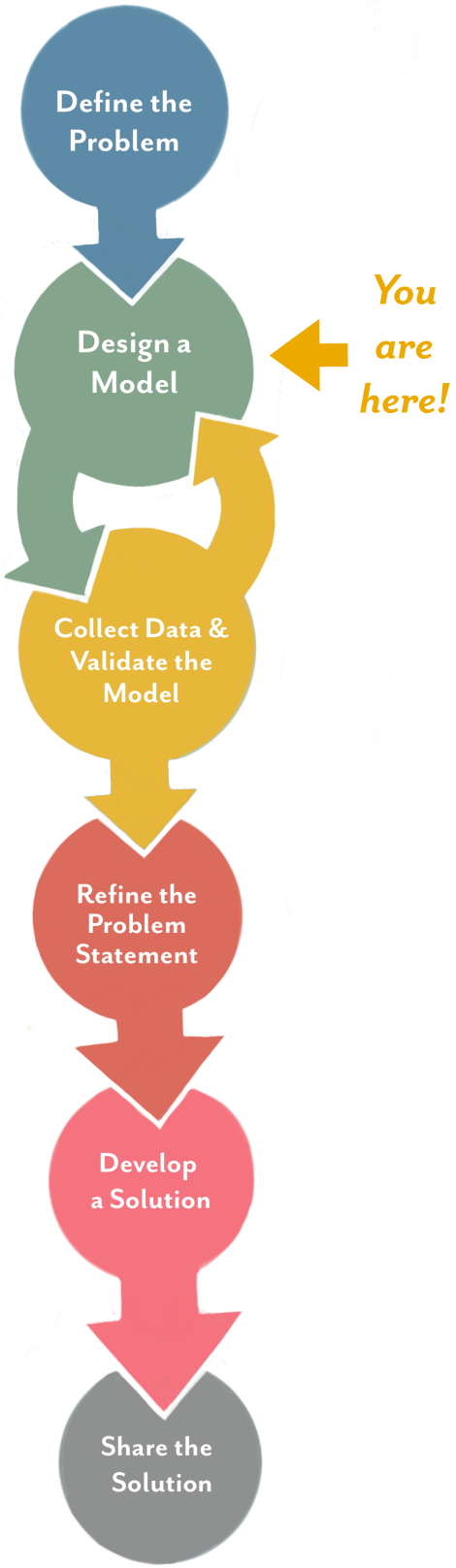
The model format that we use during the Coastal Dynamics program is intended to scaffold students so that they think specifically about how to define the relationships between different factors. Whether they use SageModeler or Padlet to build their model, they are encouraged to reflect on what happens to one factor when another increases or decreases. Clearly defining these relationships allows students to test the assumptions in their model with real-world data, giving them a chance to refine and validate them.

Ideally, the design of a computational model is an iterative process. First, students create a model showing their initial ideas about computational relationships between the different factors. Later, in Session 3, they'll have an opportunity to identify questions about the relationships in the model and conduct background investigations to build their understanding. Then, in Session 4, students will revisit and refine their model, incorporating their new ideas.

The refinement of a computational model continues in Session 5-7, when students collect and analyze environmental data from Crystal Cove State Park. This data then becomes evidence that can support the computational relationships included in the model, which could be further refined again.

You can choose how to structure Sessions 2-4 in your classroom. If you have less time available for the program, you may choose to skip background research and model revision, and instead have students move directly to collecting real-world data. Even if you choose to skip these intervening steps, however, we recommend making it clear to students that models are an iterative process that are refined and validated as our understanding deepens and as more real-world evidence becomes available.

It is also important to note that the model today may be very simple. That is okay! The initial model is intended to be used as an embedded assessment, which will allow you to identify gaps in current student understanding and decide which investigations to focus on during Session 3.



Choosing a Modeling Platform

In Session 2, student project teams work together to define a system to study and then build a model that shows how different environmental and anthropogenic factors impact the sand volume on the North Beach.

As the lead educator, you can choose which platform you want your class to use while building their model. Unfortunately, while online modeling platforms exist, no one platform is perfect. We recommend choosing between ***Padlet*** or ***SageModeler***, but you could also use Google Jamboard, another online whiteboard, or another platform entirely.

The pros and cons of our two recommended platforms are listed below.

Platform	Pros	Cons
Padlet Cost: Free for first three boards; requires $10/month subscription for additional boards	Modeling can be done collaboratively with multiple students using one online workspace at the same time. Teacher can see thinking in real time. Students can import videos, links, and images within the posts.	More difficult to show links and explain computational relationships. A free account can only create three Padlets (meaning students will need to sign up for their own account). Cannot import data and use it to test the assumptions in the model.
SageModeler Cost: Free	Specifically designed to support student modeling. Has a clear way to define computational relationships between components and processes. Can run simulations to see the effects of one component on another. Can import data to test the model and make graphs (which can be used to analyze data in Session 7).	One one person can manipulate the model at a time (meaning one student will need to manipulate the model and share their screen with others). Teacher can only view the contents when the link is shared, so it is hard to see thinking in real time.

Virtual Materials

- Session 2 Google Slides Presentation:
  - If you're using Padlet: ***http://bit.ly/3pyEjXI***
  - If you're using SageModeler: ***http://bit.ly/3qzNPev***
- Session 2 Field Notebook Template (optional): **http://bit.ly/37ufWnU**
- Template for your chosen modeling platform:
  - Padlet Template: ***http://bit.ly/2NIXsJm***
  - SageModeler Template: ***http://bit.ly/3ubpUEl***

Each student will need...

- A device with internet access (a computer, smartphone, or tablet will all work!)
- Field notebook and pencil

Before You Start Teaching

- Decide which platform you want students to use when building their project team model: Padlet, SageModeler, or another platform of your choice.

- Copy over the ***Session 2 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.)

- Review the lesson plan and decide how you will structure the session in terms of timing. Students will likely need about two hours to complete the session, so you may want to break it over two class meetings or assign some collaborative work outside of class.

Learning Sequence

Launch

Getting Started with Modeling (5 minutes)

1. Open the ***Session 2 Slideshow*** and play the video on ***Slide 2*** for your class. In this video, Erick will briefly introduce Session 2 and the fact that students will work in their project teams to define a system under study to understand how sand increases or decreases on the North Beach and then build a model of the environmental and anthropogenic factors that affect the sand volume on the North Beach at Crystal Cove.

2. After watching the video move on to ***Slide 3***, where you will find a graphic of the environmental engineering process with a marker pointing at Design a Model. Tell students that today, they will be moving onto the next step within the engineering design process to design a model that incorporates their initial ideas about what might affect the amount of sand on Crystal Cove's North Beach.

3. Once you've gone over the new step in the engineering design process, advance to ***Slide 4*** to give students an overview of what they will do and learn during Session 2.

Explore

Part 1: Brainstorming Environmental and Anthropogenic Factors (20-25 minutes)

1. Move on to ***Slide 5***. Erick will introduce the first task that students will be involved in for this session: defining a system to study. Once you finish watching the video, advance to ***Slide 6*** and have students think about how they might approach defining a system by answering the provided questions on the slide.

2. Once students have had a chance to reflect on how they would approach defining the system that they want to study, advance to ***Slide 7*** to see a video of Erick describing Crystal Cove's approach to defining a system.

Crystal Cove's approach to defining the system we want to study is very simple. We draw an imaginary box around the North Beach that signifies the area we want to study. Since we are interested in understanding how different factors increase and decrease the sand volume on the North Beach, we can simply track how the factors affect the input and output of sand within this imaginary box.

3. The next task is to think through the factors that we want to include in our model. Move onto ***Slide 8*** where students are prompted to start brainstorming the environmental (naturally-occurring) and anthropogenic (human-caused) factors that could affect the sand volume on the North Beach.

4. Once the video is done, move on to ***Slide 9*** and reiterate the task for students: They will work in their project teams to brainstorm environmental and anthropogenic factors that could affect the sand volume on the North Beach.

Let students know how you want them to record their list (in a shared Google doc, in their field notebook, etc.).

Some tips to share with students:

- We want to think about parts of the factors that could affect the sand volume (or even how sand moves) at the North Beach.
- Try to sort the list into environmental factors (components that are part of the natural environment) and anthropogenic factors (components caused by, created, or produced by humans)
- For now, all ideas are good ones! Your project team will be able to decide which factors are most important later.
- At this point, it's okay to think categorically rather than worry too much about particulars (saying "waves" instead of naming the exact features of a wave that contribute to the change).

5. Break students into their project teams and give them 10-15 minutes to brainstorm their list. If possible, give them a two-minute reminder before the end of the brainstorming time.

6. When the project teams are done brainstorming, play the video on ***Slide 10*****.** In this video, Erick will challenge students to pick the 8-10 items from their list that have the biggest effect on the sand volume.

7. Move on to ***Slide 11*** and ask students to break back into their project teams. Give them two minutes to choose the 8-10 items on their shared list that they think will be most important to include in their team model.

8. If there is time, advance to ***Slide 12*** and ask the project teams to share some of the final factors on their list with the whole class.

Part 2: Building a Team Model (30-45 minutes)

9. Once students have finished drafting their individual models, move on to ***Slide 13*** and play the video for the whole class. This will introduce them to the modeling platform that they will be using to build their team models. First, students will start by adding environmental factors to their model so that they can get a sense of how the system works without human impact. Afterwards, they will layer in the anthropogenic factors.

- If you are using Padlet, the model-building instructions are broken in two. There is one video on how to register for an account and set up a Padlet for their project team (***Slide 13***), written instructions on how to set up the Padlet (***Slide 14***), a second video and written instructions on how to use Padlet to add in environmental factors to their model (***Slides 15-16***), and third video and written instructions on how to add in anthropogenic factors to their model (***Slides 17-18***).

  Note that as students set up their model, they are asked to use conditional statements to describe the relationship between different components of the model. They will use these conditional statements to construct logical proofs later on so that they can use their model to make predictions about how changes to the system may impact the sand volume.

- If you are using SageModeler, there is a video and instructions on how to use SageModeler to incorporate environmental factors (***Slides 13-14***) and a second video with written instructions on how to add anthropogenic factors (***Slides 15-16***).

10. Give students project teams to build their models. If it is possible, visit each group (whether virtually and in person) to check in on their progress. As you do so, encourage them to think about parts of the system and factors that they can't see, as well as those that are visible.

Part 3: Using the Model to Simulate Change (Optional) (15 minutes)

11. If there is time, you can also ask student project teams to use their model to think about
how changes to factors within the system will impact the sand volume.

- If you are using Padlet, the video on ***Slide 19*** introduces the idea of how to use student models to think about change. Students will be using their created conditional statements to create a logical proof that describes how a factor with the system affects sand volume.
- If you are using SageModeler, students can use the slider bars within SageModeler to simulate change within their model. The screencast video on ***Slide 17*** will introduce how to do this.

12. After introducing the task, give students ten minutes to explore their model and determine how changes factors in the system will impact the sand volume on the North Beach.

Part 4: Identifying Questions (5 minutes)

13. After introducing the task, give students ten minutes to explore their model and determine how changes factors in the system will impact the sand volume on the North Beach.

Share

Sharing Our Models (Optional) (10-15 minutes)

1. Finally, move on to ***Slide 21*** (in the Padlet slideshow) or ***Slide 19*** (in the SageModeler slideshow), which will ask students to identify any remaining questions that they have about their models.

Move on to the next slide, which has written instructions, and give project teams a few minutes to finalize their questions.

Reflect

Reflecting on Session 2 (5 minutes)

1. Tell students that they have one last task.In the slideshow, advance to Padlet ***Slide 24*** or SageModeler ***Slide 22*** and play the video, where Erick will invite them to spend a few minutes reflecting.

2. Move on to the final slide, which shares, the reflection questions. Ask students to spend five minutes reflecting on their experiences today in their field notebook.

3. Finally, if you are able, thank the class for their time today. Tell them that when you gather again, they will dive deeper into the questions they identified they had within their model. They will later incorporate their newfound knowledge to revise their models.