Understanding Systems with Computational Models: Creating and Assessing a Computational Model

A system is a group of things which affect each other, such as plants and animals in a food web or parts of a machine. Models and simulations represent relationships and processes of systems with interrelated parts. Models can be computational or non-computational. **Computational models** represent mathematical relationships between parts of a system and are created using a computer. In this activity, you will create a computational model that represents a real world system.

1 Part 1: Identifying a Problem

Computational models can help us to understand real-world phenomena that are difficult to observe because of size, time, and/or visibility.

- Identify a real-world process or problem that a computational model might help you to illustrate.
- How does this phenomenon relate to your life and/or community?
- What do you wonder about this phenomenon?
- How can this model help you to better understand this phenomenon?

How does a submarine not sink or float (remain neutrally buoyant) in water? What factors determine if a submarine will sink or float?

A model can help me understand how a submarine remains neutrally buoyant by demonstrating the effect of variables on a submarine's buoyancy.

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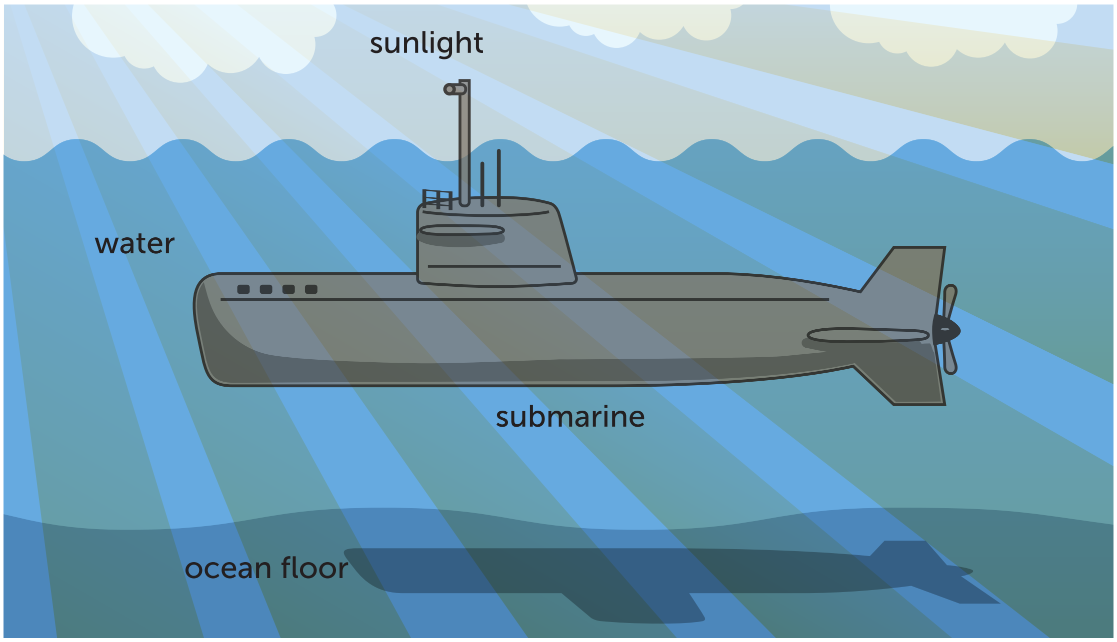
2 Part 2: Describe the Phenomenon

Sketch and label the phenomenon you will model here:



Think about the parts of the phenomenon, the purpose of each part, and if the part will perform an action in your program. Then, consider if the action depends on a variable. If it does, describe how the part, action, and variable are related. Here, you are describing the mathematical relationships you may illustrate in your model.

Parts Objects in the model	**Purpose** Role of the object in the system	**Action** Something the object might do	**Variable** A characteristic of the object that may determine if/how the action occurs	**How does the variable determine whether the object will do the action? Describe the relationship or equation.**
Ex: Lake	*Ex: storing water*	*Ex: Evaporate*	*Ex: Temperature*	*Ex: If the temperature is greater than 100 degrees C, the lake will evaporate*
Submarine	Traveling in the water	The submarine is going to sink, float, or neither in the water.	Density of the submarine The mass of the submarine: • What it's constructed of • How many people/ how much "stuff" its carrying The volume of the submarine	Density = mass/volume The volume of the submarine remains constant. The submarine can add mass by increasing the amount of water in its ballast tanks. This increases the density of the submarine. If the density is greater than the density of the water, it will sink. The submarine can lose mass by decreasing the amount of water in its ballast tanks, filling with air instead. This decreases the density of the submarine. If the density is less than the density of the water, it will float.
Water	Medium for submarine to travel	Might move/have a current Might be more or less dense based on the depth	Density of water Temperature of the water Salinity of the water Motion of the water Depth of the water	The density of water is 1 g/mL. The density of water changes with temperature and salinity. Ocean currents move objects Deeper water can be more dense due to increased pressure.
Sunlight	Affects water currents and temperatures	Might warm shallow water Might cause a current	Hours of sunlight Intensity of sunlight	Changes in water temperature cause convection currents.
Ocean floor features (subduction zones, rifts)	Affects ocean currents and temperatures	Areas of thinner crust could warm the water.	Depth of crust Temperature of water near crust	Changes in water temperature cause convection currents.

A model is a type of abstraction, or reduction of something to a very simple set of characteristics. In the last column of the chart, circle the relationships between parts, actions, and variables that are essential to understanding the purpose of the model you described in Part 1. Explain below:

In order to explore how a submarine sinks or floats in water, it is most important to determine the density of the submarine compared to the density of the water. If the submarine is more dense than water, it will sink. If it is less dense, it will float.

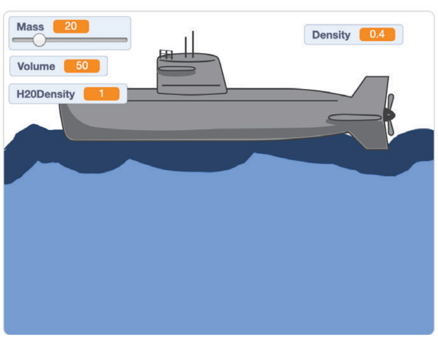
The density of the submarine is determined by mass/volume. There are factors that affect mass and volume that are determined when the submarine is constructed, such as how big it is and what it is constructed of. These will be excluded from our model because they are not easily modified. The mass of the submarine can be modified by adding people to the submarine or adding water to the ballast tank. This will be a variable that can be modified in the model.

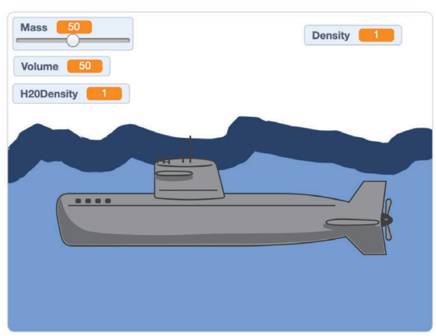
There are factors that can modify the density of water (e.g. salinity, temperature, sunlight, ocean floor features), but these variations are slight and therefore we will exclude from the computational model, keeping the density of water at a constant of 1 g/mL.

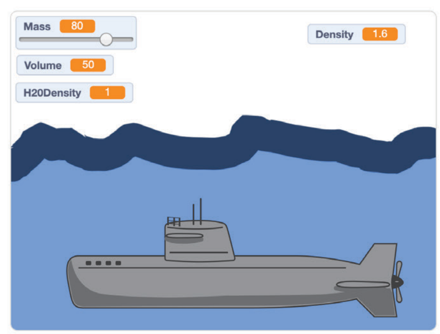
3 Part 3: Drafting Your Computational Model

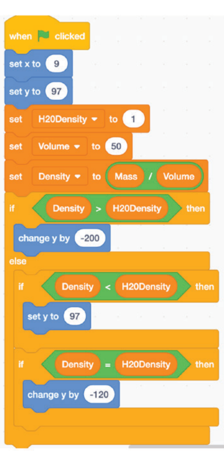
Now you will use a computational tool to create your computational model. There are many tools available to create computational models, such as coding platforms (e.g., Scratch, Snap, StarLogo Nova) or computational modeling platforms (e.g., SageModeler, Insight Maker, Loopy). Your teacher will tell you which tool(s) you may use for this assignment.

Link to Scratch model here









4 Part 4: Pair Debugging and Assessing Your Computational Model

(Note: Use this step if coding was used to create the model.)