Using Computational Models in Science

Companion Lesson to X-STEM All Access Episode "Using Data Science to Solve Problems"

Grade/ Grade Band: High School	**Topic:** Computational Thinking in Science Class

Brief Lesson Description: Students are introduced to computational thinking as a tool for science. They will begin by exploring science simulations and naming how computational thinking is used within them. Next, they will learn about key computational thinking patterns (Decomposition, Pattern Recognition, Pattern Abstraction, Algorithmic Design). Finally, students will use these computational thinking patterns to plan a computational model of a scientific phenomenon and present it to the class.

Performance Expectation(s): This lesson is focused on the science practice of Using Mathematics and Computational Thinking.

This lesson can support the following performance expectations:
HS-PS3-1: Energy
HS-LS2-1: Ecosystems: Interactions, Energy, and Dynamics
HS-LS4-6: Biological Evolution: Unity and Diversity
HS-ESS1-4: Earth's Place in the Universe
HS-ESS3-3: Earth and Human Activity
HS-ESS3-6:Earth and Human Activity
HS-ETS1-4: Engineering Design

Specific Learning Outcomes: Students will analyze a scientific phenomenon to determine components that should be included in a computational model or simulation.

Narrative / Background Information

Prior Student Knowledge: This lesson is based on students being familiar with phenomena in science class and basic understanding of systems as a way to analyze phenomenon.

Science & Engineering Practices:	Disciplinary Core Ideas:	Crosscutting Concepts:
Using Mathematics and Computational Thinking: Mathematical and computational thinking in 9–12 builds on K–8 experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions. • Create and/or revise a computational model or simulation of a phenomenon, designed device, process, or system. • Use mathematical, computational, and/or algorithmic representations of phenomena or design solutions to describe and/or support claims and/or explanations.	*Will vary based on performance expectations supported. See linked PEs above.*	**Systems and Systems Models:** • Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions–including energy, matter, and information flows–within and between systems at different scales • When investigating or describing a system, the boundaries and initial conditions of the system need to be defined and their inputs/outputs analyzed and described using models ***Connections to Nature of Science*** **Scientific Knowledge Assumes and Order and Consistency in Natural Systems** • Science assumes the universe is a vast single system in which basic laws are consistent

Possible Preconceptions/Misconceptions:
Many students have a misconception that computational thinking requires advanced skills and understanding of specific coding languages. However, the four main skills of computational thinking (decomposition, pattern recognition, abstraction and algorithm design) are fundamental across students' courses and lived experiences.

LESSON PLAN – 5-E Model

ENGAGE: Opening Activity – Access Prior Learning / Stimulate Interest / Generate Questions:

Introduce lesson to students as follows:
"Computational thinking is one of the science and engineering practices that we may not be very familiar with. Today we will explore what computational thinking is, how it is used in science and then use it to develop a deeper understanding of the phenomena we have been studying in this course."

Have students predict the meaning of computational thinking with a shoulder partner. Then explain that computational thinking is as follows:

"Computational thinking is an interrelated set of skills and practices for solving complex problems, a way to learn topics in many disciplines, and a necessity for fully participating in a computational world." (Digital Promise)

To learn about this skill set, tell students we will be learning about how Technical Sergeant Terica Clewis uses it to help the U.S. Air Force. Then, show students the video "Solving Problems with Data with TSgt Terica Clewis."

After the video, ask students, *"How do you see TSgt Clewis using computational thinking in her job?"*.

EXPLORE: Lesson Description – Materials Needed / Probing or Clarifying Questions:
Most often, computational thinking is used in science by using and creating a variety of computer models. To explore this idea a little further, we will be completing an activity at the Hour of Code.

Have each student go to an Hour of Code Learn. Using the search on the left, have students select "science" and use the tabs on top to select "Grades 9+". This will provide students many activity options to see how computational thinking can be related to science courses. Have each student finish one (or more) of the learning activities.

As an alternative, you can assign one of the suggested simulations below by course:
Physics: Coding Collision Simulations
Biology: Outbreak Simulator, Build an Animal Classifier
Engineering: Code Space Simulation: Coding Robots
Earth Science: Climate Clock, Coding in Astronomy

After providing time to explore and complete the activities, *have students discuss how these activities use computational thinking. Generate a list as a class.*

EXPLAIN: Concepts Explained and Vocabulary Defined:
Tell students that now we will define and explain computational thinking more deeply. Ask students to read the article "How Computational Thinking Sets Kids Up for Success In and Outside of the Classroom". As they read the article, have them complete the reading guide.

Following reading the article, discuss the terms and the answers to questions 1-3 from the guide. During the discussion, reinforce that these skills can be used across a wide variety of settings and are not limited to just making a computer program or programming a robot.

Vocabulary:
Computational Thinking, Decomposition, Pattern Recognition, Pattern Abstraction, Algorithmic Design

ELABORATE: Applications and Extensions:
In order to see how computational thinking can help us understand phenomena in our own class, we are going to consider how we would build a computational model for what we have been learning in this course.

As a group, pick a phenomenon you have been learning about in this science class. Then, use the Computational Thinking Graphic Organizer to plan for a model of this phenomenon.

EVALUATE:

Formative Monitoring (Questioning / Discussion): Discussion questions throughout Engage, Explore, and Explain section of lesson as well as answers to "After you Read" questions from Reading Guide.

Summative Assessment (Quiz / Project / Report): Have student groups present their planned models to the class. Following presentations, have students reflect on their own model and describe strengths and limitations of their own model after listening to other students.

Elaborate Further / Reflect: Enrichment:
Possible elaboration activities include having students develop a computer model using *Scratch* or other web based software for the plan they created. To learn more about *Scratch* simulations visit Scratch for Educators to learn more.

SOCIAL EMOTIONAL LEARNING ACTIVITY

CASEL Standard Addressed: Self Awareness

Being confident in your strengths
Technical Sergeant Clewis described in this video that she needed to find a mentor to build her confidence in her skills. Today we will be reflecting on our own strengths in order to build our own confidence. As humans, we each have unique qualities and skills that we add to our family, friends, community and school.

Have each student start by creating a sketch of themselves in the middle of a sheet of paper. Provide them 5-10 minutes and ask them to take time to represent themself.

Next, have students list 3 (or more) qualities I like about myself on the left half of the paper. If students are having difficulty generating this list, you may refer them to this list of "100+ Positive Character Traits".

Next, have students list 3 (or more) skills that I am good at on the right half of the paper. Again, if students are having difficulty generating this list, you may refer them to this list of "101+ Essential Skills to put on a resume".

Have students use "Stand Up, Hand Up, and Pair Up" to share their finished sheet with 3 other classmates.

As a class, discuss the power of being able to name our strengths. Ask students where they can put this to remind themselves of the strengths they bring when they are not feeling confident. (As an alternative, you can post them in your classroom!)

INTERDISCIPLINARY CONNECTIONS/IDEAS

Mathematics, ELA, Social Studies: Complete activities from Hour of Code Learn to see how computational thinking skills can be used in a variety of contexts.

Computer Science: Write code to create a scientific model for a science course at your school. Simulations can be built for any of the performance expectations listed on page one.

Materials Required for This Lesson/Activity	
Quantity	**Description**
Per Student	Device with Internet Access

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