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# What are Models and Simulations?

**Unit 4. Data Acquisition**

**Revision Date:** Sep 22, 2019
**Duration:** 1 50-minute session

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## Lesson Summary

### Summary

Students will define and identify models and simulations. They will work in groups to propose a simulation that could be used to investigate a hypothesis.

### Outcomes

- Students will identify real-world examples of models and simulations.
- Students will understand that models and simulations are used to generate new knowledge, as well as to formulate, refine, and test hypotheses.
- Students will understand that simulations allow hypotheses to be tested without the constraints of the real world.
- Students will provide examples of how simulations are used in an iterative and interactive way when processing information to allow users to gain insight and knowledge about data.
- Students will understand that the use of digital data to approximate real-world analog data is an example of abstraction.

### Overview

1. Getting Started (5 min)
2. Introduction to Content (10 min)
3. Guided Activities (30 min)
    1. Define and Identify Models and Simulations [10 min]
    2. Use Models and Simulations to Answer Questions [20 min]
4. Wrap Up (5 min)

### Source

Some of the ideas in this lesson were adapted from the CS10K community site, https://sites.google.com/site/mobilecsp/lesson-plans/realworldmodels (https://sites.google.com/site/mobilecsp/lesson-plans/realworldmodels)

Learning Objectives

## CSP Objectives

- *EU DAT-1 - The way a computer represents data internally is different from the way the data is interpreted and displayed for the user. Programs are used to translate data into a representation more easily understood by people.*
    - LO DAT-1.A - Explain how data can be represented using bits.

- *EU DAT-2 - Programs can be used to process data, which allows users to discover information and create new knowledge.*
    - LO DAT-2.E - Explain how programs can be used to gain insight and knowledge from data.

- *EU AAP-3 - Programmers break down problems into smaller and more manageable pieces. By creating procedures and leveraging parameters, programmers generalize processes that can be reused. Procedures allow programmers to draw upon existing code that has already been tested, allowing them to write programs more quickly and with more confidence.*
    - LO AAP-3.F - For simulations: a. Explain how computers can be used to represent real-world phenomena or outcomes. b. Compare simulations with real-world contexts.

## Math Common Core Practice:

- MP4: Model with mathematics.

## Common Core ELA:

- RST 12.7 - Integrate and evaluate multiple sources of information presented in diverse formats and media
- RST 12.8 - Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text

## NGSS Practices:

- 2. Developing and using models

## Key Concepts

- Models and simulations are used to generate new knowledge, as well as to formulate, refine, and test hypotheses.
- Simulations allow hypotheses to be tested without the constraints of the real world.
- The use of digital data to approximate real-world analog data is an example of abstraction.

## Essential Questions

- How can computational models and simulations help generate new understanding and knowledge?

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## Teacher Resources

Student computer usage for this lesson is: **optional**

These videos supplement the material covered in this lesson:

- Bill Nye and a scaled model of the solar system (4:17) https://www.youtube.com/watch?v=97Ob0xR0Ut8 (https://www.youtube.com/watch?v=97Ob0xR0Ut8)
- Computer Generated Model of a Solar System (2:41) https://www.youtube.com/watch?v=8z5mwAlxBYc (https://www.youtube.com/watch?v=8z5mwAlxBYc)
- Freedom Tower & WTC Buildings in Minecraft (3:01, start video at 1:09) https://www.youtube.com/watch?v=kWfNcjSw_3c (https://www.youtube.com/watch?v=kWfNcjSw_3c) (Could lead to a discussion of the limitations of modeling in Minecraft)
- Tsunami Propagation, NOAA (1:00) https://www.youtube.com/watch?v=BU9wR-rPpEs&index=7&list=UURvjyjVFLdCHZ6EVeOk1a4w (https://www.youtube.com/watch?v=BU9wR-rPpEs&index=7&list=UURvjyjVFLdCHZ6EVeOk1a4w)
- Interactive Simulation of an Epidemic (click on configuration data to change the parameters) http://nrich.maths.org/content/id/4489/epidemic2.swf (http://nrich.maths.org/content/id/4489/epidemic2.swf)

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## Lesson Plan

# Getting Started (5 min)

- **Journal: If I flip a coin 10 times, is it possible to predict exactly how many times it will come up heads? Why or why not?**

- A weather forecaster presented a forecast with a 20% chance of precipitation the next day. The next day it rained. Explain how the forecast may still have been correct.

# Introduction to Content (10 min)

**Introduce Vocabulary**

**Choose one of the simulations at Phet simulations and answer the following.**

- What models are being used?

- What details are included?

- What details are omitted?
- What does the simulation seem to show?

- How does the simulation repeat and interact when processing information to allow users to gain insight and knowledge about data.

**View these two videos**

**Bill Nye and a scaled model of the solar system (4:17)**

**https://www.youtube.com/watch?v=97Ob0xR0Ut8**

**Computer Generated Model of a Solar System (2:41)**

**https://www.youtube.com/watch?v=8z5mwAlxBYc** (https://www.youtube.com/watch?v=8z5mwAlxBYc)

# Guided Activities (30 min)

**Students create a journal entry responding to these two questions:**

1. What was a main idea presented by each video?
2. What aspect(s) of the models helped make that point?

**Students discuss each of the following with elbow partners then groups.**

1. How do the models in these videos depend on computing?
2. Consider the strengths and weaknesses of each model. What understanding can be better drawn from the first model and what understanding can better be drawn from the second?
3. What questions could be answered using these two models?
4. How does the use of digital data approximate real-world analog data? (point out that this is another example of abstraction.)

**From each group students share at least one response to each prompt.**

## Define and Identify Models and Simulations [10 min]

**Examples of models (do not need to show the entire videos for student understanding):**

- **Watch this video of a human heart simulation: Multi-scale Multi-physics Heart Simulator (https://www.youtube.com/watch?v=2LPboySOSvo) UT-Heart (5:15) (watch up to 2:00; the rest is interesting but not necessary).**

- What's an advantage to having so many data points? What about a disadvantage? (A supercomputer is necessary to run the simulation. Again, point out that this is an abstraction because the digital data is representing what is in the real world)

- How can you test a parachute to be used on Mars? https://www.youtube.com/watch?v=_jOzxEOlDJg (https://www.youtube.com/watch?v=_jOzxEOlDJg) (1:11)? Describe the physical test. Before that test, they create models and simulate on the computer - why? (It is very costly to run a test and to create an actual parachute. First be sure an idea passes a simulated test, then build it.)

- Freedom Tower & WTC Buildings in Minecraft (3:01, start video at 1:09) https://www.youtube.com/watch?v=kWfNcjSw_3c (https://www.youtube.com/watch?

v=kWfNcjSw_3c) (Could lead to a discussion of the limitations of modeling in Minecraft.)

**Examples of Simulations:**

- **Tsunami Propagation, NOAA (1:00) https://www.youtube.com/watch?v=BU9wR-rPpEs&index=7&list=UURvjyjVFLdCHZ6EVeOk1a4w (https://www.youtube.com/watch?v=BU9wR-rPpEs&index=7&list=UURvjyjVFLdCHZ6EVeOk1a4w)**

- Interactive Simulation of an epidemic (click on configuration data to change the parameters) http://nrich.maths.org/content/id/4489/epidemic2.swf (http://nrich.maths.org/content/id/4489/epidemic2.swf)

**Have students find and share simulations in each of the following:**

- **Financial (e.g., stock market forecasting)**

- Weather (e.g., predicting the path of hurricanes)

- Space (e.g., predicting the path of an asteroid)

- Sports (e.g., predicting championships)

## Use Models and Simulations to Refine Questions [20 min]

- **Select one of the simulations explored today.**

- Write a question the simulation could help answer.

- Run the simulation and write an answer to your question.

- Exchange your results with your elbow partner.

- Refine your elbow partners question

- Write an answer to the new question.

# Wrap Up (5 min)

**Journal: Have students record the definitions (in their own words) of the vocabulary used in this lesson: probability, model, simulation, and hypothesis.**

Evidence of Learning

# Formative Assessment

- Can students define models and simulations in their own words (and understand the difference)?
- During the activity, are students able to identify particular characteristics that will be included in a model and simulation as well as characteristics that are to be excluded?

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