Activity A Teacher Notes

Building a Simple Physical Model

Table of Contents

Activity A

Building a Simple Physical Model

Overview

In this activity students will use models to develop increased understandings of how a variety of factors influence the characteristics of planets in general and biomes, in particular. Students begin by constructing physical models of the different terrestrial biomes, using a variety of materials to represent their unique surface features. While a biome does contain both physical and living factors, students will only be considering the physical characteristics (color and an atmosphere) in this activity. By performing experiments on the effect of an atmosphere on the temperature of their model, students increase their understanding of the interrelating factors affecting environmental characteristics.

Learning Objectives

- ✓ Design an experiment that addresses a specific question and tests a hypothesis
- ✓ Differentiate independent and dependant variables
- ✓ Evaluate results and suggest modifications to an experiment
- ✓ Prepare a synthesis of the experimental results to prioritize a set of parameters
- ✓ Explain a conceptual relationship between temperature, energy inputs and surface features
- ✓ Describe strengths and limitations of physical models
- ✓ Magnitude of results and rate of change

Relevance

People all around the globe are concerned with current events and the impact they have on our daily lives. We are also interested in how events will change and affect our future lives and generations. This is especially true for events related to the Earth system that is our shared habitat. In order to make predictions about such a complicated system, we have to develop models. Only if we can improve what we know about the relative importance of specific factors/variables, can we understand the delicate balance that regulates earth's habitable temperature.

Materials

Each student group will need the following for this investigation:

2 small plastic containers (to hold the models)

Sand

A light source (150 Watt light bulb)

Cotton

2 thermometers

Transparencies

Various colors of aquarium gravel

Clear plastic wrap

Various colors of modeling clay

Aquarium moss

Period 1: Designing Biome Models and Writing Experimental Proposals

Preliminary Activity: Engagement

Assign student groups ONE of the six major terrestrial world biomes (tundra, temperate deciduous forest, coniferous forest, desert, grassland, tropical rain forest). Begin by having students think about the characteristics of that biome.

Also give students a color copy of the world vegetation map. This can be downloaded on the module's main web page for Topic 2 under *Data and Tools*. You will have students locate where their biomes are found on the surface of Earth. They should use their knowledge from the previous activities in Topic 1 to identify the locations. It may be helpful to have maps of the biome locations for the students to find their particular biome on the world vegetation map. Rather than have the students write directly on the map, give the student groups transparent acetate sheets (the kind used for overhead projectors) and markers. Students should trace all the areas where they think their biome is located.

Have the students present their ideas to the class in an informal setting. Be sure that each group can justify their selections.

Methods

Preliminary Discussion and Planning

Once the students have identified their biome areas on Earth's surface (world vegetation map) they should determine what color material will best represent its physical features in their model. Tell the students to build models that represent the same amount of different colored areas that they have seen on the world vegetation map. Before they can begin however, they must first determine the amount of each color that they want to use in their model.

1. Students will overlay their outlined transparent sheets with a transparent grid box sheet. By counting the number of boxes of each color and the total number of boxes that their biome

consists of, the students can determine the percentage of each colored material to use in their model.

2. Students should trace their biome outline onto the grid box sheet. This will allow the students to count the total number of boxes that make up their biome.
3. Students will count the number of boxes covering their biome.
4. Have students place their outlined grid box sheet onto the world vegetation map. Next, they count the number of boxes for each of the different colors they see within the outlines of their biome. Each color should have its own number of boxes.
5. Students calculate the percentage of boxes that represents each color. This can be done by dividing the number of boxes for each color by the total number of boxes and multiplying by 100. This number also represents the percentage of each colored material that they will use to construct their physical model.

Experimental Design

Now the students are ready to write up an investigation work plan. Students should be shown the materials that they will use to build their models. Often it is helpful to students if they can physically manipulate the materials as they are writing their plan. Just remind the students that they can "play" with the materials some today, but they will not be actually constructing their models until the following period.

1. Students need to determine how their team is going to work on this model building activity. They should discuss the individual team roles and complete Data Sheet 1: Team Member Roles.
2. Students should use Data Sheet 2: Experimental Design Proposal to facilitate their plan.

End the class period by having each group briefly discuss the methods they will use in building their models. Also be sure to discuss the importance of teamwork and the roles that each student has taken on. Work out any conflicts or misunderstandings.

Period 2: Model Experiments: The Influence of World's Biomes on Temperature

Preliminary Activity: Engagement

Let's hypothesize. Present two questions to the students: 1) Does an atmosphere influence the temperature of a planet system? 2) How do the different biomes influence the temperature of a planet system?

Allow some time for the students to hypothesize about these two questions. For the influence of an atmosphere on surface temperature ask them to review the information in their introduction related to Mars and Venus. For the type of biome, instruct them to think in terms of the colors that are seen in each

biome as the students look down upon them (as they did when they looked at the world vegetation map). Also, it would be helpful for students to think about the colors of clothing people tend to wear in the summer as compared to the winter. You may need to discuss the concept of albedo (reflectivity) of different colors. If you live in an area where there is snow during the winter months have students think about how a layer of snow on a sunny day affects their vision.

After students have written their hypotheses, allow for brief discussions with a partner. Have the groups share their ideas with the rest of the class.

Methods

Experimentation and Observations

Instruct students to construct their biome models using the materials that you have provided.

1. Each group will need to make two models that are as identical as possible. In order to perform the experiment each group will need to have one model that has an atmosphere and another model that does not have an atmosphere.
2. Remind students that they need to use their estimated amount of each color to build an accurate representation. You may need to help each group make the appropriate estimations.
3. After the models are constructed have each group place thermometers on the surface of their models.
4. To simulate an atmosphere, students will place clear plastic wrapping on ONE model. Be sure to explain that the greenhouse effect is a bit different than this model. In reality there is not a thin layer that holds in the heat. This plastic sheet model will be used to understand a simplistic view of a planet's atmosphere.
5. Stress that each team must follow a common measurement protocol. You can remind them of the importance of standardization.
6. Each team will take temperature measurements on their atmosphere and no-atmosphere models every minute for 20 minutes. Be sure everyone is using the same units.
7. Have each group place their data on Data Sheet 3: Box Model Temperature Data.
8. If time permits students should repeat the data. Students could make modifications to their models if it is thought that data would be more accurate. Or the data could be taken again with the models exactly as they were the first time. In this case the importance of repetition in scientific experimentation could be stressed.

Data Analysis, Comparisons and Consensus

1. Students analyze the data by completing Data Sheet 4: Experimental Results, the section titled: Your Biome Conditions.

End the class by a brief discussion of the different results. Have each group provide a preliminary comment on the results they have obtained.

Period 3: Sharing and Critiquing Results

Preliminary Activity – Engagement

Provide the student groups with the two graphs found in the References at the end of these Teacher Notes. Have students compare the data for the two different situations (atmosphere and no-atmosphere) and then answer the following questions:

a) How does an atmosphere seem to have affected the temperature in the models?

b) Are the results similar to yours? Explain.

c) Do you have any questions about the experiment?

d) Do you think it is important to repeat experiments many times? Why?

Discuss student responses. Note that the graphical data prepared for this activity is merely meant to stimulate and is not representative experimental results. For example, how do we deal with data points that are **not** expected? This is to provide you with a place to begin a discussion about scientific experimentation and interpreting results. Look for areas of concern such as different starting temperatures or points which have rapidly increased or decreased. These unexpected results should evoke questions and discussions. Try to move students away from the idea that they are trying to get the correct results to being able to discuss results even when they are unexpected.

Data Analysis, Comparisons and Consensus (continued)

At this point in the activity students begin preparing presentations of their modeling experiments, including preparing a synthesis of results and building consensus about findings.

1. Provide each group with the materials to prepare their presentations. The type of materials will depend on the type of presentation that you want the students to give (PowerPoint, Poster board, Overhead Projector). Also, the amount of time allocated for each presentation will depend on your own classroom situation. Just be sure to give the students the guidelines for their presentations. Also, be sure to tell the students to include the following information in their presentations:
   - ✓ Research question

- ✓ Hypothesis
- ✓ General methods
- ✓ Results
- ✓ Discussion of what the results mean

2. Each group present their findings. As each group presents have each other group take notes on the class results using Data Sheet 4: Experimental Results, the section titled Class Biome Conditions.
3. Following all presentations have each student make a histogram of the class results showing temperature differences from each of the different biomes, using Data Sheet 5: Graph Data.
4. There are Individual Assessment Questions for students to complete that will challenge them to use the ideas gained from this activity and to further interpret thedata table and graphs.

End with a class discussion of the activity.

Several other questions can be posed to the class in this discussion. What are the strengths and limitations of physical models? How well do you think physical models simulate the actual temperature differences found on planets with a thin atmosphere compared to those with a thick atmosphere? What could be changed in the physical models so that they could better simulate the real planets? What alternative modeling techniques are used by scientists? Explain that scientists to represent even more complexity in the planetary system also use computer models.

Figure 1. Physical Model Example Data

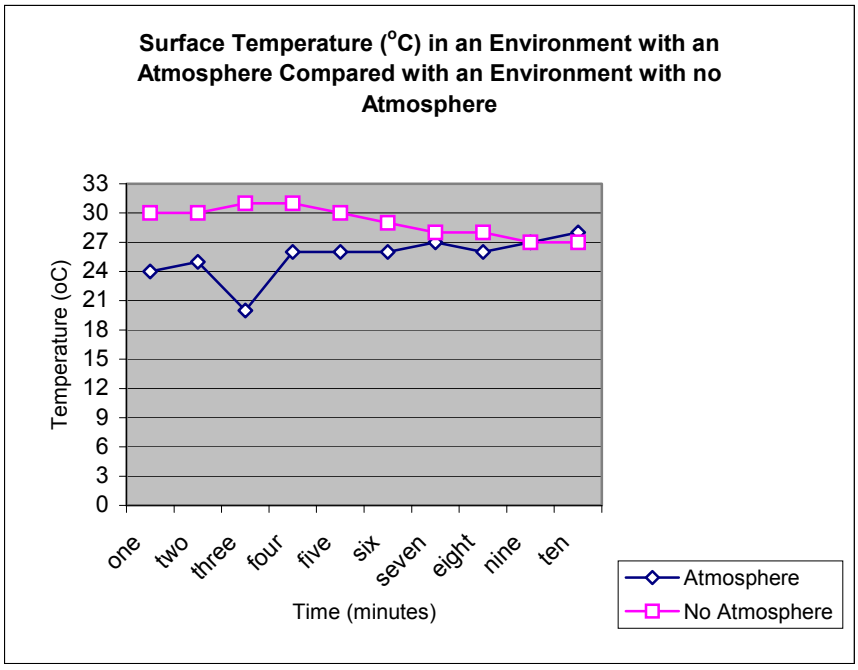

Figure 2. Physical Model Example Data