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Fish Bowl Biomes: Hands-on Education of Biomes, Climate and Climate Change

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Non-major science students often have a difficult time conceptualizing how climate works and how it may change over time. There are few hands-on climate and climate change labs that are appropriate for non-major undergraduate students. We have developed a 'fish bowl biome' exercise to help students consider climate and how it may change in response to a variety of factors. At the beginning of this lab students hypothesize how climate differs in biomes around the globe, and then circulate around the lab to document temperatures from digital readings in eight separate 'fish bowl biomes': marine, freshwater, polar desert, taiga, grassland, desert, rainforest, and city. We then modify some of the environments before discussing climate change in detail. Near the end of lab, students take final temperature readings and then graph their findings and develop conclusions prior to discussion. This exercise allows students to be actively learning to understand how climate works. It models the nature of science as they experiment to investigate climate and change over time.

Keywords: biome, active learning, climate change

Introduction

Biomes, climate workings and climate change have become important topics to include in many biology and natural science courses. These topics are often relegated to traditional approaches of teacher focused lecture and conceptual figures. The lack of hands-on activities for students to observe/manipulate does little to improve understanding of already difficult content. Hands-on learning can provide students opportunities to observe concepts in real time and space (Vesilind and Jones 1996; Michael 2006). Here we present a hands-on activity designed to be inquiry-based and promote active learning for the topics of biomes, climate and climate change.

This activity is presented near the end of a two week unit focusing on biomes, climate and climate change. The unit begins by discussing biomes. Earlier in the unit, students are asked to research biomes and characteristics of each (soils, animals, plants, climate, and geographic location). Discussion and activities demonstrating general mechanisms of how climate works on a global scale follow. Here students become familiar with the unequal heating of the Earth's surface as well as atmospheric circulation and global precipitation patterns (Hadley, Ferrel and Polar cells). This final activity, Fish Bowl Biomes, is then presented to students to tie together many of the concepts with which they have become familiar and to introduce discussion related to climate change. Students should come into this activity well prepared to work through the demonstration with little input from the instructor. This activity is done over the course of one three-hour class period, during which time an instructor-facilitated discussion of climate change occurs. Final temperature readings of the biomes are recorded at the end of the three-hour period. We begin the following class meeting with a thorough student-led discussion of what students observed during the Fish Bowl Biomes activity and reasoning for their observations.

This activity was developed for a university freshman-level course aimed at elementary education majors. However, as discussed during the ABLE mini workshop, this activity lends itself well to modifications. Some of these modifications are discussed below. "Fish Bowl Biomes" could be modified for classrooms from junior high through a university major's course.

Student Outline

Fish Bowl Biomes

Over the last week we have discussed the different biomes across the globe, their soils, animals, climate and geographic locations. We have also spent time discussing how climate works. Mock biomes are set up for you to monitor the change in air temperature between different biomes. Before recording temperatures, **design hypotheses and rationale to describe how you think biomes will differ in temperature.**

1. What factors might influence the temperature of a particular biome?

Table 1. Hypotheses for relative biome temperature.

Biome	**Hypothesis**	**Reasoning**
Tundra		
Taiga		
Rainforest		
Prairie		
Desert		
Deciduous Forest		
Ocean		
Freshwater		
City		

Table 2. Temperature recordings for observed biomes.

Biome	**Starting Temperature**	**Mid-Point Temperature**	**Ending Temperature**	**Conclusion**
Tundra				
Taiga				
Rainforest				
Prairie				
Desert				
Deciduous Forest				
Ocean				
Freshwater				
City				

2. NASA has taken satellite images of the Arctic Tundra Ice Sheet melting over the last 20+ years. To simulate this, we are going to allow the snow to melt in our biome. What do you predict will happen to the temperature in this biome? Why?

3. During the simulation, we are going to “deforest” our tropical rainforest and add some “parks” to our city. What do you predict will happen to these biomes after these manipulations? Why?

4. Using graph paper provided, sketch a bar graph showing before and after temperatures for the biomes. Don’t forget to include a description/title and a legend for this figure.

5. What are your conclusions from this demonstration?

Notes for the Instructor

Set-up Notes

- Lamps are meant to reflect the intensity of solar radiation across different latitudes. Include 25 Watt bulbs for the tundra and taiga, 60 Watt bulbs for the forest and grassland, and 100 Watt bulbs for the rainforest and desert. Other areas use 60 Watt bulbs.
- Allow biomes to stand for approximately 20 minutes before asking students conduct their initial viewing. This allows for temperatures to stabilize.
- The longer you can let the exercise run before making final observations, the better. Our class meets for 3 hours, so students take readings at the beginning, at break ~1.5 hours in, and then during the last hour of class.
- Be sure to seal each biome with saran wrap and a rubber band.
- Thermometers are simple inexpensive digital terrarium models available at many pet stores and online.

Past Iterations of Fish Bowl Biomes

At the time of the 2014 ABLE conference the *Fish Bowl Biomes* activity had been used three separate semesters in a freshman level university classroom geared toward elementary education majors. During the first semester, fish bowls (1.5 gallon size) were filled with appropriate soil and freshly cut plant material. Plant material was chosen to best mimic actual vegetation characteristics of the particular biome (e.g. broad dark leaves for the tropical rainforest, wheatgrass for temperate grassland, etc.). Soils, as well, were mixed to best mimic the particular biome (e.g. high sand content for desert, soil taken from nearby mountains for the taiga). The following two semesters, seeds were planted ~2 weeks prior to using the activity in class in order to allow for live plant-air gas exchange. The ocean biome was filled with a 3% NaCl solution to mimic sea water. The freshwater biome was filled with tap water and a small amount of mixed protozoa. Stones, leaf litter, etc. were incorporated where appropriate. The city biome included pieces of concrete and a smoldering piece of paper to represent smog. The tundra included snow or ice over the semesters, each working well to illustrate concepts.

Future Modifications

Fish Bowl Biomes can be modified a great deal to suit the needs of a variety of levels and classroom types. The activity has been well received by students in our non-majors class but could be adjusted to levels of inquiry appropriate for junior high or high school students or college level science majors. Some of the main modifications we intend to make in the future, and those brought up during the mini-workshop include:

- Connecting more to biome research by asking students to research a particular biome and then mix the soil and plant the fish bowl themselves.
- Adding more modifications beyond deforesting the rainforest, adding "green areas" to the city and allowing the tundra or polar desert to melt.
- Adding more biomes to the list.
- Adding marine protozoa to the ocean biome.
- Increasing quantitative assessment, maybe with the inclusion of determining rates of change in temperature after modification.
- Maintaining the biomes in your own lab or classroom if space is available so that students might interact with the environments beyond this activity.

This list is clearly not exhaustive and could go on. The authors both strongly support and ask for other educators to make this activity their own according to their own classroom needs.

Figure 1. Example of the general set up for the biomes.

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Literature Cited

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About the Authors

Rachel Jones recently received her Ph.D. in Ecology from the University of Wyoming. She is currently an Associate Professor in Biology at the University of Science and Arts of Oklahoma. Rachel received her B.A. in Anthropology from Arizona State University in 2006. Shortly after, she entered the field of environmental consulting before beginning graduate studies at the University of Wyoming in 2008. Over the course of her graduate years, Rachel had the opportunity to assist and instruct many courses in botany, ecology and general life sciences for both majors and non-majors. Her teaching style focuses heavily on inquiry-based and hands-on approaches in both classroom and laboratory. Rachel's research interests include paleoecology of the southeastern United States as well as education studies focusing on student learning and comfort level in active inquiry-based science classrooms.

Brianna Wright received her M.S. in Botany from the University of Wyoming in 2007, where she has since worked for the Life Sciences Program. She is presently serving as the Assistant Director of the Program. In 2005, Brianna received her B.S. in Biology and secondary education certification from the University of Wisconsin-Stevens Point. She coordinates labs for major's biology, but her current passion lies in instructing freshman enrolled in non-major science courses. Brianna's teaching style interweaves lab, lecture, and discussion as students lead investigations into complex concepts in biology. She values student choice and ownership through inquiry. Brianna's research interests include supporting students as they transition from high school to college, and providing insight to instructors who teach these students.

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