

LTRP: Methods and Materials

Days 16, 17

OVERVIEW

Planning for the data collection field trip begins in earnest with this lesson and the next one, Data Sheets (Day 18). Today, the students design their experiment for the research question they selected during LTRP: Research Questions and Hypotheses (Day 8). In planning their experiment, students must consider the basic elements of experimental design emphasized in the paper towel and worm experiments. That is, they must distinguish between treatment types, determine what other effects they need to control for, replicate the experiment, and randomly select the replicates. To write up the experimental design, the students make a list of materials they need, including the quantity, and then describe, step-by-step, how to conduct the experiment. This section needs to be typed into the computer and saved on each group's research disk. The final step is getting the materials. Each group will need a bag or box to keep their materials together.

Focus Question: *How can we design an experiment to try to answer our research question?*

SCIENCE SKILLS

- ✓ Students will be able to apply concepts of experimental design (treatment types, controlling for unwanted effects, replication, randomization) to the design of their own research project.
- ✓ Students will be able to design an experiment suitable for answering their research question.
- ✓ Students will be able to list materials needed to perform the experiment.
- ✓ Students will be able to describe methodically how they will conduct the experiment.

BACKGROUND

Background information describing the concepts in this lesson is presented in the following sections:

Section I: Research Q&H – *Four Parts of a Scientific Report*

Section II: Experimental Design – *Treatment Types*

Section II: Experimental Design – *Controlling for Unwanted Effects*

Section II: Experimental Design – *Replication*

Section II: Experimental Design – *Repeatable*

Section II: Experimental Design – *Random*

MATERIALS

- ✓ access to computer lab
- ✓ map of field site
- ✓ student worksheet (provided)



LTRP



DEVELOPMENT OF LESSON

1. Review with students the following concepts of experimental design
 - treatment types
 - controlling for unwanted effects
 - replication
 - repeatable experiments
2. Ask the students how arbitrary choices might influence or bias data? For example, if you are comparing the number of different types of plants that grow on the forest floor near a stream and far away from the stream, you could bias your results by always choosing sites next to the trail for your far from stream replicates. How might the trail influence your results? *People walking on the edge of the trail could kill smaller plants. Dogs that urinate along the trail could affect what grows there. You might decide that all replicates must be at least 5 meters from the trail. Then where do you put your replicates?*

The following scenarios can be used as discussion tools to develop the concept of what is random. As students prepare their methods for their LTRP, they should think about how they will select exactly what to measure. Wherever possible, the selection process should be random.

- A) Dray wanted to study ferns. He wanted to know if they grew better in the sun or in the shade. He thought that they would grow better in the shade. He found 20 ferns that were growing in the shade at his study site. He picked the 5 healthiest looking ferns. Then he found 13 ferns growing in the sun and he picked the 5 weakest looking ferns. He compared their growth rates over the next 4 years and concluded that ferns do like the shade better. *This isn't random because all ferns did not have an equal chance of being in the study. He biased his results by selecting observations that already fit his hypothesis. The results from this study wouldn't give you any good information. A better way to select ferns would be to number them all and draw a number from a hat or to spin in a circle until someone with their eyes closed says stop then walk in that direction until the person says stop again and then take the closest fern. You could also pick a random direction and a random distance using a second hand (for direction) and the seconds on a digital watch (for distance). Just have someone who can't see the watches say stop and take the readings.*
- B) Franny loved blackberries. She wanted to know if blackberry plants produced more berries in wet soil or in dry soil. She surveyed her neighborhood and found 10 plants living in wet soil and 17 living in dry soil. She numbered each plant. She asked her friend to pick 4 numbers between 1 and 10. Then she included the blackberry plants in wet soil with those numbers in her research project. Next she asked another friend to pick 4 numbers between 1 and 17. She studied the blackberry plants in dry soil with those numbers. She counted how

many berries were on each plant. In the end, she found an average of 45.3 berries on the plants in wet soil and 23.9 berries on plants in dry soil. She concluded that blackberry plants produce more berries in wet soil than in dry soil. *This was a good random selection of observations or study units. It would be easy to believe the conclusions from this study.*

3. Ask for an example of a research question. Brainstorm possible experiments that could be done to try to answer the research question. Use the terms reviewed above to push the students to be more specific about the experimental design. Why are some approaches better than others? Is there such a thing as a wrong approach? You may need to go through this with more than one research question depending on whether the students are suggesting appropriate designs. You can choose a question from the group(s) most likely to have difficulty designing an experiment.
4. Hand out the worksheets and map of the field site. Review directions, then let the groups get started. You will have to circulate to answer questions and trouble shoot the experimental design. Elaborate experiments may be too difficult to realize unless the group is highly motivated and works well together.
5. Groups can divide responsibilities for typing and getting materials together. Many groups may need tape measures. If the tape measure will be used to measure transects or quadrats, a string or lightweight rope can be used as well. Meter divisions can be marked with a permanent marker or by tying a knot at the appropriate place. This will save on the number of tape measures needed.



DISCUSSION QUESTIONS

1. Why must some factors be controlled for?
2. Give an example of an experiment where some factor was not controlled for and may have affected the results.
3. Why are some approaches better than others? Is there such a thing as a wrong approach?
4. How is a randomly chosen replicate different from an arbitrarily chosen replicate?
5. Describe different ways to randomly choose a field plot.
6. What happens if, after carefully planning your experiment, you arrive at the field site and can't go to the area you planned on using?