

Using bean beetles to teach experimental design and experimental variables

Instructor Notes:

1st lab period.

1) Introduce the bean beetle to students.

A brief (10–15 minutes) lecture introduces students to the bean beetle. Photographs are used to train the students to recognize this species and identify the sexes (Blumer & Beck, 2011). The bean beetle's life cycle (egg -larva -pupa -adult) is discussed. Next, students are given Petri dishes containing beetles growing on mung beans and are trained how to observe and handle the beetles.

2) Engage the students in experimental design and data analysis using a previously set-up experiment

Following the introduction, a brainstorming session is facilitated. The whole class participates in the design of a controlled experiment to answer the question "If given a choice of various bean types, do beetles prefer to lay their eggs on the bean type from which they hatched (natal bean)?" ([Blumer & Beck](#)).

The entire class works together to formulate a hypothesis and design an experiment to test it. The class defines the control group, experimental group, independent variable, dependent variable, and controlled variables and decides the number of replicates that are appropriate. The instructor then provides the class with the results of the previously set-up experiment. Students tally the data and make conclusions on whether the data support or reject the hypothesis that was developed. The lab is concluded with a discussion of the strengths and weaknesses of the experiment.

Experimental setup: The instructor sets up the experiment as follows, a week before the laboratory. This will provide "real data" for students to tally while in the lab. To set up, place three virgin male beetles and three virgin female beetles hatched from mung beans (natal bean) into Petri dishes containing an equal number of mung, adzuki, and black-eyed peas (10 beans each) for about 1 week. A week later the plates are ready for the students to tally the number of eggs on each bean type to determine whether the beetles had a preference for their natal bean or not (Blumer & Beck, 2011).

3. Student groups choose a question and design their own experiment with appropriate sample sizes and controls

Students are divided into groups of four and are told that they will perform their own group experiment during the next lab period. They are provided a list of bean beetle observations and questions, as well as a list of materials that will be available for their use (see Student handouts).

This experiment was written by Allison D'Costa and Mark Schlueter, Georgia Gwinnett College (www.beanbeetles.org).

2nd lab period

4) Students present experimental design to peers and perform the experiment in class

As each group presents, the instructor and peers make recommendations. The students set up their experiment and, in the next few weeks, gather data and make conclusions on whether their data support or reject their hypothesis. Students are asked to reflect on how they could improve their experiment. Each student writes a laboratory report.

Preparation:

Fresh cultures of bean beetles can be obtained from Carolina Biological Supply. Stocks are made by growing the beetles to sufficient numbers in mason jars containing whole mung beans (or other bean type) covered with mesh. After 4–6 weeks at room temperature (or 3–4 weeks at 30°C), new beetles will emerge in large numbers, and they are ready to divide further. Stocks in mason jars should be replenished with fresh beans every 4–6 months. Because bean beetles are potential agricultural pests, the old cultures should be placed in a freezer for 4 days and then thrown in the trash.

To obtain virgin females and males, add fresh mung beans to a Petri dish along with several males and females. Allow females to lay eggs for several days. Beans with a single egg must be isolated (for example, each placed in a well of a 12-well plate), so that when the adult hatches, it remains a virgin.

Data collection:

An example of a typical student experiment: (see [Student BB Food Expt outline & data](#))

Observation (from student handout): It is claimed that adult bean beetles do not need to eat or drink.

Question: Would adding suitable food or water increase the life span of the adult bean beetle?

Hypothesis: If food or water was provided, adult bean beetles would live longer.

Control group: 2 males and 2 females in empty Petri dish, no beans/ food/ water

Experimental group A: 2 males and 2 females placed in Petri dish containing fruit fly media

Experimental group B: 2 males and 2 females placed in Petri dish containing some yeast

Experimental group C: 2 males and 2 females placed in Petri dish containing whole mung beans

Experimental group D: 2 males and 2 females placed in Petri dish containing natal beans

Experimental group E: 2 males and 2 females placed in Petri dish containing naked beans (seed coat removed)

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Independent variable: The food item or water given to the beetle

Dependent variable: Lifespan of the beetle measured in days

Controlled variables: Equal number of newly emerged males and females, all placed at the same temperature in a lab drawer.

Experimental Design:

There will be 6 groups (1 control and 5 experimental A, B, C, D, E). Each group will have 3 replicates, or 3 Petri dishes. Petri dishes will be stored in a lab drawer at room temperature. Each group will be checked every day around the same time and the number of dead beetles will be recorded. The experiment ends when all the beetles are dead.

Data analysis:

Students were introduced to t-test. Some data required ANOVA which was conducted by the instructor (See Student raw and Stat data)

References:

Blumer, L.S. & Beck, C.W. (2011). Bean beetles: a model organism for inquirybased undergraduate laboratories. [Online.] Available at <http://www.beanbeetles.org>.

D'Costa, A.R. & Schlueter, M.A. (2013). Scaffolded instruction improves student understanding of the scientific method & experimental design. *American Biology Teacher*, 75, 18–28.

Schlueter M.A. & D'Costa, A.R. (2013). Guided Inquiry Lab using Bean Beetles for Teaching the Scientific Method and Experimental Design. *American Biology Teacher*, 75, 214-218.

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