AP STAT DEBRIEF – Question 2

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2019 QUESTION 2: Experimental Design

Question 2: INTENT OF THE QUESTION

The primary goals of this question are to assess a student's ability to (1) identify components of an experiment; (2) determine if an experiment has a control group; and (3) describe how experimental units can be randomly assigned to treatments.

SAMPLE SOLUTION and COMMENTS:

Reading (grading) questions like question two can be a challenge for readers. There is a very precise easy to read version of the answers to this question, but students tend to write way more than is required by the rubric. In general on this question, students included extra information (like double blinding the insects and the researchers or calling the 0 ml/L a placebo) that did not negatively impact their score, though they occasionally would add something that changed the intent of their correct answer and result in a lower score. My overall suggestion for teachers is to remind students to: 1. answer the question, 2. be concise, and then 3. stop writing.

"Researchers are investigating the effectiveness of using a fungus to control the spread of an insect that destroys trees. The researchers will create four different concentrations of fungus mixtures: 0 milliliters per liter (ml/L), 1.25 ml/L, 2.5 ml/L, and 3.75 ml/L. An equal number of the insects will be placed into 20 individual containers. The group of insects in each container will be sprayed with one of the four mixtures, and the researchers will record the number of insects that are still alive in each container one week after spraying.
a. Identify the treatments, experimental units, and response variable of the experiment.
Treatments:
Experimental units:
Response variable:
b. Does the experiment have a control group? Explain your answer.
c. Describe how the treatments can be randomly assigned to the experimental units so that each treatment has the same number of units."

(a) Students had to identify the concentrations of fungus mixtures as the treatments, either explicitly or by listing the four treatments. Students had to identify the 20 containers as the experimental units and they had to identify the number of insects alive in each container after being sprayed by the mixtures as the response variable.
(b) The simplest answer to this question was "Yes, 0 ml/L," though students could include more information about why this is the case (and often did).
(c) The three components of the answer to part (c) included:

- 1. an appropriate labeling strategy
- 2. the description of an appropriate randomization application process
- 3. that the randomization results in an equal number of containers for each treatment.

NOTES/COMMON MISTAKES

1. Treatments and experimental units needed plural language for a correct response. Some students lost credit for saying things like “concentration of fungus and container” instead of their plural counterparts.
2. Many students incorrectly identified the insects as the experimental units, instead of the containers (or groups of insects). They did not get credit for this component of the rubric, but if they made this mistake they could get credit for saying that the response variable was “whether or not the insect lived or died” and they could get credit in part (c) by correctly randomizing the insects into groups for treatment.
3. Some students did not recognize the containers receiving the 0 ml/L treatment as control group in part (b). These students often felt this way because all containers were sprayed. They mistakenly believed that a control group necessitated that nothing at all was sprayed.
4. Another common mistake in part (b) was to claim that the 0 ml/L concentration formed a control group (which is correct) but also include that these containers did not get a treatment (which is incorrect).
5. Students could get credit in part (a) by listing out the four treatments. Many students that made the mistake in note 4 also failed to list 0 ml/L as one of the treatments in part (a).
6. Defining the response variable without language like “number of …” was a mistake some students made. “Insects alive in each container” is not a variable and was not accepted.
7. In order to get full credit for part (c), students had to create appropriate labels for the units/treatments, describe how to implement the random assignment process, and have a process that results in an equal number of experimental units assigned to each treatment. Students could use many different methods to earn full or partial credit, but, in my opinion, the students who used “the hat method” tended to consistently do well. This method usually went something like, “label all of the containers from one to twenty. Write the label for each container on an index card. Put the index cards in a large hat and shake the hat to randomize the cards. The first 5 cards pulled would represent containers that get the 0 ml/L concentration. The next 5 cards pulled would represent container that got the 1.25 Ml/L concentration, etc.” More complicated randomization strategies usually introduced a concept that wasn’t quite correct. Random number tables, rolling dice, and randomly assigning insects to treatments (instead of containers) would often result in a lower score.

TEACHER SUGGESTIONS

Experimental design questions on the AP Statistics exam require students to understand the vocabulary of experimental design in context. The language students use should be precise with attention to the details of the question asked. For example, when asked for the response variable, students often responded with something akin to “insects still alive.” They understood, to some degree what the question was asking them, but did not earn any credit for this response. With that response, was the student referencing the number of insects alive overall, which is not a variable? Or those alive in each container, which is closer to correct? Even if they included “insects still alive in each container” they are still not referencing a measurable variable, so still no credit. Students had to refer to “the number of insects still alive in each container” to get credit. I think this practice of answering the question precisely requires constant practice throughout the school year, with real consequences when students aren’t precise. I know that when I am grading student responses, I often unconsciously tend to see what the student intends and not necessarily what they wrote. Students must understand that language and precision to details is important. Sometimes using the wrong tense or wrong plurality can lower a student’s score, even when they know the correct answer.

Also, especially in part c., students seem to think that their answer must be overly complicated to get full credit. Or they are expecting the test to try to throw them a curve ball. My experience is that most questions are straight forward. The test writers are not trying to trick students with overly complicated questions. They ask a straightforward question and are just expecting students to answer with a straightforward answer. If students are writing and writing and writing on a question, there is a good chance that they have gone off the rails of the intent of the question. Caution students to “answer the question and then get out.” They don’t need to throw everything that they know at every question. They simply just need a simple precise answer.