Formulating a Scientifically Testable Question

Competency

Student can formulate a scientifically testable question(s) that relates to the context or data provided.

Focus of this assessment:

- ☐ Declarative knowledge
- ☑ Procedural knowledge
- ☐ Problem solving

Evidence

Students are provided a short list of variables that are related to a scientific topic or concept with which the students are familiar. The variables are listed without reference to how they could be observed, measured, or quantified. Approximately half of the variables are objectively measurable while the other variables are less objectively measurable. Students are asked to create and write down a scientifically testable research question that relates two of these variables in some way. To facilitate scoring, students also are asked to explain how each variable could be observed or measured. If a student selects a variable that is less objectively measurable, the student must describe a specific process to quantify observations of the variable that clearly is both objective and appropriate. A student's performance is scored with respect to whether a scientifically testable question is provided that relates two of the listed variables.

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Example Task

In this exercise, you will **create a scientifically testable question** related to behaviors and other characteristics of flowers. Use **two** of the following seven variables when you create your scientifically testable question:

- How beautiful a flower looks
- How often insects (pollinators) visit a flower
- How many flowers there are in a certain area
- How much nectar a flower produces
- How much a person enjoys the smell of a flower
- How much time insects spend visiting a flower
- How much familiarity a person has with a flower

1. **Choose two variables from the list above** that you think might have a relationship with one another. Be careful about which two variables you choose. Only pick variables you (or another scientist) could actually **observe or measure scientifically**. Write those two variables in the space below.

   1st variable:

   2nd variable:

2. For each of the two variables you chose, tell why it is possible to study the variable. To do this, **explain how each variable could be observed or measured**.

   Explain how your 1st variable could be observed or measured:

   Explain how your 2nd variable could be observed or measured:

3. In the space below, **write a scientifically testable question** that relates your two variables to each other.

Scoring Plan for the Example Task

1st Variable

Selected variable is one of the **more** objectively measurable variables. • How often insects (pollinators) visit a flower • How many flowers there are in a certain area • How much nectar a flower produces • How much time insects spend visiting a flower	1 pt.
Selected variable is one of the **more** objectively measurable variables, ***and*** one could quantify or categorize the variable given the student's explanation.	2 pts.

OR

Selected variable is one of the **less** objectively measurable variables, but student describes a specific process to quantify observations of the variable that clearly is both objective and appropriate. • How beautiful a flower looks • How much a person enjoys the smell of a flower • How much familiarity a person has with a flower	3 pts.

2nd Variable

Selected variable is one of the **more** objectively measurable variables.	1 pt.
Selected variable is one of the **more** objectively measurable variables, ***and*** one could quantify or categorize the variable given the student's explanation.	2 pts.

OR

Selected variable is one of the **less** objectively measurable variables, but student describes a specific process to quantify observations of the variable that clearly is both objective and appropriate.	3 pts.

Question Characteristics

Statement is phrased as a question.	1 pt.
Statement references the two variables that the student previously listed and no others.	1 pt.
Statement implies a relationship (causal or correlational) between the two listed variables.	1 pt.

Procedure for Creating Parallel Tasks

Parallel tasks will use a different research context and different list of variables. **The directions to the student, however, will remain the same across all tasks.**

- A list of six to eight variables is provided.
- Students are familiar with each variable, including all its characteristics relevant to the assessment.
- Students are not to have had previous experience using these variables to generate scientifically testable questions, conduct research, or interpret research results.
- All variables pertain to a single scientific context.
- These variables are not to be operationally defined. In other words, variables are expressed in a generic form without specifying how they might be observed, measured, or quantified. For example, "How many flowers there are in a certain area" is appropriate; "Number of flowers within an area one-meter square" is not.
- Approximately half of the variables relate to variables in the natural world that can be measured in an objective manner, including objects, organisms, events, natural forces, and the like. A competent seventh-grade student should be able to imagine how these variables could be observed or measured without much difficulty.
- The rest of the variables, however, pertain to things that typically are observed or measured less objectively, such as personal opinions and preferences or pseudoscientific claims (e.g., desirability of a fragrance or the attractiveness of an object). These are variables that students typically should avoid when formulating a scientifically testable question. However, a student may receive full credit when using less objectively observed or measured variables to form a scientifically testable question *if* the student sufficiently operationally defines the variables in order to indicate how they could be studied scientifically (e.g., the attractiveness of a flower to bees is related to the amount of UV light reflected by a flower).
- More objectively and less objectively observed or measured variables are phrased similarly so that students cannot easily distinguish between these variables based on superficial characteristics.

Scoring Plan for Parallel Tasks

Scoring plan used for the example task	Generic scoring criteria for all parallel tasks

1st Variable

Selected variable is one of the **more** objectively measurable variables. • How often insects (pollinators) visit a flower • How many flowers there are in a certain area • How much nectar a flower produces • How much time insects spend visiting a flower	Selected variable is one of the **more** objectively measurable variables.	1 pt.
Same as generic.	Selected variable is one of the **more** objectively measurable variables, ***and*** one could quantify or categorize the variable given the student's explanation.	2 pts.

OR

Selected variable is one of the **less** objectively measurable variables, but student describes a specific process to quantify observations of the variable that clearly is both objective and appropriate. • How beautiful a flower looks • How much a person enjoys the smell of a flower • How much familiarity a person has with a flower	Selected variable is one of the **less** objectively measurable variables, but student describes a specific process to quantify observations of the variable that clearly is both objective and appropriate.	3 pts.

2nd Variable

Same as generic.	Selected variable is one of the **more** objectively measurable variables.	1 pt.
Same as generic.	Selected variable is one of the **more** objectively measurable variables, ***and*** one could quantify or categorize the variable given the student's explanation.	2 pts.

OR

Same as generic.	Selected variable is one of the **less** objectively measurable variables, but student describes a specific process to quantify observations of the variable that clearly is both objective and appropriate.	3 pts.

Scoring Plan for Parallel Tasks (continued)

Question Characteristics

Same as generic.	Statement is phrased as a question.	1 pt.
Same as generic.	Statement references the two variables that the student previously listed and no others.	1 pt.
Same as generic.	Statement implies a relationship (causal or correlational) between the two listed variables.	1 pt.