

Specification for Assessment #2

Creating a Plan for a Scientific Investigation

Competency

Student can create a plan for carrying out a scientific investigation, including what, when, and how to measure variables.

Focus of this assessment:

- ☐ Declarative knowledge
- ☐ Procedural knowledge
- ☒ Problem solving

Evidence

Students are presented with a research question that can be addressed through systematic observation (not experimentation) that involves one independent variable and one dependent variable. The variables are ones with which students are familiar, but for which students have not previously used or studied in the context of conducting a scientific investigation. Students are instructed to develop a detailed and specific plan that describes the actions or steps they would perform to investigate the research question. Students are instructed to carefully explain how they would obtain observations or measurements of the independent and dependent variables. Because their plans are hypothetical, students may propose fieldwork and the use of materials or personnel not actually available to them. Students will be scored with respect to whether they convey which variables function as the independent and dependent variables, describe the plan in enough detail to allow replication by an independent scientist, propose measurements or observations that would result in meaningful data, consider at least one external factor that could influence the results, and include repetitive measurements of the variables.

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Example Task

Every fall, during their migration south to Mexico, thousands of monarch butterflies come to the St. Marks National Wildlife Refuge and other locations near Tallahassee. They feed on the nectar of saltbush flowers, one of their favorite food sources, which are blooming at that time. The photograph below shows monarch butterflies on a saltbush.



People prefer to eat at certain times. Maybe monarch butterflies also prefer getting food from saltbushes at certain times. In this exercise, you will **create a plan to investigate** whether butterflies prefer to eat at certain times of the day.

Example Task (continued)

- Research Question:** What is the relationship between the hour of day and the number of monarch butterflies feeding on saltbushes?
- Develop Your Plan:** Develop your plan for investigating this research question. Your plan must be very specific. Be sure to address each of these four points in your plan:
- **Describe** what you would do (and when you would do it) to investigate the research question.
 - **Describe** how you would obtain your observations or measurements and what instruments or equipment you would use.
 - **Provide enough detail** so that another person could carry out the investigation according to your plan.
 - **Describe** at least **one external factor** that could affect the results of your investigation.

In your research plan, an **external factor** is anything other than time of day that affects the number of butterflies feeding on the saltbush. It is important to be aware of possible external factors because they could affect the research. The external factors rather than the time of day might affect when butterflies feed on the saltbush.

You must prepare this research plan by yourself. However, it is okay if carrying out the plan you create requires others to help you. It also is okay if your plan would require going to places away from your school or using materials not available at your school.

On the paper provided, describe the plan you create. Again, be very specific and careful to address each of the four points listed above.

Scoring Plan for the Example Task

Plan Characteristics

Plan conveys that <i>time of day</i> is what might affect <i>number of butterflies feeding on a saltbush</i> . <i>For example, the point is awarded if the student</i> <ul style="list-style-type: none"> <i>explicitly states which variable affects the other variable,</i> <i>labels variables as “independent” and “dependent,” or</i> <i>implicates a relationship (e.g., hypothesizing a data trend indicating a relationship between the variables).</i> 	1 pt.
Plan describes a way to measure <i>time of day</i> .	1 pt.
Plan conveys that <i>number of butterflies feeding on a saltbush</i> might be affected by <i>time of day</i> .	1 pt.
Plan describes a way to measure <i>number of butterflies feeding on a saltbush</i> .	1 pt.
Plan consists of a logical sequence of actions or steps.	1 pt.
Plan description is sufficiently detailed to allow an independent researcher to replicate its fundamental elements (with replication of any errors within the plan).	1 pt.

Data Quality

<i>Time of day</i> measured via clock or watch and recorded in hours and minutes. Point is also awarded for measurements using a clock or watch taken on the hour (e.g., at 8 a.m. or at 8 o'clock) or every minute. <i>Point is awarded if an appropriate means of measurement is proposed, even if it is not the anticipated method listed above.</i>	1 pt.
<i>Number of butterflies feeding on a saltbush</i> recorded.	1 pt.
<i>External factor indicated</i> , such as presence of a predator (e.g., birds or any other reasonable factor) or weather condition (e.g., high wind) that could also influence <i>number of butterflies feeding on a saltbush</i> .	1 pt.

Repetition of Measurements

<i>Number of butterflies feeding on a saltbush</i> measured at two times (minimum) within a day. <i>The dependent variable must be measured at least once for at least two values or levels of the independent variable.</i>	1 pt.
<i>Number of butterflies feeding on a saltbush</i> measured at three times (minimum) within a day.	1 pt.
<i>Number of butterflies feeding on a saltbush</i> measured for same time period on at least two days, or <i>number of butterflies feeding on a saltbush</i> simultaneously measured using at least two observers. <i>The dependent variable must be measured multiple times for at least two values or levels of the independent variable.</i>	1 pt.

Procedure for Creating Parallel Tasks

Each task is to contain a different research question and pertain to a different research context. **The directions to the student, however, will remain the same across all tasks.**

- Research question proposes an observational (not experimental) scientific investigation (i.e., one that will involve only measured, not manipulated, variables).
- Research question presents two variables—one independent and one dependent—that are familiar to and readily understood by the students, but for which students have not previously used or studied in the context of conducting scientific investigations.
- A scientific investigation devised to address the research condition would invariably have to consider at least one external factor for which it is reasonable students would detect were they to seek out external factors that may influence results.
- Both an independent and dependent variable are embedded in the stated research question, but are not to be labeled as such.
- The dependent variable is **not** to be categorical. An example of a categorical variable is state of matter (solid, liquid, gas), which therefore could not be used as a dependent variable.
- The independent variable may be either categorical or continuous, but should have at least three values or levels. An example of a continuous variable is weight of a person.

Scoring Plan for Parallel Tasks

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

<p>Plan conveys that <i>time of day</i> is what might affect <i>number of butterflies feeding on a saltbush</i>.</p> <p><i>For example, the point is awarded if the student</i></p> <ul style="list-style-type: none"> <i>explicitly states which variable affects the other variable,</i> <i>labels variables as “independent” and “dependent,” or</i> <i>implicates a relationship (e.g., hypothesizing a data trend indicating a relationship between the variables).</i> 	<p>Plan conveys which variable functions as an <i>independent variable</i>.</p> <p><i>For example, the point is awarded if the student</i></p> <ul style="list-style-type: none"> <i>explicitly states which variable affects the other variable,</i> <i>labels variables as “independent” and “dependent,” or</i> <i>implicates a relationship (e.g., hypothesizing a data trend indicating a relationship between the variables).</i> 	1 pt.
Plan describes a way to measure <i>time of day</i> .	Plan includes a description of how the <i>independent variable</i> would be measured.	1 pt.
Plan conveys that <i>number of butterflies feeding on a saltbush</i> might be affected by <i>time of day</i> .	Plan conveys which variable functions as a <i>dependent variable</i> .	1 pt.
Plan describes a way to measure <i>number of butterflies feeding on a saltbush</i> .	Plan includes a description of how the <i>dependent variable</i> would be measured.	1 pt.
Same as generic.	Plan consists of a logical sequence of actions or steps.	1 pt.
Same as generic.	Plan description is sufficiently detailed to allow an independent researcher to replicate its fundamental elements (with replication of any errors within the plan).	1 pt.

Scoring Plan for Parallel Tasks (continued)

Data Quality

<p><i>Time of day</i> measured via clock or watch and recorded in hours and minutes. Point is also awarded for measurements using a clock or watch taken on the hour (e.g., at 8 a.m. or at 8 o'clock) or every minute.</p> <p>Instances of meaningful data include: student proposes an appropriate scale of measurement; student proposes an appropriate instrument with which to make measurements; student describes an appropriate means of recording data.</p> <p><i>Point is awarded if an appropriate means of measurement is proposed, even if it is not the anticipated method listed above.</i></p>	<p>Description of how the <i>independent variable</i> is measured or determined would result in meaningful data.</p> <p>Instances of meaningful data include: student proposes an appropriate scale of measurement; student proposes an appropriate instrument with which to make measurements; student describes an appropriate means of recording data.</p> <p><i>Point is awarded if an appropriate means of measurement is proposed, even if it is not the anticipated method listed above.</i></p>	1 pt.
<p><i>Number of butterflies feeding on a saltbush</i> recorded.</p>	<p>Description of how the <i>dependent variable</i> is measured would result in meaningful data.</p>	1 pt.
<p><i>External factor indicated</i>, such as presence of a predator (e.g., birds or any other reasonable factor) or weather condition (e.g., high wind) that could also influence <i>number of butterflies feeding on a saltbush</i>.</p>	<p>Plan includes consideration of at least one external factor that might influence the validity of the results (e.g., student explicitly mentions the need to account for a particular external factor; student's plan inherently accounts for one or more external factors).</p>	1 pt.

Repetition of Measurements

<p><i>Number of butterflies feeding on a saltbush</i> measured at two times (minimum) within a day.</p> <p><i>The dependent variable must be measured at least once for at least two values or levels of the independent variable.</i></p>	<p>Plan includes measurements of the <i>dependent variable</i> at different values or levels of the independent variable.</p> <p><i>The dependent variable must be measured at least once for at least two values or levels of the independent variable.</i></p>	1 pt.
<p><i>Number of butterflies feeding on a saltbush</i> measured at three times (minimum) within a day.</p>	<p>Plan includes measurements of the <i>dependent variable</i> for at least three different values of the independent variable.</p>	1 pt.
<p><i>Number of butterflies feeding on a saltbush</i> measured for same time period on at least two days, or <i>number of butterflies feeding on a saltbush</i> simultaneously measured using at least two observers.</p> <p><i>The dependent variable must be measured multiple times for at least two values or levels of the independent variable.</i></p>	<p>Plan includes multiple measurements of the <i>dependent variable</i> at each value or level of the independent variable for which data would be collected.</p> <p><i>The dependent variable must be measured multiple times for at least two values or levels of the independent variable.</i></p>	1 pt.