Formative Assessment Worksheet  
Specification #3

Teacher ID: CALA   
School ID: CALA

|  |  |  |
| --- | --- | --- |
| **Target competency:**  special arrow.wmf Student can organize data by creating a table, chart, or other representation to facilitate interpretation.  Student can make inferences and predictions and use the data to defend or refute conclusions.  NOTE: **Specification #3 combines two competencies. You should treat these two as one for the purpose of formative assessment; there is no need to complete separate worksheets.** | | |
| Anticipated student misconceptions relevant to this target competency:   * The data from a scientific investigation are corrupt and worthless to science if there is variation between trial measurements. | | |
|  | **Learning Progression Leading to the Target Competency** (List Building Blocks in Reverse Chronological Order) | **Type of Knowledge** |
| 5. | Student can identify data trends as supporting or refuting a proposed inference or prediction. | Procedural |
| 4. | Student can identify trends in a set of data presented in a table, scatterplot, bar graph, or pie chart. | Procedural |
| 3. | Students can identify characteristics of low- and high-quality tables, charts, and other representations of data. | Procedural |
| 2. | Student can hypothesize external factors that could confound the results of an investigation. | Procedural |
| 1. | Student can explain how repetition of trials and replication of scientific investigations help minimize the effects of measurement error. | Declarative |

Copy/paste **Building Block 1** into this box:

Student can explain how repetition of trials and replication of scientific investigations help minimize the effects of measurement error.

In two to four sentences, describe what you will do with your students to help them achieve this building block.

→ I will ask students to make measurements that I anticipate will vary slightly between students (e.g., having volunteers count how many paces the width of the front of the classroom is). Next, I will ask students to share their answers and, as a class, discuss implications and solutions to problems associated with inconsistent measurements. Then, I will guide discussion toward methods of minimizing the effects of measurement error through methods such as replication and repetition. Lastly, to address the misconception that variation between trials corrupts a scientific investigation, my students and I will discuss why it is important to both minimize and report inconsistencies; however, some inconsistency usually occurs but can be tolerated if it is small relative to true differences in the phenomena being measured.

State how you will assess this building block. In other words, what will you ask your students to do to establish whether they have achieved this building block? Identify the assessment format you will use.

→ I will provide students data obtained from an experiment measuring the weight of mice fed different diets. The data will contain variation within the different trials of the same diet (i.e., multiple mice fed the same diet will have different weights). Next, I will indicate that the researcher averaged the multiple measurements and that the study was replicated by other researchers. Then, I will ask students to answer the following questions during an in-class discussion: How does repeating the experiment with multiple trials help the researcher get a better idea of how each diet affected the weight of the mice? What was gained by having the study replicated by another researcher? How did averaging the measurements make them more usable? How do the inconsistencies between trials compare to the effect of the independent variable? Are the data still usable?

Copy/paste **Building Block 2** into this box:

Student can hypothesize external factors that could confound the results of an investigation.

In two to four sentences, describe what you will do with your students to help them achieve this building block.

→ I will present students with several hypothetical studies that demonstrate fallacious conclusions (e.g., a study that showed rooster crows cause sunrises). Students are asked to explain why they think the researchers’ conclusions were wrong and offer better explanations for the results. Through a discussion of other studies with confounding variables, I will demonstrate how confounding variables may provide alternative explanations for study results. I will then emphasize that if confounding variables cannot be controlled, a study’s results may not be meaningful.

State how you will assess this building block. In other words, what will you ask your students to do to establish whether they have achieved this building block? Identify the assessment format you will use.

→ Working in groups of two or three, students will list external factors that could confound three experiments that I select from their textbook. To help understand their thought processing related to external factors, I will ask students why each identified variable could confound the interpretation of results.

Copy/paste **Building Block 3** into this box:

Students can identify characteristics of low- and high-quality tables, charts, and other representations of data.

In two to four sentences, describe what you will do with your students to help them achieve this building block.

→ I will present students with data sets from studies (e.g., how sports drink consumption affects marathon finish times) along with two figures for each study (i.e., table, chart, or other representation) that summarize its data. The two figures will differ in respect to how efficiently they organize data to facilitate its interpretation. For instance, the first figure will not have data sorted or arranged according to the levels or values of the independent variable, averages computed, nor proper headings while the second figure will have all of these characteristics. Students will be asked to discuss which figure they think is more conducive to interpreting the study’s results and justify their response by identifying specific characteristics of the figures.

State how you will assess this building block. In other words, what will you ask your students to do to establish whether they have achieved this building block? Identify the assessment format you will use.

→ Students will be assessed individually. Using a handout to present various figures, students will be asked to identify characteristics of those figures that are low and high quality. They will be asked to briefly describe each identified characteristic to help me understand their reasoning.

Copy/paste **Building Block 4** into this box:

Student can identify trends in a set of data presented in a table, scatterplot, bar graph, or pie chart.

In two to four sentences, describe what you will do with your students to help them achieve this building block.

→ I will give students tables and graphs of results from studies that involve easily understood variables (e.g., weights of giant pumpkins from farms that use different quantities of fertilizers). After I explain the independent variable and dependent variable for each study, I will describe a trend in the data. Occasionally, I will describe a trend that is false to see if students are paying attention and can demonstrate their understanding by objecting to my incorrect statements. After I have described trends in the data, students will discuss whether they think my summary of the data is valid and if not, determine the true relationship between the independent variable and the dependent variable as well as how the relationship changes with differing levels or values of the independent variable.

State how you will assess this building block. In other words, what will you ask your students to do to establish whether they have achieved this building block? Identify the assessment format you will use.

→ Using the tables from the handout used in the assessment of Building Block 3, for each table, I will ask students to write a description of the relationship between the independent variable and the dependent variable. They will also be asked to write about whether the relationships change with differing levels or values of the independent variables.

Copy/paste **Building Block 5** into this box:

Student can identify data trends as supporting or refuting a proposed inference or prediction.

In two to four sentences, describe what you will do with your students to help them achieve this building block.

→ Building Block 5 will be addressed at the same time as Building Block 4. As each of the tables and graphs is discussed, I will present different inferences and predictions that the researchers might have made. I will ask the students to support or refute the inferences and predictions using specific data. If students struggle with this, I will more extensively model how one could use the data to support or refute a particular inference or prediction.

State how you will assess this building block. In other words, what will you ask your students to do to establish whether they have achieved this building block? Identify the assessment format you will use.

→ Using the handout mentioned in Building Block 3, I will ask the class to conclude whether or not the hypotheses were supported, citing specific data as evidence.

**Target Competency:**

Student can organize data by creating a table, chart, or other representation to facilitate interpretation.

Student can make inferences and predictions and use the data to defend or refute conclusions.

In two to four sentences, describe what you will do with your students to help them achieve this target competency, assuming they have achieved the above building blocks.

→ I will provide students with a small set of raw data that involves familiar or easily understood variables and have them practice summarizing the data in the form of a table, chart, or other representation. I will provide the students the *Student Formative Assessment Checklist* from this documentto evaluate their work. Groups of two or three students will work together to discuss and correct any errors. The final step will be to reconvene as a class to address any aspects the students had trouble with and how their answers might best be revised.

NOTE: **Do not state how you will assess this target competency in this box.** The design of the assessment is established by the specification. Use the following pages of the worksheet to describe what you will do to assess this target competency. Refer to the guidelines in the “**Procedure for Creating Parallel Tasks**” section in Specification #3 when developing this formative assessment.

**Student Instructions**

In this exercise, you will use data already collected by a researcher to help **evaluate this research question**:

What effect does salt have on the boiling point of water?

This research involves one independent variable and one dependent variable:

* Independent variable: amount of salt in the water
* Dependent variable: temperature at which water boiled

**Experimental Procedure:**

Three identical beakers were each filled with 1.0 liter of distilled (pure) water. Salt was added in different amounts, shown in the illustration below:

C:\Users\alamee\Desktop\beaker_illustration_fon#1A2.eps

The researcher heated each beaker. When the water began to boil, the researcher measured the temperature with a thermometer and recorded the measurement in a lab notebook. Then, the researcher conducted two more trials using the same procedure.

The data for all three trials are provided in the following table:

Trial 1

|  |  |
| --- | --- |
| Amount of salt | Boiling point |
| 1 liter water (0 g salt) | 99.8 °C |
| 1 liter water + 100 g salt | 101.5 °C |
| 1 liter water + 200 g salt | 103.4 °C |

Trial 2

|  |  |
| --- | --- |
| Amount of salt | Boiling point |
| 1 liter water (0 g salt) | 100.1 °C |
| 1 liter water + 100 g salt | 101.7 °C |
| 1 liter water + 200 g salt | 103.2 °C |

Trial 3

|  |  |
| --- | --- |
| Amount of salt | Boiling point |
| 1 liter water (0 g salt) | 99.9 °C |
| 1 liter water + 100 g salt | 101.8 °C |
| 1 liter water + 200 g salt | 103.6 °C |

**Student Answer Sheet Name:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

In the space below, **create a table, graph, or chart** that makes the data easier to understand.

**Answer the research question**: What effect does salt have on the boiling point of water?

Here are some things you should write about:

* Describe in detail any relationships between the amount of salt and the boiling point of water.
* Describe how the data support your conclusions. Refer to specific data.
* Explain why the researcher repeated the procedure three times. What does this additional information tell us?

Student Formative Assessment Checklist

**Directions:** Use this checklist to evaluate your work. Read each section below and put a check in the box (🗹) next to each statement that accurately describes your work.

**Data Representation**

|  |  |
| --- | --- |
| I created a table, graph, or chart that made the data easier to understand. | 🞎 |
| I put all of the data in a single table, graph, or chart. | 🞎 |
| I grouped the data by level of salinity (0 grams, 100 grams, and 200 grams). | 🞎 |
| I accurately recorded all of the data in my table, graph, or chart. That is,   * I did not leave any data out. * I did not accidentally change the values of any measurements. * If I averaged the data for each level of salinity, I did not make any calculation errors. | 🞎 |

**Measurement Error Observations**

|  |  |
| --- | --- |
| For each level of salinity, I either   * reported all three measurements, or * calculated the average of the three measurements. | 🞎 |
| I said that for each level of salinity, the temperature measurements were somewhat different from each other. | 🞎 |
| I said that these differences were small compared to the differences caused by the effect of salinity. | 🞎 |

**Major Findings**

|  |  |
| --- | --- |
| From what I said, it is obvious I saw that the boiling point is higher when salinity is higher. | 🞎 |
| I supported my explanation of the overall effect by using actual data. That is, I included actual values of both salinity and boiling point. | 🞎 |
| Better yet, I specifically explained that water’s boiling point increases with **each** increase in salinity. | 🞎 |
| I supported this more specific observation using actual data. This is, I used actual values of both salinity and boiling point. | 🞎 |