

Specification for Assessment #3

Organizing and Making Inferences/Predictions from Data

Competencies

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.

Focus of this assessment:

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

Evidence

Students are given a research question, along with data appropriate for evaluating this question and a description of how the data were obtained. Data include at least three observations or measurements of the dependent variable for each level or value of the independent variable. Students are asked to organize the data in the form of a table, graph, or chart; use the data to evaluate the research question; and present their findings and the procedures they used. The research question and the data involve concepts and variables with which students are familiar, but that are distinct from ones for which they have previously organized data or made inferences/predictions.

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Example Task

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

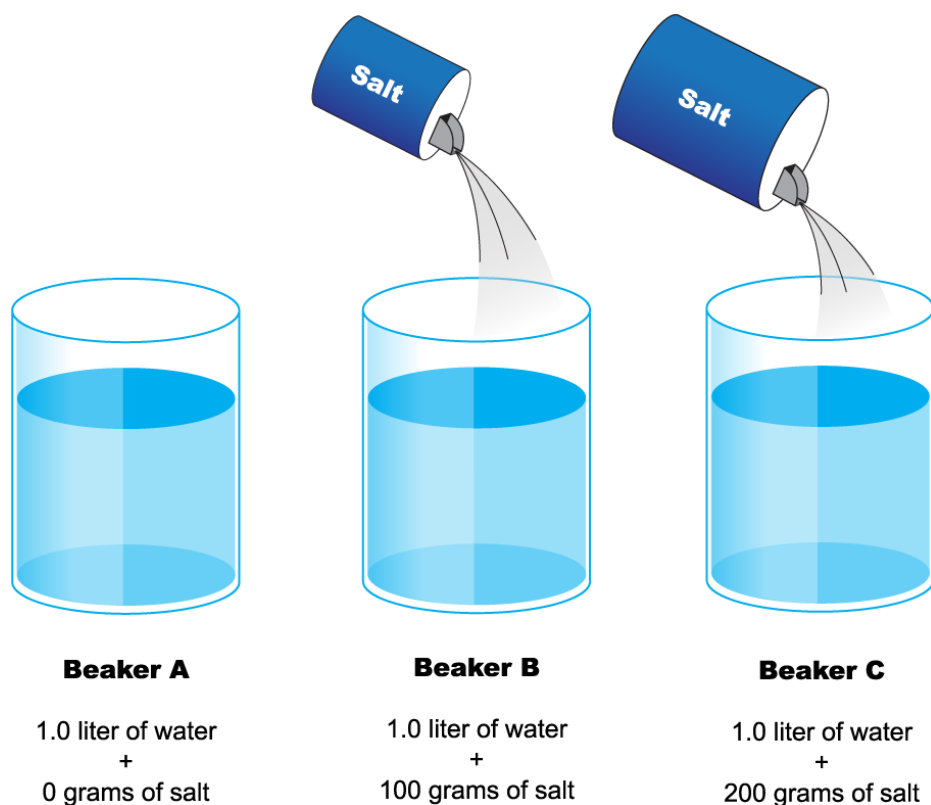
What effect does salt have on the boiling point of water?

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:



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:

Example Task (continued)

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

Example Task (continued)

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?

Scoring Plan for the Example Task

Data Representation

Student reorganizes data using a table, graph, or chart that improves interpretability of raw data.	1 pt.
Data are grouped in a single table, graph, or chart by level of salinity (0 grams, 100 grams, and 200 grams).	1 pt.
All data are represented in the table, graph, or chart (either averaged or as individual data points) and at least 2/3 of data are reported correctly.	1 pt.

Measurement Error Observations

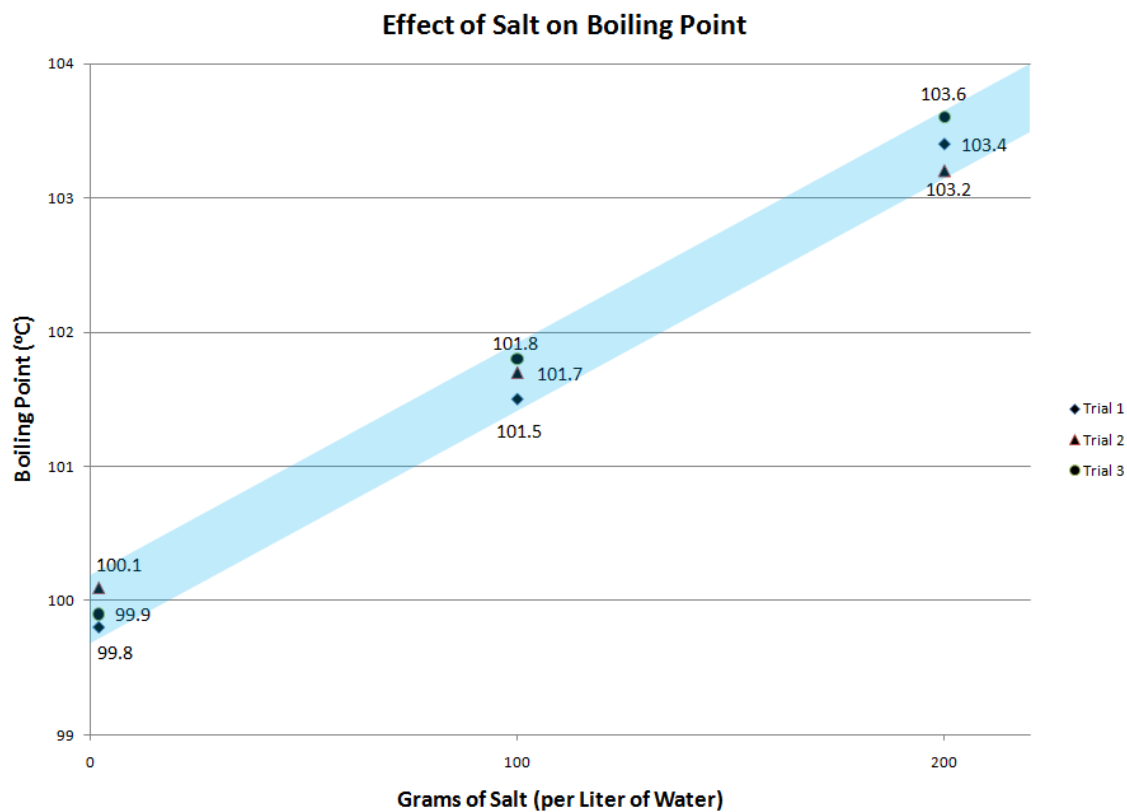
Inconsistency of temperature measurements obtained for each level of salinity is represented in the table, graph, or chart. If average values are reported, awareness of inconsistency is implied.	1 pt.
Student's narrative references above inconsistency of temperature measurements.	1 pt.
Student notes inconsistency is small compared to the effect of salinity.	1 pt.

Major Findings

Student observes that a higher temperature is required to make water boil when salinity is higher or the inference is obvious in the student's response.	1 pt.
Student cites specific data to support this conclusion. Numerical values of both the independent and dependent variables must be cited.	1 pt.
Student observes that water's boiling point increases with each increase in salinity.	1 pt.
Student cites specific data to support this conclusion. Numerical values of both the independent and dependent variables must be cited.	1 pt.

Scoring Plan for the Example Task (continued)

To facilitate scoring, this graph summarizes the data provided in the example task.



Salinity	Average Boiling Point
0 grams	99.9 °C
100 grams	101.7 °C
200 grams	103.4 °C

Procedure for Creating Parallel Tasks

Each task is to contain a different data set and research context. **The instructions to the student, however, will remain the same across all tasks.**

Students are given a research question, along with data appropriate for evaluating this question and a description of how the data were obtained. Students are asked to organize the data in the form of a table, graph, or chart; use the data to evaluate the research question; and present their findings and the procedures they used.

To allow the use of a common scoring plan for performance assessments developed from this specification, the following constraints are provided:

- The assessment presents two variables—one *independent* and one *dependent*—that are familiar to and readily understood by the students.
- 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. Instead, the dependent variable should be continuous (e.g., weight of a person) or discrete (e.g., count of number of people).
- The independent variable may be either categorical or continuous, but should have at least three values or levels.

In order to indicate the degree of measurement error, data should include at least three observations or measurements of the dependent variable for each level or value of the independent variable. Measurement error should be relatively small compared to the size of the effect of the independent variable on the dependent variable, so as not to obscure the effect.

Data presented to students should appear as if in the originally recorded form and should require reordering, summarizing, and/or graphing in order to detect relationships or patterns within the data (i.e., effects). Data for variables other than those directly addressed by the research question are excluded.

When appropriately represented by a student, the data exhibit an obvious effect of the independent variable on the dependent variable.

Each student's write-up is evaluated with respect to its documentation of how data are

- organized in order to facilitate their interpretation.
- used to support interpretations and predictions.

Scoring Plan for Parallel Tasks

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

Same as generic.	Student reorganizes data using a table, graph, or chart that improves interpretability of raw data.	1 pt.
Data are grouped in a single table, graph, or chart by level of salinity (0 grams, 100 grams, and 200 grams).	Data are grouped in a single table, graph, or chart by the levels or values of the independent variable.	1 pt.
Same as generic.	All data are represented in the table, graph, or chart (either averaged or as individual data points) and at least 2/3 of data are reported correctly.	1 pt.

Measurement Error Observations

Inconsistency of temperature measurements obtained for each level of salinity is represented in the table, graph, or chart. If average values are reported, awareness of inconsistency is implied.	Inconsistency of the dependent variable measurements observed at each value of the independent variable is represented in the table, graph, or chart. If average values are reported, awareness of inconsistency is implied.	1 pt.
Student's narrative references above inconsistency of temperature measurements.	Student's narrative references above inconsistency of the dependent variable measurements.	1 pt.
Student notes inconsistency is small compared to the effect of salinity.	Student notes that inconsistency is small compared to the effects of the independent variable on the dependent variable.	1 pt.

Major Findings

Student observes that a higher temperature is required to make water boil when salinity is higher or the inference is obvious in the student's response.	Student correctly identifies overall effect of the independent variable on the dependent variable or the inference is obvious in the student's response.	1 pt.
Same as generic.	Student cites specific data to support this conclusion. Numerical values of both the independent and dependent variables must be cited.	1 pt.
Student observes that water's boiling point increases with each increase in salinity.	Student correctly describes specific effect of the independent variable on the dependent variable (Example: Notes the dependent variable changed in the same direction each time the independent variable increased in value).	1 pt.
Same as generic.	Student cites specific data to support this conclusion. Numerical values of both the independent and dependent variables must be cited.	1 pt.