Competency #1: Investigating a Problem

Background research

Research is focused and directly relates to question and hypothesis.

Prompts

1. What is the goal of doing background research? Where does it fit into the process of carrying out an experiment? How should you organize the research?
2. Why is it important to summarize others' research?
3. How does a well-researched literature review relate to a good hypothesis?

Sources

Sources cited appropriately and paraphrased consistently and accurately.

Prompts

1. How do you cite sources in a scientific paper? Why is it necessary to cite sources in your research? How are these citations related to your bibliography?
2. How well did you paraphrase the writings you found? Why is it necessary to paraphrase the writings?

Making a testable question

Testable question demonstrates clear relevance and value to society.

Prompts

1. What makes a question testable?
2. What is the importance of a problem statement? How should it be formed?
3. What is cause and effect? How are cause and effect related to independent and dependent variable?

Making hypotheses

Hypothesis reflects a synthesis of background research and prior observations and states degree of certainty.

Prompts

1. What is an if…then statement? Why is it necessary to formulate a hypothesis in an if… then format?
2. In what sense does a hypothesis synthesize the background research?
3. What does it mean that a good hypothesis is predictive?

Competency #2: Construct and Explain Materials and Methods

Materials and diagram

Materials are listed in specific amounts and correctly named, and schematic diagram or diagrams shown.

Prompts

1. Why is it important to be specific about names, amounts, concentrations, brands, types, etc. when listing materials?
2. Why are diagrams an important part of a procedure? What is a schematic diagram?

Procedure

Sequential procedure is generated and independently documented.

Prompts

1. How does one write a procedure? How can trials and levels be easily incorporated into a procedure?
2. Why is it important to write procedures that are sequential and reproducible?

Variables

Knowledge of independent and dependent variables guides selection of materials and methods; controls are stated in design.

Prompts

1. What variables are important in a scientific study? Define them.
2. What does it mean to have a controlled experiment?
3. What are constants?

Competency #3: Gathering Data and Analyzing Results

Collecting data

A series of observations, comparisons, and measurements are made with precision using a wide range of apparatus. Multiple trials are carried out.

Prompts

1. What is the difference between qualitative and quantitative data?
2. What is the difference between discrete and continuous data?
3. Why is it important to be precise in data collection? What are units? Why do units need to be used as well as numbers?
4. What is the importance of repetitive trials?

Organizing data

Appropriate tables and graphs are chosen and constructed.

Prompts

1. What is the relationship between the type of data you are generating and the appropriate graph to be used?
2. What are statistical tables?
3. How do you determine the appropriate statistics in an experiment?

Analyzing data

Patterns are discerned in the data; outliers are identified. Data are subjected to statistical analysis.

Prompts

1. What are data sets?
2. What statistics are important when looking at data sets?
3. How and why do you compare data sets? What are you comparing?
4. What does it mean to look for patterns in your data?
5. What are outliers? How do they affect data sets?

Competency #4: Making Conclusions and Evaluations

Supporting a hypothesis with data.

Conclusion summarizes all findings and discusses connections to research.

Prompts

1. What does it mean to support your hypothesis with data?
2. How is your conclusion connected to your background research?

Error analysis

The magnitude of possible errors are indicated by showing how they affect results.

Prompts

1. What is experimental error? How is it connected to your procedure?
2. What does it mean to evaluate the magnitude of possible errors?
3. How is an error analysis related to the variation in your data?

New directions

Improvements are discussed, included how they are likely to affect results; new directions are logical and insightful.

Prompts

1. How are suggested improvements in your procedure connected to your error analysis?
2. How are your suggested improvements likely to affect the amount of variation in your data sets?
3. What does it mean to suggest new directions to your experiment? How can your suggested new directions help increase the breadth of scientific knowledge? How can they affect society?