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Parts of a STEM fair Project

Question

Good science investigations begin with a question. This question often asks "what if," "how," or "what effect something will have." The question should be relevant to the student and have an authentic connection to a real-world problem. The question should be testable and appropriate for the student. It should lead to an experiment which will yield either quantitative or qualitative data. A question that is well written will often identify the independent variable in the experiment (see procedure section below). Students should use the identified variable in the question to guide the research.

Research

The research provides the opportunity to read several different expository selections about the general topic. Acquisition of information allows the student to make an informed hypothesis. This also helps the formulation of a procedure for testing the hypothesis. Information may be found on the Internet or in non-fiction books. Students should identify the independent variable in order to narrow the research needed to make an informed scientific hypothesis.

Hypothesis/Scientific Claim

A scientific hypothesis is an attempted answer to the question being investigated. The hypothesis attempts to predict the outcome of the experiment and suggests a possible reason(s) for this outcome. The hypothesis should be based on research and/or prior knowledge/observations and is supported or not supported by the evidence collected from the investigation.

Materials

Materials used in the experiment need to be listed in specific amounts and sizes. (Example – three five-gram weights) This allows other people to replicate (repeat) the experiment exactly to see if they get the same results. This process is called verification.

Procedure

The procedure used in an experiment must be written in a clear, sequential manner in order to allow someone else to follow the same steps to replicate the experiment. Numbering the steps followed in the procedure is helpful to someone who is reading the procedure. The procedure should repeat the investigation a minimum of five times, or trials. This will provide the student with adequate data for locating the measure of central tendency. In determining the procedure that will be used in the investigation, the variables must be identified and controlled. Variables are the factors that will affect the outcome of the experiment. There are three types of variables that must be considered:

- **Independent variable (manipulated variable)** – the factor that will be intentionally changed during the experimental procedure in order to find out what effect it has on something else. An example of a manipulated (independent) variable is using different lengths of string to construct a pendulum in order to observe the effect the length of the string has on the swing of the pendulum.

- **Dependent variable (responding variable)** – the factor that is observed and measured to see if it is affected by the change made in independent variable. An example of a dependent variable is the number of swings the pendulum makes when the length of its string is changed.

- **Variables that are controlled** – the factors in the experiment that must be kept exactly the same to make sure that they are not having any effect on the dependent variable. Variables that would need to be controlled in the pendulum experiment would be the mass of the pendulum, the type of string, and the release height of the pendulum.

Results

Conducting the experiment or investigation produces evidence, which includes the measurements taken and observations made as well as a written explanation of the outcome. Evidence (data) that are observed or measured during the experiment should be recorded as the experiment is conducted. The best format to collect evidence (data) is a data collection table. When constructing a data collection table, it should be remembered that repeated trials (minimum of five) of the experiment must be conducted to obtain valid results. Data can then be analyzed and graphed. A statistical analysis of the collected data to include the median, or measure of central tendency, should be completed where appropriate. It is helpful to present the evidence (data) in the form of a graph so that the evidence (data) illustrated can easily be interpreted. The two most commonly used types of graphs for science experiments are detailed below.

Bar Graphs are used to display discrete data, or data that is distinct and separate from other information. Data shown on a bar graph often reflect measured or counted amounts. For example, the average number of drops of plain water versus the average number of drops of soapy water that will fit on a penny would best be shown on a bar graph. The bars drawn on a bar graph should all be the same width and are separated by spaces in between them. This is the most common type of graph used by fourth and fifth grade students to show relationships with data.

Line graphs are used to display continuous data or data that goes on without a stop or break. Experiments that have dependent (responding) variables involving temperature, time, or distance will usually yield data that should be graphed as a line graph. Line graphs are useful to analyze relationships among

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collected data. In particular, line graphs can show trends in data – increasing, decreasing, or staying the same. The dissolving time of a solid in a range of different temperatures would be an example of data best displayed on a line graph. Line graphs are used less frequently by fourth and fifth grade students, but may be used when appropriate.

The independent (manipulated) variable is usually represented on the horizontal (x) axis of a graph, and the dependent (responding) variable is represented on the vertical axis of a graph. The graph should also have:

- Numbers in even intervals (1's, 2's, 5's, 10's, 100's, etc.).
- Labels for both the horizontal (x) and vertical (y) axes.
- A title that reflects the information that is being represented on the graph.

Students should make use of appropriate software to complete the graph.

Written Results- Analysis of Data or Observations

The data chart and/or graph are followed by a paragraph describing the results. The paragraph should

- Note highs and lows of data collected.
- Include the calculated median as appropriate for the grade level.
- Describe trends in the data.
- Restate the number of trials completed.
- State any inferences and/or observations evidenced by the data.

Conclusion

Conclusion:

1. Should reflect back on the **hypothesis** and state whether it was supported or not supported by results (data or observations).
2. Should **answer the original question** that started the investigation and include evidence used to support the conclusion.
3. Should include **specific evidence** from the investigation.
4. Should include **inferences** that can be made **from the evidence** of the experiment.
5. Should include any **additional questions** that could be investigated or information that could be researched in the future. In addition, any problems that were experienced during the experiment can be discussed.