Elements of Experimental Design

Understanding the process of experimental design. It is a process that is structured in order to control variables, maintain consistency, incorporates a hypothesis or a prediction and is testable. The design of the experiment specifies that the experiment must be repeated 3-5 times in order to validate your findings.

Subject(s): Science
Grade Level(s): 8
Intended Audience: Educators
Instructional Time: 1 Hour(s) 40 Minute(s)

Suggested Technology: Document Camera, Computers for Students
Freely Available: Yes

Instructional Component Type(s): Lesson Plan, Problem-Solving Task, Instructional Technique
Instructional Design Framework(s): Guided Inquiry (Level 3), Cooperative Learning
Resource Collection: iCPALMS

ATTACHMENTS
General Layout for an Experimental Design Diagram.docx

LEsson CONTENT

Lesson Plan Template: Learning Cycle (5E Model)
Learning Objectives: What will students know and be able to do as a result of this lesson?
Students will gain a thorough understanding of how to design an experiment as well as all of the vocabulary associated with this process.

Content Statement: By conducting a guided inquiry activity regarding experimental design, students will be able to develop an excellent foundation for designing and performing experiments.

Prior Knowledge: What prior knowledge should students have for this lesson?
This benchmark requires prerequisite knowledge from SC.3.N.1.1, SC.3.N.1.3, SC.4.N.1.1, SC.4.N.1.6, SC.5.N.1.1, SC.5.N.1.2, SC.5.N.1.4, and SC.5.N.1.5.

Guiding Questions: What are the guiding questions for this lesson?
- What is experimental design?
- What are the steps to experimental design?
- Why is it necessary to perform these steps?
- What is a hypothesis?
- What must a hypothesis be?

Engage: What object, event, or questions will the teacher use to trigger the students' curiosity and engage them in the concepts?
You have a desire to know how high a ball can bounce from being dropped. How could you conduct a simple experiment utilizing a variety of balls to determine their ability to bounce?
Ask the students to place their ideas in their notebook citing their ideas as well as any definitions.

**Explore: What will the students do to explore the concepts and skills being developed through the lesson?**

Safety Precautions: Do not bounce the balls unnecessarily. Use them as intended for this lab activity.

Present the key question for this lab activity: What might be a way to design an experiment using the following materials: a table tennis ball, a golf ball, a superball, a small rubber ball, a meter stick?

How can experimental design be best observed in a laboratory activity?

Make sure that students clearly understand the question.

Present the materials required for the activity.

Students can work in pairs in the development of this activity. (DO NOT give the answers to the students. They should be able to determine that experimental design begins with a hypothesis and an experiment that is carried out in a controlled environment.

Students will be asked to conduct a guided inquiry activity by using the following materials: a table tennis ball, a golf ball, a superball, a small rubber ball, and a meter stick. They will need to drop these objects from a height of 1 meter and record and graph their bounce height.

The goal with this activity is that the students gain a thorough understanding of experimental design.

**Explain: What will the students and teacher do so students have opportunities to clarify their ideas, reach a conclusion or generalization, and communicate what they know to others?**

IMPORTANT: During this phase of the 5E model, the teacher guides students toward coherent and consistent generalizations, helps students with distinct scientific vocabulary, and provides questions that help students use this vocabulary to explain the results of their explorations.

**Analyze and Conclude**

Students should be able to understand that experimental design is a multi-step process that starts with a hypothesis that is testable in a controlled environment. Graphs and charts also are a part of this process and are open for interpretation.

**Checking for student understanding**

Have students write conclusion statements in their science journals. Students should discover the following:

- Experimental design
- Hypothesis
- Control variable
- Test variable
- Outcome variable
- Graphs/charts

**Teacher Explanation**

Experimental design is most important in answering a question or solving a problem. It is structure in that it begins with a hypothesis which must be testable. If not, then another hypothesis must be developed. This is a controlled experiment which means that one is controlling certain aspect of an experiment that can vary. In this type of experiment, only one variable can be changed at a time and that being the different types of balls observed, thus, named the test variable. The height was held constant as well as the room temperature and the location used. These are the controlled variables in the design. The students recorded the outcome or the dependent variable in terms of height for each ball. And as with all good science, each test MUST be repeated 3-5 times in order to eliminate erroneous results.

**Elaborate: What will the students do to apply their conceptual understanding and skills to solve a problem, make a decision, perform a task, or make sense of new knowledge?**

IMPORTANT: Teachers need to make sure that students can apply any new concept to a different scenario. A writing exercise will be an excellent way to assess mastery.

Challenge students to pretend they are on the scientific frontier and they need to design an experiment as a result of working in a laboratory. Ask the students to write 2-3 paragraphs describing what they would test and why this might be important in science and the real world. They might need to include the following terms:

- Experimental design
- Test variable
- Outcome
- Control variable
- Hypothesis
- Testable
- Graphs and charts

**Feedback to Students**

There will be an opportunity for the teacher to engage the students in discussion shortly after the activity to offer clarity and eliminate misconceptions.

**ACCOMMODATIONS & RECOMMENDATIONS**

**Accommodations:** Allow extra time for those students who are in need and confirm IEP.

**Extensions:** Bellwork quiz for the next class on experimental design.

If this cannot be completed during a class, it may be completed either before classes begin or at the end of the school day.

If the students are experiencing difficulty with experimental design, they can consult their text or reading materials.

**Suggested Technology:** Document Camera, Computers for Students
Special Materials Needed:
A table tennis ball, a golf ball, a superball, a small rubber ball, a meter stick

General Layout for an Experimental Design Diagram, attached

Further Recommendations: Textbook, various web sites.

Related Standards
<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>SC.8.N.1.1</td>
<td>Define a problem from the eighth grade curriculum using appropriate reference materials to support scientific understanding, plan and carry out scientific investigations of various types, such as systematic observations or experiments, identify variables, collect and organize data, interpret data in charts, tables, and graphics, analyze information, make predictions, and defend conclusions.</td>
</tr>
</tbody>
</table>