

SESSION 2: ASKING SCIENTIFIC QUESTIONS

~45 - 60 minutes

SESSION OVERVIEW

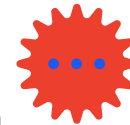
In this session, students learn how scientists turn curiosity into investigations by asking focused and testable questions. They also explore independent, dependent, and control variables through hands-on activities. Students also learn to modify their scientific questions so that they follow the SMART framework, which provides them with the foundation for designing good experiments in future sessions.

LEARNING GOALS

- **Identify** different variables in an experiment
- **Explain** the importance of controlling certain variables
- **Differentiate** between a testable and non-testable scientific questions
- **Design** good scientific questions using the SMART framework
- **Investigate** different variables to understand how they affect an experiment



Investigate



Design

SCIENTIFIC BACKGROUND

Science begins with curiosity, but good investigations start with a testable question. Scientists design good tests by changing one variable, measuring what happens, and keeping other variables the same. Learning to identify variables and ask SMART scientific question helps students plan investigations and collect meaningful evidence. These same skills are used by scientists at SNOLAB to investigate some of the world's biggest physics questions.

CURRICULUM CONNECTIONS

Science & Technology

- Grade 4-8: A1.1 - A1.5

Language Arts

- Grade 4-8: A1.2, A3.1, B1.1, B1.2

*Mathematics

- Grade 4: E2.2 & Grade 5-6: E2.1

*Health & Physical Education

- Grade 4-8: B1.1, B3.1, C1.2, C1.3, C1.4

* Indicates an extension activity connection

SESSION 2: ASKING SCIENTIFIC QUESTIONS

~45 - 60 minutes

MATERIALS

- Session 2 presentation
- Small boxes with small items inside
- Various small items (eraser, marble, etc)
- Metre sticks or measuring tapes
- Toy cars
- Cardboard pieces (for ramps)
- Laptop
- SMART board or projector

DISCUSSION PROMPTS

Before

- Can every question be answered with an experiment? Why or why not?
- What is something in science that you wonder about?
- How do scientists know if what they observed is actually true?

During

- What did you change? What did you keep the same?
- What did you notice when you changed one of the variables?
- How did changing more than one variable (adding a second object) make it harder?

After

- What did you learn about variables today?
- Why is it important to change only one variable at a time?
- What new questions are you curious about? Are they SMART?

EXTENSIONS & ASSESSMENT

STEM focused: Egg buoyancy experiment

- Students investigate how salt water affects how well an egg floats

Cross-curricular: Changing variables hula hoop toss (Phys. Ed)

- Students explore changing variables with an activity using bean bags and a hula hoop

Assessment: Session 2 Exit ticket

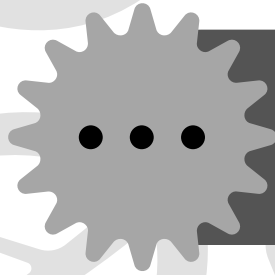
See the appendix for more details on this section



SESSION 2

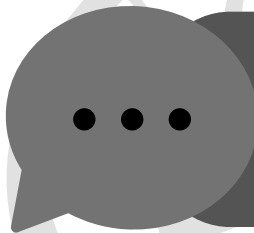
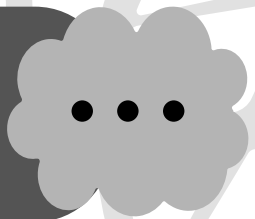
- Printable classroom poster - How to ask SMART questions
 - Printable classroom poster - Know your scientific variables
 - Asking Scientific Questions Exit Ticket (Grade 4 - 6)
 - Asking Scientific Questions Exit Ticket (Grade 7 - 8)
 - The Scientific Questions Worksheet Answer Keys
 - Extension Activity: Egg Buoyancy experiment (optional)
 - Extension Activity: Changing variables hula hoop toss (optional)
- 

HOW TO ASK SMART QUESTIONS



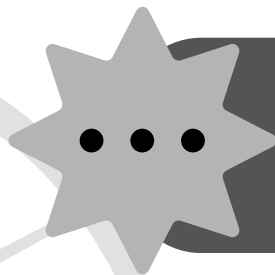
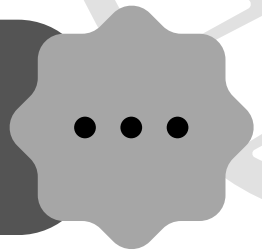
SPECIFIC

M EASURABLE



A CHIEVABLE

R ELEVANT



TIMELY



KNOW YOUR SCIENTIFIC VARIABLES



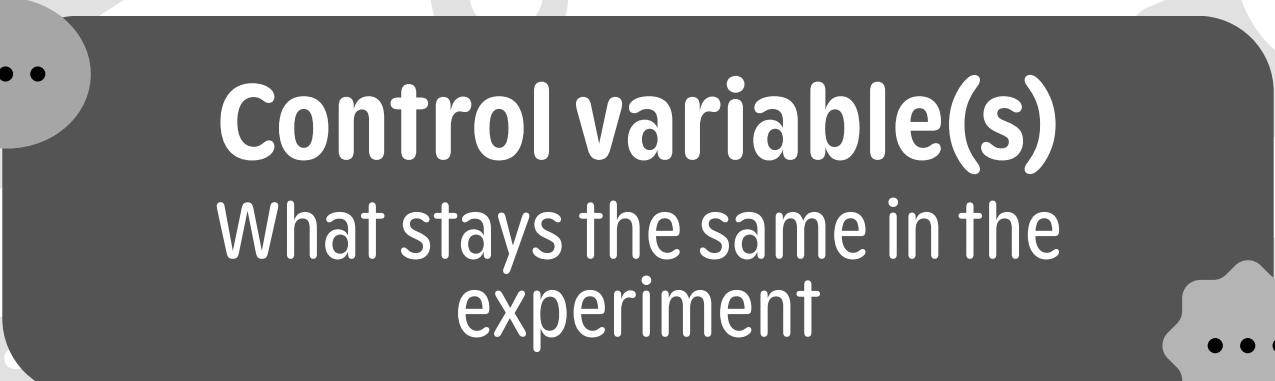
Independent variable

What is changing in the experiment



Dependent variable

What is measured in the experiment



Control variable(s)

What stays the same in the experiment



ASKING SCIENTIFIC QUESTIONS

Name: _____

1

A student wants to find out if sunlight affects plant growth. Match the variables below with the correct type.

Plant height

Independent (what is changing)

Amount of sunlight

Dependent (what is being measured)

Type of plant used

Control (what is staying the same)

2

Is this a SMART scientific question? Circle YES or NO.

a) Which pet is the best?

YES NO

b) Does temperature affect how fast ice melts?

YES NO

c) Is chocolate delicious?

YES NO

3

The question below is not a good scientific question. Rewrite it so it can be tested. (Hint: Use SMART to help you).

Which toy car is the best?



ASKING SCIENTIFIC QUESTIONS

Name: _____

1

A student is investigating if the temperature of water affects how quickly sugar dissolves. Identify the variables the student will need to complete the experiment.

Independent (what is changing): _____

Dependent (what is measured): _____

Control (what is staying the same): _____

2

Is this a SMART scientific question? Circle YES or NO and briefly explain why.

a) Are dogs better than cats?

YES NO

Reason: _____

b) Which paper towel brand is the most absorbent?

YES NO

Reason: _____

3

Choose one of the prompts and design your own investigation.

Paper airplane flight time **OR** Ball bounce height

SMART question: _____

Independent variable: _____

Dependent variable: _____

Control variable(s): _____



Name: TOTAL: 8 points

ASKING SCIENTIFIC QUESTIONS

1

A student wants to find out if sunlight affects plant growth. Match the variables below with the correct type.

Plant height ~~Independent (what is changing)~~
Amount of sunlight ~~Dependent (what is being measured)~~
Type of plant used Control (what is staying the same)

3 points

2

Is this a SMART scientific question? Circle YES or NO.

3 points

a) Which pet is the best?

YES ☒ NO

b) Does temperature affect how fast ice melts?

☒ YES NO

c) Is chocolate delicious?

YES ☒ NO

3

The question below is not a good scientific question. Rewrite it so it can be tested. (Hint: Use SMART to help you).

Which toy car is the best?

Answers may vary. EXAMPLE: Which toy car is the
fastest at going down a ramp?

2 points



Name: TOTAL: 11 points

ASKING SCIENTIFIC QUESTIONS

1

A student is investigating if the temperature of water affects how quickly sugar dissolves. Identify the variables the student will need to complete the experiment. 3 points

Independent (what is changing): Water temperature

Dependent (what is measured): Time to dissolve sugar

Control (what is staying the same): Amount of water, stirring, etc.

2

Is this a SMART scientific question? Circle YES or NO and briefly explain why. 4 points

a) Are dogs better than cats? YES NO

Reason: Requires an opinion, so it is not testable.

b) Which paper towel brand is the most absorbent? YES NO

Reason: Abides by the SMART acronym, so it's testable.

3

Choose one of the prompts and design your own investigation.

Paper airplane flight time OR Ball bounce height 4 points

SMART question: Does the type of paper affect how far a paper airplane flies?

Independent variable: Type of paper

Dependent variable: Distance (cm)

Control variable(s): Starting point, throwing angle/speed, etc.



EGG-CELLENT SCIENCE

MATERIALS

- Raw eggs
- Table salt
- Clear cups or bowls
- Water
- Tablespoons or measuring cups
- Stir sticks or spoons
- Paper towels
- Egg-cellent science worksheet
- Optional: Tray or tub for spills
- Rulers or measuring tapes

INSTRUCTIONS

1. Briefly discuss the different types of variables in a scientific investigation and review the importance of writing SMART scientific questions
2. Divide students into groups of 3-5 and distribute all materials to each group.
3. Give students a few minutes to discuss what questions they could investigate about how salt affects an egg's ability to float, their predictions, and the experiment's variables.
4. Once all group members have completed their planning, they may begin the investigation.
5. Fill two clear cups or bowls with equal amounts of water (this is a control variable).
6. Add 1-2 tablespoons of table salt to one of the cups and stir until it is completely dissolved.
7. Gently place the egg into the cup with plain water (no salt).
8. Observe for 30 seconds and record observations on the worksheet.
9. Use a ruler or measuring tape to measure the distance between the bottom of the container and the egg. Record the measurement.
10. Carefully remove the egg and dry it with a paper towel.
11. Place the egg into the saltwater solution.
12. Observe for 30 seconds and record observations.
13. Repeat the experiment using different amounts of salt, recording the amount each time.
14. Students discuss in their groups about what they observed, why they think it happened, how it relates to variables, and how changing the salt affected the egg's ability to float.
15. Gather as a class and discuss the experiment, focusing on what students observed and how it relates to changing variables in an experiment.

DISCUSSION QUESTIONS

- Did the egg sink, float, or partially float in each cup?
- What differences between the two cups did you observe?
- What were the variables?
- Why is it important to change only one variable at a time?

CURRICULUM CONNECTIONS

- Language Arts: A1.2, A3.1, B1.1, B1.2
- Science & Technology: A1.1, A1.2, A1.3, A1.4, A1.5



EGG-CELLENT SCIENCE!

Name: _____

1 What SMART scientific question are you answering in this experiment?

2 What do you predict will happen during the experiment? Use your question to help you.

3 What variables are being tested?

Independent: _____

Dependent: _____

Control: _____

4 Record your measurements below.

Water: _____

Salt water: _____

5 Are the results of the experiment what you predicted? Why or why not?



VARIABLE BEAN BAG TOSS

MATERIALS

- Hula hoop
- Bean bags
- Open space (either outside or gym)
- Cones or pylons (if outside)

INSTRUCTIONS

1. Place a hula hoop about 2 - 3 metres away from the starting point (either a line on the gym floor or a pylon/cone outside)
2. Instruct students to line up in a single file line behind the starting point
3. Before beginning, ask students to make prediction about how many bean bags they think will land inside the hula hoop
4. One at a time, students take turns tossing a bean bag towards a hula hoop using an underhand toss. Students are trying to get their bean bag into the hoop target
5. Once all students have a turn, count the number of bean bags that made it into the hoop
6. Ask students to predict what they think will happen if one variable is changed, such as the distance between the starting point and the hula hoop
7. Repeat the activity after changing one variable and count the number of successful throws
8. Discuss how changing the single variable affected the outcome and compare the results to the first round
9. Ask students to predict what will happen if multiple variables are changed at the same time
10. Repeat the activity while changing two or more variables (i.e. further increase the distance and have students throw with their non-dominant hand)
11. Count the number of successful throws
12. Compare the results from all rounds and discuss whether it is easier to determine the cause of a change in results when only one variable is changed at a time

EXAMPLE VARIABLES TO CHANGE

- Increase/decrease distance between hula hoop and starting point
- Have students toss the bag with their non-dominant hand
- Have students spin around 1-2 times before tossing the bean bag
- Any combination of the above

DISCUSSION QUESTIONS

- What happened when multiple variables were changed at once?
- Was it easy to determine which variable affected the outcome?
- What other variables could we test? What might happen if we tested it?

CURRICULUM CONNECTIONS

- Language Arts: A1.2, A3.1, B1.1, B1.2
- Science & Technology: A1.1 - A1.5