Focused Learning Lesson
Science
Grades 9-11
SI-H-A1

Overview: This lesson can be used to review hypothesis formation.

Approximate Duration: 30 minutes.

Benchmark:
SI-H-A1 identifying questions and concepts that guide scientific investigations.
SI GLE: 1. Write a testable question or hypothesis when given a topic.

Objective:
Given an investigation scenario, the learner will create a testable hypothesis.

Teacher Preparation:
- Assign students into groups of 2 –3 students before class begins.
- See Attachment 1 for teacher background information.
- Make a transparency of Attachment 2 for activity one.
- See Attachment 3 for answers to Attachment 3.
- Make 1 copy of Attachments 4-6 to be used in activity two.
- See Attachments 7-8 for answers to Attachment 4-6.
- Make a transparency of Attachment 10 for assessment.
- See Attachment 11 for teacher answers to assessment.

Materials/Equipment/Resources:
- Transparency
- Overhead projector
- Unlined sheets of paper
- Colors/colored pencils/markers

Lesson Procedures:
Set or Opener:
Tell students that your houseplants are dying. Ask them what could be wrong? *Not watering, not fertilizing, not enough sunlight, insect infestation, or pollution.* Then ask students how they would the test for the above-mentioned cases. *Water more, fertilize more, more sunlight, treat with pesticide, or check for pollution problems.* Then explain to students that they can choose only one of the problems discussed and to write down a statement that can be tested. *If plants are not watered/fertilized, then they will die. If plants do not receive enough sunlight, they will die. If plants have too many bad insects, they will die. If plants are exposed to too much pollution, they will die.*

Body of the Lesson:
1. Review with students the information in Attachment 1, Teacher Background.
2. Use Attachment 2 as a guide to walk students through making hypotheses and listing variables of those hypotheses. (5-8 minutes)

3. Once students have a grasp on the information you are trying to deliver, pass out sheets of unlined paper and colors, pencils, or markers.
4. Pass out Attachments 4-6 to student groups and have them decide on a hypothesis and variables to be tested. Have students write their hypothesis and the variables they will test on the unlined paper using the colors, pencils, or markers.
5. Allow 10-15 minutes for students to discuss. Walk around the room to check for understanding and to clarify any misconceptions.
6. After 15 minutes have passed, have one student from each group present the group's information to the class. Discuss the answers that the students came up with and point out any misconceptions.
7. Hang papers on the wall to use a reference in future lessons.

Closure:
Review concept of a hypothesis as an answer to a question, pointing out that the hypothesis must be testable. Use assessment items, Attachment 10, to determine level of students' comprehension.

Attachments:

Attachment 1: Teacher Background
Attachment 2: Activity 1 (to use with students)
Attachment 3: Teacher Key to Activity 1.
Attachment 4: Scenario 1; give to one group of students.
Attachment 5: Scenario 2; give to a different group of students.
Attachment 6: Scenario 3; give to a different group of students.
Attachment 7: Key to Attachment 4.
Attachment 8: Key to Attachment 5.
Attachment 9: Key to Attachment 6.
Attachment 10: Assessment
Attachment 11: Key to Attachment 10.

Assessment items:
Use observation and group responses to scenarios as formative assessment.
Use Attachment 10 as a summative assessment of student learning.
Note: For this final scenario, students must realize that there are two variables and two tests to be done.

References and Links:
Chemical Concepts and Connections, C3, LA Tech, 2002.

Davis, R., Metcalfe, H.C., Williams, J., and Castka, J. (2003). *Modern Chemistry* (pp. 30-31). Austin, TX: Holt, Reinhart, and Winston.

Miller, K. (2002). *Biology* (pp. 1034-1040). Upper Saddle River, NJ: Prentice Hall.

Attachment 1
Teacher Background

1. Experiments are designed to help us answer questions, solve problems, or make decisions. By changing one variable or condition at a time and measuring the effects of the change, we can collect data to help us determine if a relationship does or does not exist between two variables (things). If a relationship exists, we can analyze the data through graphs and data charts to determine what that relationship is.

2. A variable is a factor or condition that can affect the outcome of an experiment. A variable may be deliberately changed or it may be kept constant.

3. A hypothesis is a prediction about the relationship that exists between variables. A hypothesis is important because it provides guidance in what data should be collected in the experiment. For a hypothesis to be valid, it must be testable. That is, it must be possible to design an experiment or an investigation in which the effect of the variable you will deliberately change (independent variable) on the variable (dependent variable) you expect to respond can be measured. A hypothesis is usually written as an "if, then" statement or a cause and effect statement.

4. One method for identifying a testable hypothesis is to consider all the variables that can be changed and to identify the possible responses to this change that can be measured. For example, for the problem, "How fast will an object fall through a liquid?" there could be variables related to the object, to the liquid, and to the container.

5. To develop a hypothesis, list all the variables you can think of in each of the three categories. Then chose a variable that you think might affect the rate at which an object falls and state how you think changing this variable will affect the length of time it takes the object to fall through the liquid. An example of a hypothesis is, the lower the environmental temperature, the slower snails crawl.

6. Be sure to consider the *null hypothesis*; the null hypothesis states that when you change your test variable, there will be no response in the variable you are measuring.

Attachment 2
Activity 1

Analyze each of the following problems to identify variables that, if changed, could affect the outcome.

A. How fast will an object fall through a liquid?
List variables related to the object here.

List variables related to the environment here.

B. For the above problem, the variables you have listed are ones that you could change to determine their effect on the object in question. Look at the problem statement above. Choose one variable that you could change. List the variable and tell what you would measure.

Variable	What You Would Measure

C. Using the variable and measurement you selected, write a hypothesis for the problem, keeping in mind, (1) what you will vary, (2) how it will vary, (3) what you will measure, and (4) how you expect that measurement to vary.

What factor will you change (independent variable)? _____

Hypothesis: _____

_____

What will you measure? Dependent Variable(s): _____

_____

What factors or conditions should be kept constant?

D. Propose a null hypothesis for the above problem.

_____

_____

Attachment 3
Key to Activity 1

Student answers are in *italics.*
Analyze each of the following problems by identifying variables that, if changed, could affect the outcome.

A. How fast will an object fall through a liquid?

List variables related to the object here.

1. *What is the liquid*
2. *How much liquid is in the container*
3. *What size is the container*
4. *Mass of the object*
5. *Shape of the object*

List variables related to the environment here.

1. *Temperature*
2. *Person dropping object*
3. *Height object is dropped*

B. For the above problem, the variables you have listed are ones that you could change to determine their effect on the object in question. Choose one variable that you could change. List the variable and tell what you would measure.

Variable	**What You Would Measure**
1. *Liquid – different brands of liquid soap or different liquids*	*how fast object falls in different liquids*
2. *Size of container – have varying container sizes*	*Rate of fall in each liquid*
3. *Type of object – use objects of different masses or use objects of different shapes*	*Rate of fall in one liquid*

C. Using the variable and measurement you selected, write a hypothesis for the problem, keeping in mind 1) what you will vary, 2) how it will vary, 3) what you will measure, and 4) how you expect that measurement to vary. *Below is an example of a correct student response.*

What factor will you change (independent variable)? *The liquid or brand of liquid soap*

Hypothesis: *The thicker the liquid, the slower the object will fall.*

What will you measure? Dependent variable(s): *The time it takes for the object to fall to the bottom of the container. (in seconds)*

What factors or conditions should be kept constant?
The object, the container, and the temperature should all be kept constant.

Other possibilities:

- *Keeping the type of liquid I use and the object constant, if I vary the size of the container, I can measure how long it will take for that object to sink in the different containers. The object will take the longest to fall in the container with the greatest height.*
- *Keeping the size of the container and the type of liquid used, if I vary the type of object used, I can measure how long it will take for each object to sink in the container. The object with the greatest mass will sink the fastest.*

D. Propose a null hypothesis for the above problem.

No matter the size of the container, the type of liquid used, or the mass of the object, all objects will fall in a given liquid at the same rate.

Attachment 4
Scenario 1
(To be given to one group of students.)

June wished to determine whether the concentration of salt in water affected how long it takes water to cool. She put four identical plastic glasses, each of which contained 225 mL of a different concentration of salt solution, into a freezer. For example, the glasses contained 0%, 10%, 20%, and 30% salt solutions. She recorded the amount of time it took for each solution to cool to a temperature of 30^{o} C.

Develop a testable hypothesis based on the above scenario.
Be sure to list the variable to be tested and what you will measure.

Variable to be tested

What will be measured?

Hypothesis

Attachment 5
Scenario 2
(To be given to one group of students.)

Michael bought four identical, inexpensive bar magnets and labeled them A, B, C, and D. He put the north end of magnet A into iron filings and measured the mass of the filings the magnet could lift.

He dropped magnet B from a height of 6 feet onto a cement floor. From the same height, he dropped magnet C twice and magnet D three times. Using the north end of the magnets, he picked up iron filings. He measured the amount of filings lifted by each magnet on the same scales. Michael was careful to use the same batch of iron filings to test each magnet.

Develop a testable hypothesis based on the above scenario.
Be sure to list variable to be tested and what you will measure.

Variable to be tested

What will be measured?

Hypothesis

Attachment 6
Scenario 3
(To be given to a group of students.)

Kim wanted to find out if diluting liquid tile cleaner would change the speed at which it would dissolve the material that causes the "ring around the tub." Each day for 30 days she submerged the lower half of 12 tiles in used bath water for 30 minutes. She then soaked three of the tiles in 250 mL pure liquid tile cleaner. She placed three more of the tiles in a mixture of 200 mL tile cleaner and 50 mL water. She placed another three of the tiles in a mixture of 150 mL liquid tile cleaner and 100 mL water. She placed another three tiles in a mixture of 100 mL liquid tile cleaner and 150 mL water.

Develop a testable hypothesis based on the above scenario.
Be sure to list variable to be tested and what you will measure.

Variable to be tested

What will be measured?

Hypothesis

Attachment 7
KEY to Attachment 4

June wished to determine whether the concentration of salt in water affected how long it takes water to cool. She put four identical plastic glasses, each of which contained 225 mL of a different concentration of salt solution, into a freezer. For example, the glasses contained 0%, 10%, 20%, and 30%. She recorded the amount of time it took for each solution to cool to a temperature of 30^{o} C.

Develop a testable hypothesis based on the above scenario.
Be sure to list variable to be tested and what you will measure.

Lists of possible correct student responses are found below.

Variable to be tested
Concentration of salt affects cooling of water

Concentration of water affects cooling of salt (wrong – concentration of salt is changed)

What will be measured?
Amount of time it will take to cool different concentrations of salt water

Amount of time it will take to cool different amounts of water (wrong – amount of water is constant)

Hypothesis
If I increase the amount of salt in water, the time it takes for that solution to cool to 30^{o} C *will increase.*

As the salt concentration of the solution increases, the time required for cooling the solution to 30^{o} *C will increase.*

The lower the salt concentration of a solution, the shorter the cooling time will be.

Allow for all correct variations.

Attachment 8
KEY to Attachment 5

Michael bought four identical, inexpensive bar magnets and labeled them A, B, C, and D. He put the north end of magnet A into iron filings and measured the mass of the filings the magnet could lift.

He dropped magnet B from a height of six feet onto a cement floor. From the same height, he dropped magnet C twice and magnet D three times. Using the north end of the magnets, he picked up iron filings. He measured the amount of filings lifted by each magnet on the same scales. Michael was careful to use the same batch of iron filings to test each magnet.

Develop a testable hypothesis based on the above scenario.
Be sure to list variable to be tested and what you will measure.

Lists of possible correct student responses are found below.

Variable to be tested
If dropping a magnet has an affect on its ability to pick up iron filings.

What will be measured?
The mass of iron filings picked up by different magnets.

Hypothesis
The more times a magnet is dropped from a height of six feet, the less (or more) iron filings will be picked up, than with a magnet that has not been dropped.

Both less and more are testable hypotheses and are thus correct.

Attachment 9
KEY to Attachment 6

Kim wanted to find out if diluting liquid tile cleaner would change the speed at which it would dissolve the material that causes the "ring around the tub." Each day for 30 days she submerged the lower half of 12 tiles in used bath water for 30 minutes. She then soaked three of the tiles in 250 mL pure liquid tile cleaner. She placed three more of the tiles in a mixture of 200 mL tile cleaner and 50 mL water. She placed another three of the tiles in a mixture of 150 mL liquid tile cleaner and 100 mL water. She placed another three tiles in a mixture of 100 mL liquid tile cleaner and 150 mL water.

Develop a testable hypothesis based on the above scenario.
Be sure to list variable to be tested and what you will measure.

Variable to be tested
The concentration of the liquid tile cleaner solution is to be tested.

What will be measured?
Amount of "ring around the tub" reside is left on tiles after soaking in liquid tile cleaner. It is to be measure in the width of the ring.

Hypothesis
If I dilute liquid tile cleaner more than a 2:3 ratio, it will be less effective for removal of the "ring around the tub."

The more dilute the liquid tile cleaner solution, the less effective it is in removing the "ring around the tub."

Attachment 10
Assessment of Student Learning

Anthony worked in the produce department of a grocery store in the afternoons. He wondered how much the price and ripeness of bananas affected the sale of the fruit. He collected data for five days on the total number of pounds of bananas sold when priced at 20, 30, and 40 cents per pound. Anthony also determined the number of pounds of green, yellow, and brown-black bananas sold on Saturday.

Develop a testable hypothesis based on the above scenario.
Be sure to list variable to be tested and what you will measure.

Variable to be tested:

What will be measured?

Hypothesis:

Attachment 11
KEY to Attachment 10

Anthony worked in the produce department of a grocery store in the afternoons. He wondered how much the price and ripeness of bananas affected the sale of the fruit. He collected data for five days on the total number of pounds of bananas sold when priced at 20, 30, and 40 cents per pound. Anthony also determined the number of pounds of green, yellow, and brown bananas sold on Saturday.

Develop a testable hypothesis based on the above scenario.
Be sure to list variable to be tested and what you will measure.

***** For this scenario, students must realize that there are 2 variables and 2 tests to be done.**

Variable to be tested:
*1 - If **the price of bananas** determines the number of bananas sold.*
*2 - If the **color of bananas** determines the number of bananas sold.*

What will be measured?
For both 1 and 2, measure pounds of bananas sold.

Hypothesis:
Possible answers are listed below:

1. *If bananas are sold at 20 cents per pound, the supermarket will sell more.*

   The lower the cost, the greater the number of pounds of bananas will be sold.

   If bananas are sold at 40 cents per pound, the number of pounds of bananas will be less than if they were at 20 cents per pound.

2. *More pounds of yellow bananas will be sold on Saturday than green or brown bananas.*

   More pounds of green bananas will be sold on Saturday than yellow or brown, so they will ripen during the week.