

A Hypothesis is More than Just a Guess – Building Science Knowledge

**Tuesdays for Teachers
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Before We Get Started



During the webinar, **please:**

1. Keep your sound and video **muted**. This will limit background noise.
2. Ask questions using the **chat function**.
3. Keep in mind that the session is being **recorded** for future viewing.

Our Focus Today



Science Investigations



Sample Items



Science Content



Resources

Guess Prediction Hypothesis



A guess is usually based on knowledge and experience.

A hypothesis is not an educated guess.

“I guess this plant is going to die.”



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A prediction uses observable phenomena to make a future projection.

A prediction is used to describe what will happen in the future based on current information or a belief

“I predict that if I don’t water my plants, they will die.”

A hypothesis is an educated, testable guess in science or a prediction.

Hypothesis and prediction are both a type of guess.

“The amount of water required to keep a plant alive is directly proportional to the plant's size and environmental conditions.”

Is it any wonder that a student
has a difficult time
understanding what a
hypothesis is?

So, what is a hypothesis?

A hypothesis is a specific, testable statement that suggests a possible relationship between two or more variables. It's essentially an educated guess that can be supported or disproven through experimentation or observation.

Key Characteristics

Testable: It must be possible to test the hypothesis through an experiment or study.

Falsifiable: It must be possible to prove the hypothesis wrong.

Specific: It identifies the variables involved and the nature of the relationship between them.

Predictive: It should predict what will happen under certain conditions.

“If...then..” format?

"If" part: Describes the independent variable, or the condition being manipulated.

"Then" part: Describes the dependent variable, or the outcome that is expected.

Example: “If...then..”

If the temperature in a room is lowered, **then** the leaves on plants will change color.

If a new drug is given to cancer patients, **then** their tumor size will decrease more effectively than with current treatments.

If motorists talk on the phone while driving, **then** they will be more likely to make errors on a driving course.

Science Content Issues

10



Focusing Themes

Science Content Topics

Life Science (40%)

Physical Science (40%)

Earth & Space Science (20%)

Focusing Themes

Human Health and Living Systems

- Human body and health
- Organization of life
- Molecular basis for heredity
- Evolution

- Chemical properties and reactions related to human systems

- Interactions between Earth's systems and living things

Energy and Related Systems

- Relationships between life functions and energy intake
- Energy flows in ecologic networks (ecosystems)

- Conservation, transformation, and flow of energy
- Work, motion, and forces

- Earth and its system components
- Structure and organization of the cosmos

Science Practices



Comprehending scientific presentations



Investigation design (experimental and observational)



Reasoning from data



Evaluating conclusions with evidence



Working with finding



Expressing scientific information

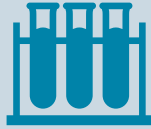


Science theories



Probability and statistics

Can your students . . .



Design the correct process for an experiment?



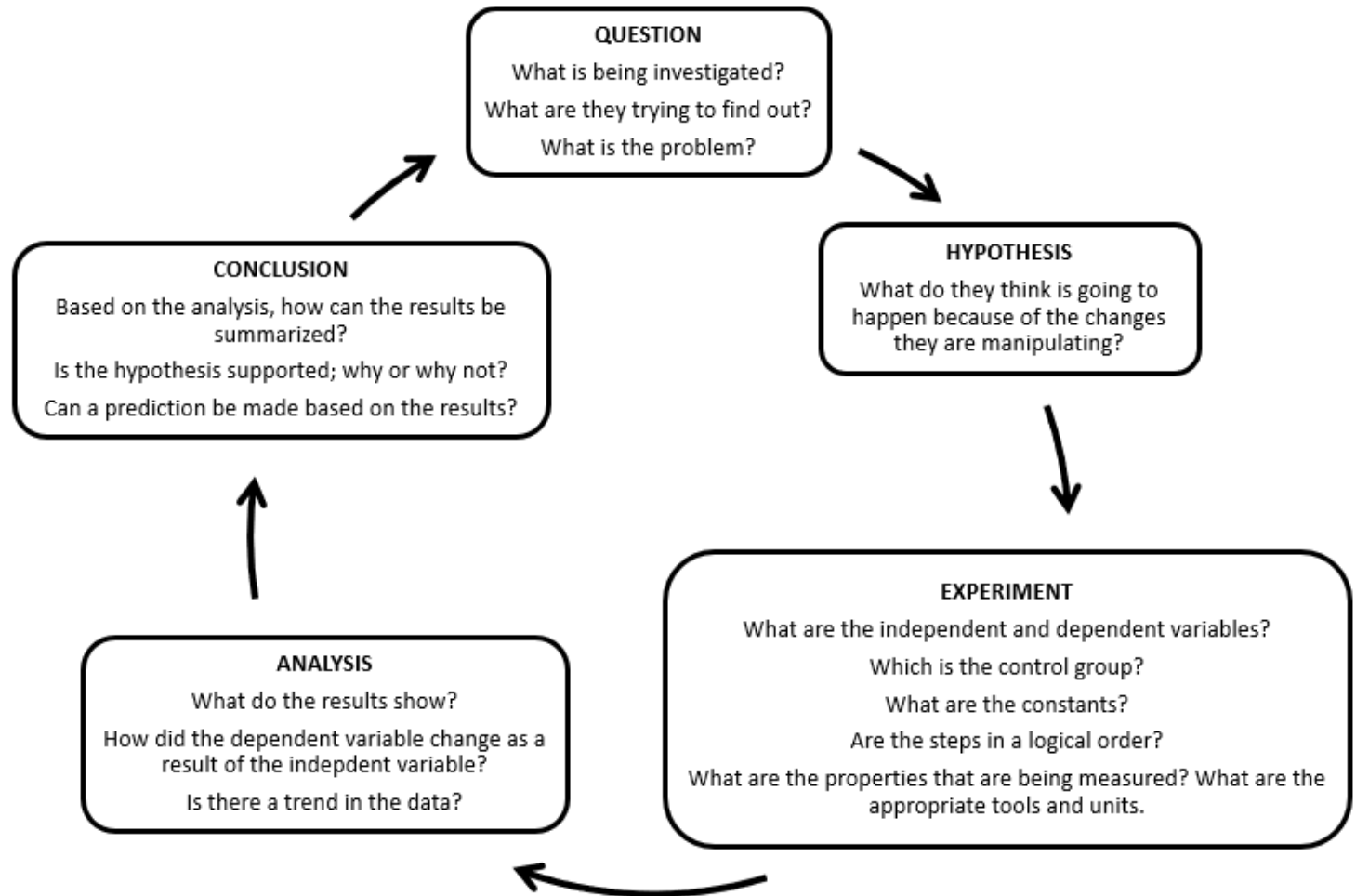
Determine a method for collecting data?



Design a scientific investigation based on a given hypothesis?

Scientific Investigations

EVALUATING SCIENTIFIC INVESTIGATIONS STRATEGIES



Formulate a Hypothesis

- Educated guess about how things work
- Prediction
- Use If, then statements
 - If _____ [*I do this*], then _____ [*this will happen*]
- Focus on one variable only



Use a Real-World Scenario

Formulate the hypothesis



A S'well[®] bottle will keep hot water warm the longest.

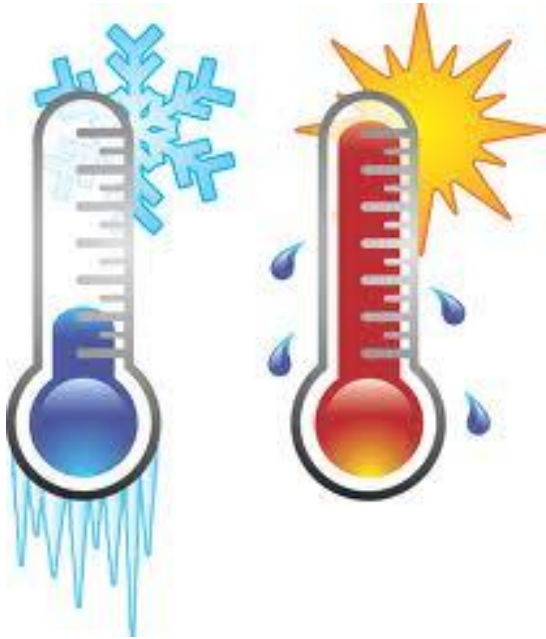
If hot water is poured into a S'well[®] bottle, a Styrofoam cup and a plastic cup, **then** the water in the bottle will stay warmer longer, **because** the bottle has better insulation.

Don't Forget the Vocabulary

- **Independent**, or manipulated variable, is a factor that's intentionally varied by the experimenter.
- **Dependent** or responding variable, is the factor that may change as a result of changes made in the independent variable.



Start with Real-World Scenarios



The cooler the temperature in a lake, the more oxygen the water holds. Daniel notices that he catches more fish in a lake that is cooler than 55 degrees. He wants to conduct a study so he can catch the most fish possible this year. Write a hypothesis for the study.

Gather Evidence and Experiment

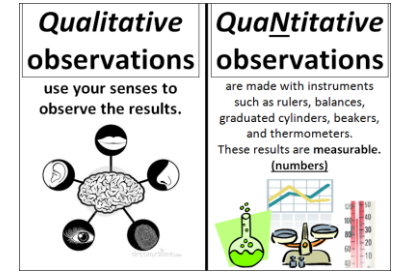
- Develop and follow a procedure.
- Include a detailed materials list.
- Make sure the outcome is measurable.
- Develop a procedure, list the needed materials and then, determine the control group.



Gather Evidence and Experiment

Record data in a data table.

- Numerical (quantitative) data organized in rows and columns
- The specific independent variables are listed
- The number of trials are listed
- Blanks are left for data (dependent variable) to be filled in



Trial	Variable 1	Variable 2	Variable 3
1			
2			
3			
AVERAGE			

Back to S'well, Styrofoam & Plastic

Variables

- **Controlled** – water temperature, amount of water, and room temperature
- **Experimental** – types of cups

Collect and Analyze Results

- Check temperature at regular intervals of 30 minutes
- Record data in a table
- Analyze results of the experiment

Cup Type	S'well®	Styrofoam	Plastic
Starting Temp	160	160	160
Temp after 30 minutes	105	95	88
Temp after 60 minutes	92	84	74
Temp after 120 minutes	86	75	70

Conclusion

- Look back at the hypothesis.
- Analyze the data to see if the hypothesis was accepted or rejected.
- If hypothesis is rejected, give possible reasons for the difference between the hypothesis and the experimental results.

Back to S'well, Styrofoam & Plastic

Hypothesis - If hot water is poured into a S'well® bottle, a Styrofoam cup and a plastic cup, **then** the water in the bottle will stay warmer longer, **because** the bottle has better insulation.

Experiment – compared same temperature water in three bottles to determine if hypothesis is correct

Evidence – Water in S'well® bottle stayed at a higher temperature after 120 minutes (160°-105°-92°-84°) as compared to other cups

Results – hypothesis is confirmed – S'well® has better insulation.

It's Your Turn!

To test the effectiveness of a new vaccine; 50 volunteers are selected and divided into two groups. One group will be the control group, and the other will be the experimental group. Both groups are given a pill to take that is identical in size, shape, color and texture.

Describe the control group.

Describe the experimental group.

What variables are kept constant?

What variable is being changed?

Example

To test the effectiveness of a new vaccine; 50 volunteers are selected and divided into two groups. One group will be the control group, and the other will be the experimental group. Both groups are given a pill to take that is identical in size, shape, color and texture.

Describe the control group.

Even though the volunteers are given identical looking pills, the control group will not actually receive the vaccine.

Describe the experimental group.

This group will receive the vaccine.

What variables are kept constant?

The size, shape, color, and texture of the pill.

What variable is being changed?

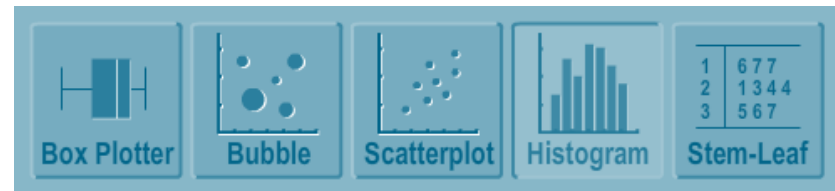
Whether or not the pill contains the vaccine.

It's Your Turn!

To test the effectiveness of a new vaccine; 50 volunteers are selected and divided into two groups. One group will be the control group, and the other will be the experimental group. Both groups are given a pill to take that is identical in size, shape, color and texture.

What data would you collect?

How would you display the data?



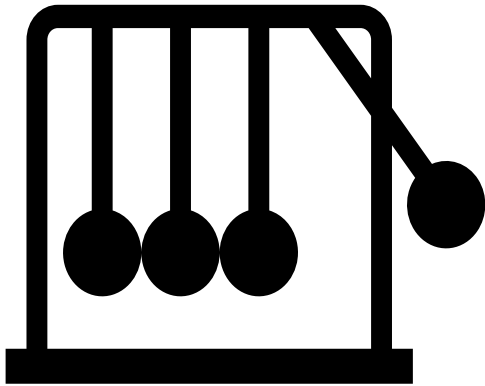
Conclusion

- Look back at the hypothesis.
- Analyze the data to see if the hypothesis was accepted or rejected.
- If hypothesis is rejected, give possible reasons for the difference between the hypothesis and the experimental results.

Sample Conclusion

We have concluded that the new vaccine is effective as the experimental group had 90% less chance of contracting the disease than the control group who received a placebo. However, additional studies should be performed to ensure accuracy of the results.

Focus on Indicators



SP.2.c Identify the strengths and weaknesses of one or more scientific investigations (i.e., experimental or observational designs)

SP.2.e Identify and interpret independent and dependent variables in scientific investigations

SP.4.a Evaluate whether a conclusion or theory is supported or challenged by particular data or evidence

SP.5.a Reconcile multiple findings, conclusions or theories

SP.6.a Express scientific information or findings visually

Example

A biology student wants to determine the carrying capacity of trout in a region. He selects a lake that is open to the public that does not have trout but is capable of supporting trout. He plans to follow the steps shown to determine the carrying capacity of trout in the lake.

1. Stock the public lake with a predetermined number of trout.
2. Count the trout population three times a year for two years.
3. When the trout population begins to decrease, count individual trout for an additional three years.

Which statement describes a weakness of this investigation?

- ☐ A. The student will use a predetermined number of trout.
- ☒ B. The student plans to conduct the study using a public lake.
- ☐ C. The student will evaluate the lake for three years after the trout population decreases.
- ☐ D. The student plans to count the trout population three times a year for two years.

Example

An enzyme called pectinase is used by the fruit juice industry to increase the yield obtained during the juice extraction process. A researcher is investigating the effectiveness of pectinase by using this procedure.

1. Label two beakers A and B.
2. Add 50 g of chopped apple to each beaker.
3. Add 4 milliliters (mL) of prepared pectinase solution to beaker A.
4. Add 4 mL of distilled water to beaker B.
5. Stir the contents of both beakers.
6. Allow the beakers to remain undisturbed for 30 minutes.
7. Filter out the solids and measure the juice in each beaker.

Click on the variables you want to select and drag them into the boxes.

Independent Variable	Dependent Variable	Controlled Variables

Variables

amount of chopped apple used	presence of pectinase
amount of juice extracted	number of minutes

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Example

Plants live in symbiosis with soil microbes. These microbes colonize plants' roots. Researchers hypothesized that because different microbes perform different functions to aid plant growth, a greater microbial diversity will lead to a greater uptake of plant nutrients, such as nitrogen and phosphorus. Researchers performed an investigation of two species of microbes (AM fungi and rhizobia) in a grassland community containing two types of plants: grasses and legumes.

Which observation provides evidence that *best* supports this hypothesis?

- ☐ A. Grasses have higher survival rates than legumes when rhizobia are present in the soil.
- ☐ B. Legumes contain greater phosphorus concentrations than grasses when AM fungi are present in the soil.
- ☒ C. Plants take up more phosphorus when AM fungi are present in the soil and more nitrogen when both species of microbes are present.
- ☐ D. Plant communities are more diverse when both species of symbiotic microbes are present in the soil than when only rhizobia are present.

Example

Two teams of researchers studied the interactions between fungi and trees. Team A found that when olive trees form a symbiotic relationship with the fungus *G. mosseae*, the trees grow larger roots and shoots because *G. mosseae* provides the trees with increased nutrients, including nitrogen, phosphorus, and potassium. This table shows the results of team A's study.

	Control	<i>G. mosseae</i>
Shoot Surface Area (cm²)	66.98	206.60
Root Surface Area (cm²)	80.58	282.36

Team B found that when white spruce trees form a symbiotic relationship with the fungus *P. scopiformis*, populations of the tree's insects decline due to toxins within the fungus that kill adult and larval insects. This table shows the results of team B's study.

	Control	<i>P. scopiformis</i>
Larval Survival	59%	50%
Total Survival	55%	40%

Which statement *best* evaluates the teams' results?

- ☐ A. Team A's results are more reliable because this team studied two characteristics of the trees.
- ☐ B. Team B's results are more reliable because this team studied the effects on both the trees and the insects.
- ☐ C. Neither team's results are reliable because both teams only tested a single species of fungus, resulting in similar effects.
- ☒ D. Both teams' results are reliable because both teams tested different fungus and tree species, so different effects are expected.

General strategies

- Share the GED® indicators and content topics with your students.
 - The content topics can be used as a teaching/study guide (vocabulary/processes).
- Provide students with opportunities to evaluate scientific investigations
 - Identify purpose, hypothesis, variables
 - Evaluate whether the procedure aligns well with the purpose and hypothesis
 - Identify tools and units that were used to measure specific properties
 - Analyze data—patterns, relationships between variables
 - Determine possible conclusions
 - Identify evidence supporting the conclusions
- Provide students opportunities to evaluate diagrams/illustrations and describe what is being shown.

General Strategies

Remind	Remind students to carefully read the questions and to read through all four options before selecting their answer.
Remind	Remind students to use the highlighter and the white board that are provided.
Encourage	Encourage students to read more. Strong reading skills will benefit students in all four subject area tests.
Encourage	Encourage students to analyze the content they read <u>daily</u> . Strong critical thinking skills will benefit students in all four subject area tests.

Scientific Tools and Processes as shown in Indicators and Content Topics (handout)

Balance (triple beam)

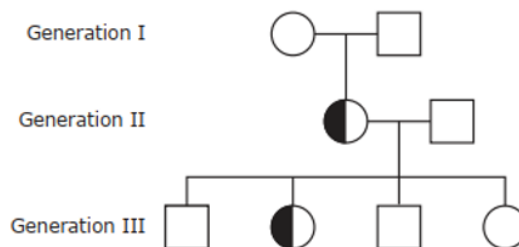
An instrument that measures the mass (grams; milligrams) of an object



Rabbitmindphoto/Shutterstock

Pedigree Chart

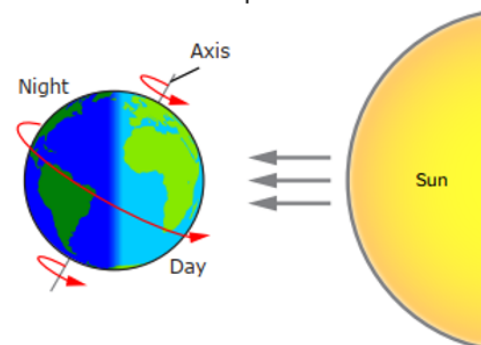
A diagram that shows an inherited trait in a family over several generations



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Earth's Rotation

The amount of time (approximately 24 hours; 1 day) it takes Earth to complete one rotation on its axis



Thank you!

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