FOCUS ON 2014 GED® CONTENT: THE WONDERFUL WORLD OF SCIENCE

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The IPDAE project is supported with funds provided through the Adult and Family Literacy Act, Division of Career and Adult Education, Florida Department of Education.

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Science Practices

SP.1 Comprehending Scientific Presentations

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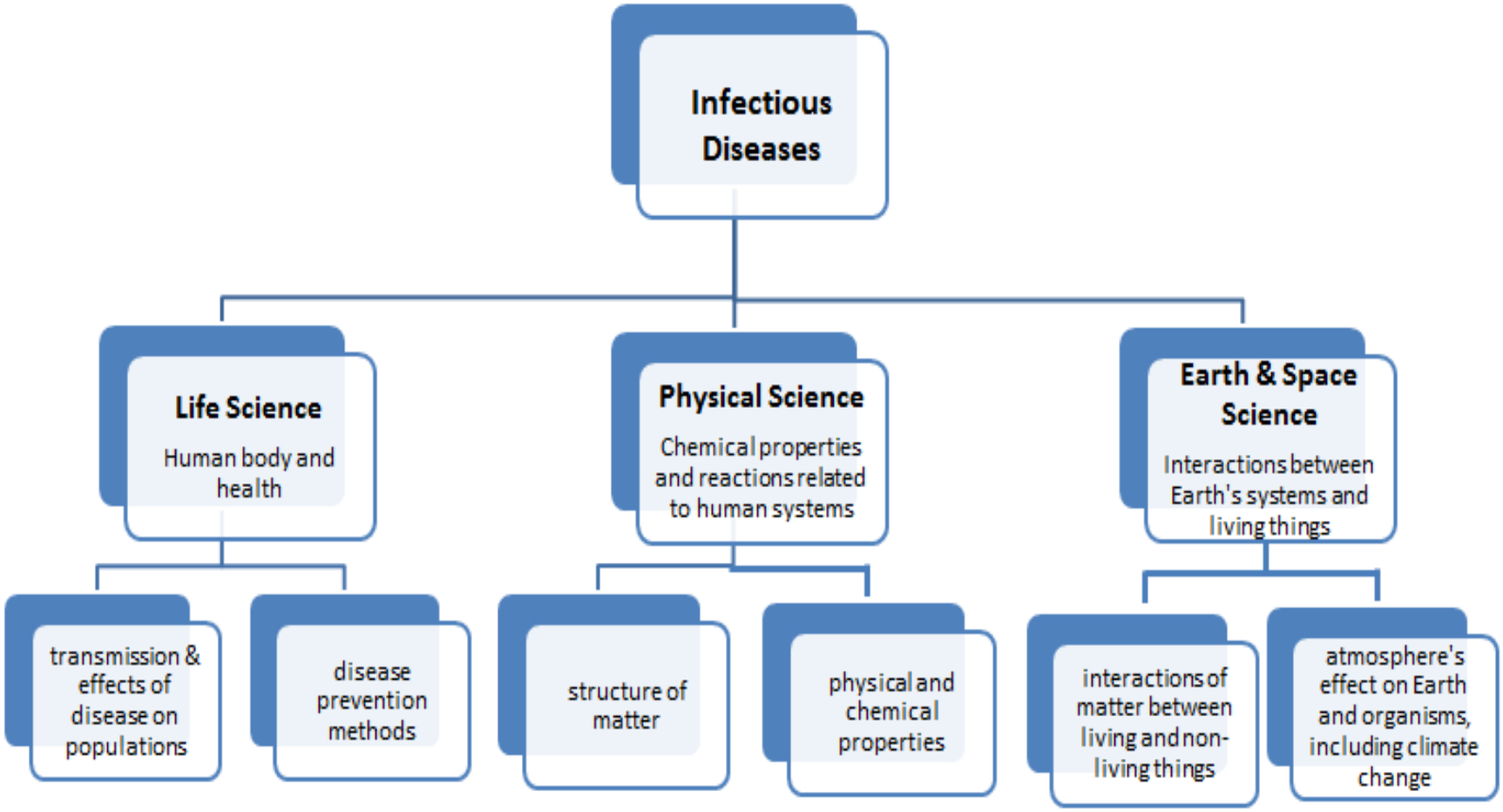
Overview of Science Themes and Example Content

		Science Example 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

Focusing Theme



Activity 2 – What Reading Strategies Do You Use When Reading Science Texts?

Activity 3 – Time Reading

Second Hand Smoke

Most everyone knows that smoking is harmful, but the effects of secondhand smoke are not as clearly understood. Secondhand smoke, which is also called environmental tobacco smoke, is the combination of smoke that is exhaled by a smoker and the smoke that comes from the burning end of a tobacco product. Most secondhand smoke comes from cigarettes, but some also comes from pipes and cigars. With secondhand smoke, people are exposed to smoke without choosing to smoke themselves.

Many times when people are exposed to secondhand smoke it is against their will. Children are especially at risk for being exposed to it against their wishes. People can breathe secondhand smoke in their homes, cars, at work, and at places such as bars and restaurants. Recently many new laws have **banned** smoking in public places. This has helped reduce the effects of secondhand smoke.

Secondhand smoke has many harmful effects. There are over 250 harmful chemicals found in secondhand smoke; 50 of these are cancer causing chemicals. According to the U.S. Surgeon General and the U.S. Environmental Protection Agency, secondhand smoke causes lung cancer in nonsmoking adults. It is also linked to many other forms of cancer. It is important to make people aware of this, especially smokers, so that there can be a continued effort to reduce secondhand smoke exposure.

In addition to cancer, secondhand smoke can cause other health problems. The smoke can irritate airways and damage the heart and blood vessels. It increases the risk of heart disease, and there may also be a link between secondhand smoke and strokes.

Children who are exposed to secondhand smoke have additional risks. For these kids, there is an increased risk for Sudden Infant Death Syndrome (SIDS), ear infections, colds, bronchitis, pneumonia, and asthma. Secondhand smoke exposure for kids even

slows the growth of their lungs and causes coughing, wheezing and shortness of breath. Smoking should never occur around children, especially in enclosed areas.

There is no excuse for putting innocent nonsmokers at risk to the harmful effects of smoking. Positive changes to protect against the danger of secondhand smoke have begun. More efforts need to follow in order to stop the terrible effects of smoking.

Source: www.cancer.gov

Reading Skills for Today's Adult. Marshall Adult Education.
http://resources.marshalladulteducation.org/rs/l8/smoke_timed1.htm

Activity 4 – Close Reading

"Untangling the Roots of Cancer" by W. Wayt Gibbs

Recent evidence challenges long-held theories of how cells turn malignant—and suggests new ways to stop tumors before they spread.

What causes cancer?

Tobacco smoke, most people would say. Probably too much -- alcohol, sunshine or grilled meat, infection with cervical papillomaviruses; asbestos. All have strong links to cancer, certainly. But they cannot be root causes. Much of the population is exposed to these carcinogens, yet only a tiny minority suffers dangerous tumors as a consequence.

A cause, by definition, leads invariably to its effect. The immediate cause of cancer must be some combination of insults and accidents that induces normal cells in a healthy human body to turn malignant, growing like weeds and sprouting in unnatural places.

At this level, the cause of cancer is not entirely a mystery. In fact, a decade ago many geneticists were confident that science was homing in on a final answer: cancer is the result of cumulative mutations that alter specific locations in a cell's DNA and thus change the particular proteins encoded by cancer-related genes at those spots. The mutations affect two kinds of cancer genes.

The first are called tumor suppressors. They normally restrain cells' ability to divide, and mutations permanently disable the genes. The second variety, known as oncogenes, stimulate growth—in other words, cell division. Mutations lock oncogenes into an active state. Some researchers still take it as axiomatic that such growth-promoting changes to a small number of cancer genes are the initial event and root case of every human cancer.

Gibbs, W. Wayt. "Untangling the Roots of Cancer." *Scientific American Special Edition.* June 2008.

Text Dependent Questions

Activity 5 – Science Excerpt, Prompt, and Scoring Guide

Tropical rain forests contain diverse communities of organisms with many interesting relationships. One such relationship connects parasitic fungi and their insect hosts. A type of parasitic fungus, called *Ophiocordyceps unilateralis*, disperses spores onto the forest floor, but cannot successfully grow on the ground. The fungus requires specific conditions and must grow inside of a specific ant species, called the host, to reproduce. The ants, various species of carpenter ant, make nests in the trees.

O. unilateralis feeds on and grows inside the insect host, and within a few days the fungus affects the insect's brain. The insect exhibits unusual behaviors such as wandering away from the colony to where light and humidity favor fungal growth. Just before dying, the insect bites into and firmly attaches itself to a plant. Then, the fungus slowly grows outward from the dead insect's head, producing a pod of spores that eventually bursts open. The spores fall to the ground, restarting the life cycle of the fungus.

Though this relationship may sound gruesome, researchers note that these parasitic fungi may help maintain biodiversity in the tropical rain forest. Some parasitic fungi may be host-specific, meaning that a fungus species only infects a particular type of insect. Scientists have observed that if an insect population begins to grow, more fungal infections occur, and then the insect population levels off again. This relationship may prevent overpopulation of the habitat by any one insect species.

Prompt

Deforestation, or clearing away trees, is occurring in tropical rain forests.

Explain how deforestation could disrupt the life cycle of *Ophiocordyceps unilateralis* in tropical rain forests. Include multiple pieces of evidence from the text to support your answer.

Type your response in the box. This task may require approximately 10 minutes to complete.

Scoring Guide

3-Point Response
Response contains

- A clear and well-developed explanation of how deforestation could disrupt the life cycle of *Ophiocordyceps unilateralis* in tropical rain forests
- Complete support from the passage

2-Point Response
Response contains

- An adequate or partially articulated explanation of how deforestation could disrupt the life cycle of *Ophiocordyceps unilateralis* in tropical rain forests
- Partial support from the passage

1-Point Response
Response contains

- A minimal or implied explanation of how deforestation could disrupt the life cycle of *Ophiocordyceps unilateralis* in tropical rain forests
- Minimal or implied support from the passage

0-Point Response
Response includes

- No explanation of how deforestation could disrupt the life cycle of *Ophiocordyceps unilateralis* in tropical rain forests
- No support from the passage

Sample Anchor Papers for Science Short Answer

Sample Paper 1

Deforestation destroys the environment where thousands of species of animals flourish including Ophiocordyceps. Ophiocordyceps rely heavily on the environment to survive for two major reasons. First of all, Ophiocordyceps often find hosts in Carpenter Ants which build their nests high up in the trees of rainforests. When deforestation occurs, Carpenter Ants lose their nests and homes which would likely result in the diminishment of their species. This would disrupt the Ophiocordyceps species significantly as Ophiocordyceps cannot survive without a host – without the Carpenter Ants, there would be no Ophiocordyceps. The other reason that Ophiocordyceps would suffer is because with the trees, there would be nothing for them to climb to reach greater amounts of light and less humidity. While a lack of trees would lead to more light reaching the ground, the issue of humidity affecting the Ophiocordyceps would still exist. With tall trees, the Ophiocordyceps are able to reach heights with less humidity ultimately slowing the growth of fungus. In conclusion, deforestation would have a very significant impact on the life cycle of the Ophiocordyceps for without trees there would be no hosts for the Ophiocordyceps to grown and without a way to escape humidity there would be a slowing of growth.

Sample Paper 2

Ophiocordyceps unilateralis feed off of the carpenter ant, which nests in the trees. Deforestation will cause many carpenter ants to die out because of the lack of homes. As a result, O. unilateralis lose many hosts to feed off of, and in turn reproduction is disrupted.

Sample Paper 3

WITHOUT THE TRESS OPHIOCORDYCEPS UNILATERALIS CANNOT GROW BECAUSE THEY EED THE TRESS TO DISPERSE SPORES ONTO THE FOREST FLOOR IN ORDER TO GROW AND REPRODUCE

Annotations

Annotation for Sample Paper 1: Score Point 3

This 3-point response explains how deforestation could disrupt the life cycle of Ophiocordyceps unilateralis by stating, “Deforestation destroys the environment where thousands of species of animals flourish including Ophiocordyceps.” This statement makes the connection between the destruction of the environment and its negative effect on the life cycle of Ophiocordyceps unilateralis. The explanation is supported with the following piece of evidence, “Ophiocordyceps often find hosts in Carpenter Ants which build their nests high up in the trees of rainforests.” This piece of evidence links the trees with the living environment of the Ophiocordyceps. The explanation is further supported with a second piece of evidence, “The other reasons that Ophiocordyceps would suffer is because without the trees, there would be nothing for them to climb to reach greater amounts of light and less humidity. This piece of evidence links the explanation of a loss of environment back to this statement in the passage which describes how the insects need the light and humidity because those conditions favor growth.

Annotation for Sample Paper 2: Score Point 2

This response explains how deforestation could disrupt the life cycle of Ophiocordyceps unilateralis by stating, “Deforestation will cause many carpenter ants to die because of the lack of homes.” This statement describes how the destruction of the habitat or “home” of the Ophiocordyceps unilateralis has a negative effect on the life cycle of Ophiocordyceps. The explanation is supported with the following piece of evidence, “. . . feed of the carpenter ant, which nests in trees.” This evidence, which is taken from the last sentence of the paragraph, provides an indirect reference as to how deforestation will destroy the “home” of the carpenter ant, which will in turn affect the Ophiocordyceps unilateralis. However, this response contains only partial support from the passage and therefore it receives a score of 2.

Annotation for Sample Paper 2: Score Point 1

This response gives an explanation of how deforestation could disrupt the lifecycle of the Ophiocordyceps unilateralis by stating, ‘BECAUSE THEY NEED THE TREES TO DISPERSE SPORES ONTO THE FOREST FLOOR IN ORDER TO GROW AND REPRODUCE.” The response explains how the Ophiocordyceps unilateralis requires the trees in order to continue its lifecycle. However, it does not include any supporting textual evidence from the passage; therefore, this response receives a score of 1.

Science Excerpt, Prompt, and Scoring Guide

Prompt

A farmer purchased 30 acres of farmland. The farmer calculated that the average topsoil thickness on the farmland is about 20 centimeters.

The farmer wants to maintain the thickness of the soil on this farmland by reducing erosion. The farmer plans to test the effectiveness of two different farming methods for reducing soil erosion.

Method 1: No-till (planting crops without plowing the soil)

Method 2: Winter cover crop (growing plants during the winter that are plowed into the soil in spring)

The farmer hypothesizes that using either method will reduce erosion compared to using traditional farming methods (plowing and no cover crop).

Design a controlled experiment that the farmer can use to test this hypothesis. Include descriptions of data collection and how the farmer will determine whether his hypothesis is correct.

Type your response in the box. This task may require approximately 10 minutes to complete.

Scoring Guide

3-Point Response
Response contains

- A well-formulated, complete controlled experimental design
- A well-formulated data collection method
- A well-formulated, complete explanation of the criteria for evaluating the hypothesis

2-Point Response
Response contains

- A logical controlled experimental design
- A logical data collection method
- A logical explanation of the criteria for evaluating the hypothesis

1-Point Response
Response contains

- A minimal experimental design
- A minimal or poorly formulated data collection method
- A minimal or poorly formulated explanation of the criteria for evaluating the hypothesis

0-Point Response
Response includes

- An illogical or no experimental design
- An illogical or no data collection method
- An illogical or no explanation of the criteria for evaluating the hypothesis

Sample Anchor Papers for Science Short Answer

Sample Paper 1

The farmer would have to set up 3 experiments. The first would be a years worth of tratitional farming methods (plowing and no cover crop) on a 5 x 5 acres of land. He would have to measure the top soil in every month throughout the year and record it in a data table. For the second experiment the farmer would have to farm a plot of land 5 x 5 acres of land with winter cover crop and measure the soil every month and record it in a lab table. At the end of the year the farmer would have to compare the 2 mehos against the traditional methid and determine if he is correct.

Sample Paper 2

The farmer could separate the land into two sections (15 acres each), and use mone method on each section over a two season period. Over the two season period he would record how much soil was left after using each method, comparing the results to each other and the traditional farming method.

Sample Paper 3

To test his hypothesis the farmer should divide his land into three equal parts one for the first method, one for the second method and one for the controle group. In the first part he divided he should test method one and keep a record of the process and the results. In the second part he divided he should test the second method and keep a record of the process and the results. In the third p5rt that he divided he should have the controle group where he would use the traditional method keep a record of tre process and the results, then compare the records he has collected identify the different results, make an annalasys and decide which method is the best way to prevent soil erosion.

Annotations

Annotation for Sample Paper 1: Score Point 3

The response earns all three points because it includes a complete description of the experiment and includes the controlled variable, “The farmer would have to set up 3 experiments. The first would be a years worth of tratitional farming methods (plowing and no cover crop) on a 5 x 5 acres of land.” The response also dexcribes data collection methods for the control group and experimental group by stating that the farmer “…He would have to meaure the top soil every month for a year and record it in a data table.” Finally, the response provides an explanation of how the farmer will determine if his hypothesis is correct, “At the end of the year the farmer would have to compare the 2 methos against the traditional methid and determine if he is correct.”

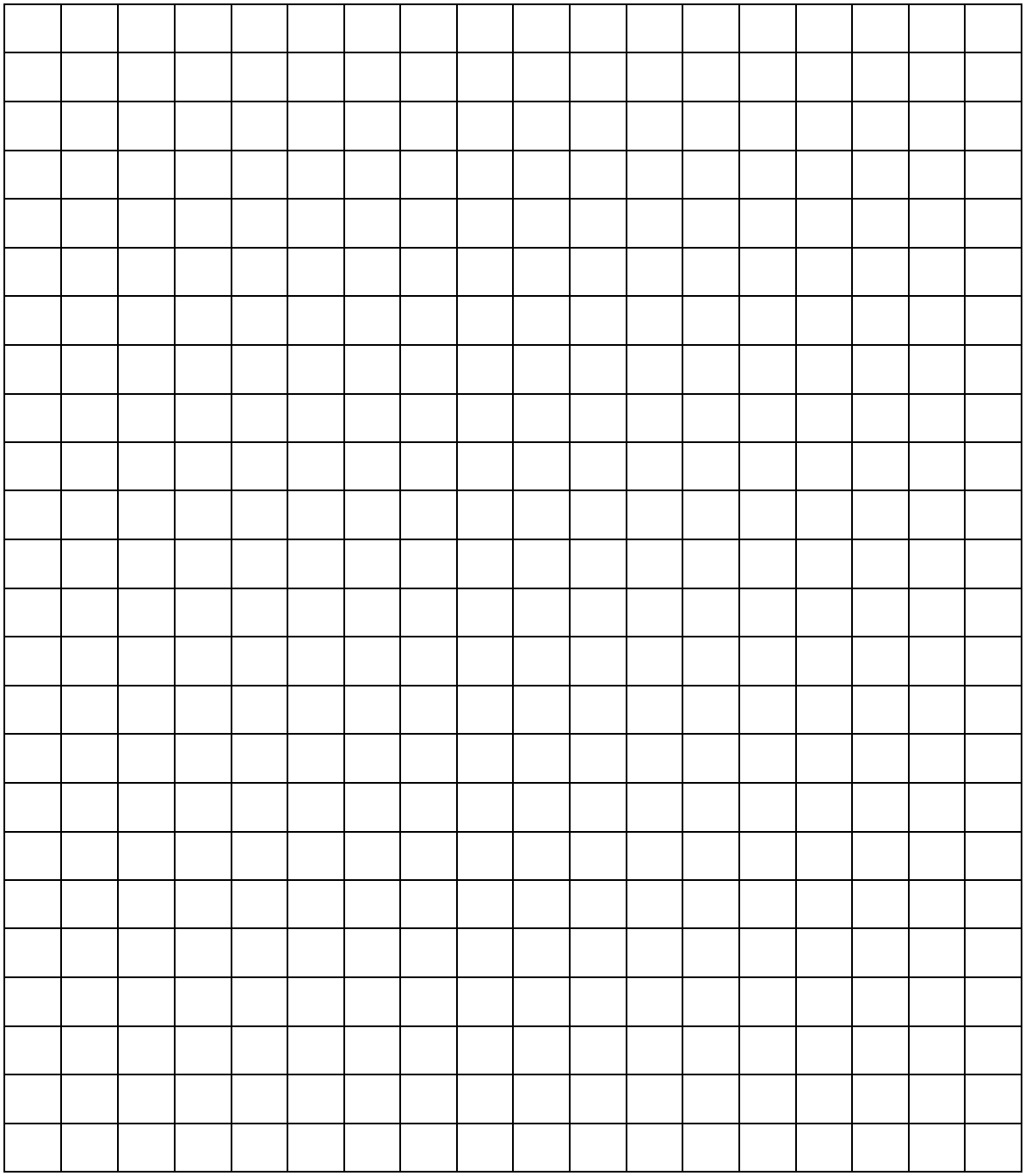
Annotation for Sample Paper 2: Score Point 2

The response includes a logical description of the experiment, “The farmer could separate the land into two sections (15 acres each) and use one method on each section…” While the response does not include the controlled variable in this initial description of the experiment, in the last sentence of the response the writer states, “comparing the results to each other and the traditional method.” This statement demonstrates that the writer understands the connection and importance of having the controlled variable as part of the experiment and data collection methods. The response also describes a logical data collection method by stating, “over the two season period he would record how much soil was left after using each method…” However, this response only provides an implied, logical explanation of the criteria for evaluating if the hypothesis is correct by stating, “comparing the results to each other and the traditional method.” While it is clear that the response is attempting to connect the results of the experiement with an evaluation of the hypothesis, this is not a complete statement.

Annotation for Sample Paper 3: Score Point 1

The response includes a description of the experiment, “the farmer should divide his land into three equal parts one for the first method, one for the second method and one for the controle group…” The response also describes a poorly formulated data collection method by stating, “In the first part he divided he should test method one and keep a record of the process and the results. In the second part he divided he should test the second method and keep a record of the process and the results. In the third p5rt that he divided he should have th controle group where he would use the traditional method keep a record of tre process and the results…” While the response is describing the collection of data in all three sections of land, the phrase “keep a record of tre process and the results” is NOT a clear statement describing what data will be collected. The response also describes a minimal explanation of the criteria for evaluating the hypothesis by stating “then compare the records he has collected identify the different results, make an annalasys and decide which method…”.

Activity 6: Checking Your Heart Rate Grid Paper



Activity 7: Determining BMI

Convert weight in pounds (without clothes) to kilograms *(have student identify the procedure needed to convert from pounds to kilograms)*

Divide pounds by 2.2 = _____kg
Convert height in inches (without shoes) to meters *(have students identify the procedure for converting from inches to meters)*
Divide inches by 39.4 = _____meters
Square the meters = _____
Divide body weight by height squared = _____Body Mass Index *(*Kg ÷ (m)2 = BMI)

You may wish to put the following table on the board or overhead so students can evaluate their own BMI calculations and the associated health risks.

Relationship of Body Mass Index to Health Risk

BMI	**Health Risk**
Less than 25	Very Low
25-30	Low
30-35	Moderate
35-40	High
Greater than 40	Very High

Evaluation:

Check student calculations to ensure that they have made the correct conversions. For further practice and evaluate student skills, have them calculate BMI for the following:
1. Adult male, 175 lbs., 6'2" (BMI – 22.54)
2. Adult female, 110 lbs., 4'11" (BMI - 22.22)
3. Adult male, 245 lbs., 5'9" (BMI – 36.39)
4. Adult female, 175 lbs., 5'11" (BMI – 24.55)
5. Adult male, 180 lbs., 5'9" (BMI – 26.74)

Activity 8: Scientific Inquiry

Which shape of paper falls fastest: An unfolded sheet of paper, a paper folded in fourths, or a sheet of crumpled paper? Or can you create a different shape with paper that falls even faster?

Make Your Plan:

What is your independent (manipulated variable)?	
What is your dependent (responding) variable	
What is your question?	
What is your hypothesis?	If, then . . .
What are the constants (name at least 3)	

Data:

Identify your dependent and independent variables for each trial.

- Independent variables are the variables that are changed in a given model or equation. One can also think of them as the 'input' which is then modified by the model to change the 'output' or dependent variable.
- Dependent variables are considered to be functions of the independent variables, changing only as the independent variable does.

Dependent Variables _____

Independent Variables _____

	Unfolded paper	Paper in Fourths	Crumpled Paper	Unique Shape
Trial 1				
Trial 2				
Trial 3				
Trial 4				
Average				

Calculations: Show work below:

Average for _____ paper:
_____ + _____ + _____ + _____ = _____÷ 4 =

Average for _____ paper:
_____ + _____ + _____ + _____ = _____÷ 4 =

Average for _____ paper:
_____ + _____ + _____ + _____ = _____÷ 4 =

Average for _____ paper:
_____ + _____ + _____ + _____ = _____÷ 4 =

Find your largest difference:
_____ paper fell in the slowest average time which was _____s.

_____ paper fell in the fastest average time which was _____s.

The difference between these two number (use subtraction) is =_____s

Is this Qualitative or Quantitative Data? Why?

Conclusion:

Based on the data from my experiment, I reject or accept the hypothesis that (Restate your hypothesis WORD FOR WORD)_____

_____

_____.

The evidence to support this is that the average time for an unfolded piece of paper was _____ s, for a sheet folded in fourths was _____s, and a crumpled sheet of paper was _____s. The difference between the _____ piece of paper and _____ piece of paper was _____s. This difference does or does not seem significant to me. Therefore, I conclude that _____ paper

Activity 9: Forensic Science

The chef at a prize-winning restaurant found his kitchen ransacked. He was furious, especially because he had been preparing for a big banquet. In fact, he had been working so frantically that he had spilled flour and baking soda all over the counter. As soon as the chef reported the crime, the police got right on the job. They have narrowed the search to two suspects. One suspect is the local caterer, a man who is competitive with the chef. He was known to be baking a cake for the banquet to try to steer some attention away from the chef. The second suspect is the woman who owns the banquet hall. Even though she hired the chef, she has never really liked him for reasons no one really knows.

The police have collected important evidence: samples of different white substances found throughout each suspect's house. Police officers think that whoever committed this crime tracked the substance home. For this reason, police want to determine what the substances are and deduce whether they might have come from the chef's kitchen. They have labeled the substance at the caterer's house "substance 1" and the substance at the banquet hall owner's house "substance 2."

Conduct the following tests to see who ransacked the chef's kitchen.

Test 1: Observe each of the substances. When smelling an unknown substance, move your hand over the top of the container to create a diluted, but distinguishable odor. Do not taste the unknown substances. Complete the following chart with your findings.

Substance	Color	Texture	Odor
Substance 1			
Substance 2			

Test 2: Mix each substance with water. Measure 2 ½ tablespoons of water to pour into a small cup. Put 2 tablespoons of substance 1 into the water. Stir the mixture. Repeat the steps for the second substance. Record your findings onto the following chart. These are the physical properties of your substances.

Substance	What Happens When Mixed with Water
Substance 1	
Substance 2	

Test 3: The following test will reveal the chemical properties of the two substances. Follow the steps for each substance.

- Measure 2-1/2 tablespoons of vinegar into a small paper cup.
- Add 2 tablespoons of substance 1 to the cup.
- Stir the mixture.
- Repeat these steps for substance 2.

After you have completed the test for both substances, record your findings in the following chart.

Substance	What Happens When Mixed with Vinegar?
Substance 1	
Substance 2	

Conclusion: Examine the following two tables: “Physical Properties of Three Materials” and “Chemical Properties of Three Materials.” Using the tables and your own test results, determine the identity of each substance.

PHYSICAL PROPERTIES OF THREE MATERIALS

Substance	What Happens When Mixed with Water
Sugar	Dissolves; liquid is clear
Baking soda	Dissolves; liquid is clear
Cornstarch	Does not dissolve; liquid is milky

CHEMICAL PROPERTIES OF THREE MATERIALS

Substance	What Happens When Mixed with Vinegar
Sugar	Dissolves
Baking soda	Dissolves; makes fizzing and bubbling sounds
Cornstarch	Does not dissolve; liquid is cloudy

Answer the following:

- Substance 1 is:
- Substance 2 is:
- Who ransacked the chef's kitchen?

Activity 10: Bubble Gum Trivia Challenge

Test your knowledge of bubble gum!

____ 1. How many sticks of gum does the average American chew in a year?

A. 200 B. 300 C. 400

____ 2. How many tons of gum are chewed every year?

A. 50,000 B. 75,000 C. 100,000

____ 3. If all the five-chunk packs of Bubble Yum ever chewed in the U.S. since it's introduction in 1975 were laid end-to-end, how many times would it circle the earth at the equator?

A. 2 B. 5 C. 7

____ 4. San Luis Obispo, California, is the home of 'Bubble Gum Alley'. What is it?

A. An alley with brick walls covered with ABC (already-been-chewed) gum wads.
B. The place where bubble gum was invented.
C. The home of the largest collection of bubble gum machines.

____ 5. Richard Walker holds the record for the Chomp Title by chewing 135 sticks of gum for the longest time. How long did he chomp?

A. 5 hours B. 6 hours C. 8 hours

____ 6. The Topps company holds the record for having made the largest single piece of bubble gum. How many pieces of normal-sized Bazooka did it equal?

A. 5000 B. 8000 C. 10, 000

____ 7. The 1952 Mickey Mantle rookie card is the most valuable Topps Company card. How much did it sell for at auction?

A. $75,000 B. $120,000 C. $1,000,000

____ 8. What is the Official Gum of Major League Baseball?

A. Bubble Yum B. Bazooka C. Topps/

____ 9. When was the first successful bubble gum invented?

A. 1891 B. 1906 C. 1928

____ 10. Susan Mont"Gum"ery Williams is the Guinness Record Holder Of the Worlds Largest Gum Bubble. How big was it?

A. 19 inches B. 23 Inches C. 27 inches

Activity 10: Bubble Gum Physics

Obtain a piece of bubble gum from your teacher and start chewing to get ready for the experiments!

Part A: Chomper Challenge

For this experiment, you will conduct five trials to determine the number of chomps you can do in 30 seconds. A chomp is defined as a "big chew", or the kind that usually causes you to get caught with gum!

Use a timer to determine the number of chomps you can do in 30 seconds. Record your data in the chart. Repeat the same process for the other trials.

Trial	Chomps	Time	Speed
1			
2			
3			
4			
5			

Speed = # of Chomps ÷ Time
Round speeds to the nearest hundredth.

What is your average speed? Round answers to the hundredth. _____ chomps/second

Based on your average chomping speed, how many chomps could you do in five minutes, one hour, or one day? Show your work!

5 min = _____ chomps 1 hour = _____ chomps 1 day = _____ chomps

Part B: Speedy Chompers

Use a timer to determine the number of chomps you can do in 1 minute. As the time reaches each point, record the number of chomps you have completed. Do not stop the timer as you record your data. You may want to practice a few times before running an "official" trial.

Time	Chomps
20 sec.	
40 sec.	
60 sec.	

Round speeds to the nearest hundredth!

Calculate your chomping speed at each point (20 sec., 40 sec., and 60 sec) using the data from your experiment. Show your work! Round all answers to the nearest hundredth!

Speed at T = 20 sec = _____ chomps ÷ 20 sec = _____ chomps/sec

Speed at T = 40 sec = _____ chomps ÷ 40 sec = _____ chomps/sec

Speed at T = 60 sec = _____ chomps ÷ 60 sec = _____ chomps/sec

Did you maintain a constant rate? Explain.

Think About It!

Write a paragraph to summarize the results of your experiments.
Are your results accurate and reliable? Why or why not?
What other experiments could you do with bubble gum?

Answer Key to Trivia Challenge

1. How many sticks of gum does the average American chew in a year? Answer: B. 300
2. How many tons of gum are chewed every year? Answer: C. 100,000
3. If all the five-chunk packs of Bubble Yum ever chewed in the U.S. since it's introduction in 1975 were laid end-to-end, how many times would it circle the earth at the equator? Answer: C. 7 (and a little more!)
4. San Luis Obispo, California, USA is the home of 'Bubble Gum Alley'. What is it? Answer: A. An alley with brick walls covered with ABC (already-been-chewed) gum wads.
5. Richard Walker holds the record for the Chomp Title by chewing 135 sticks of gum for the longest time. How long did he chomp? Answer: C. 8 hours
The first person to win the 'Chomp Title' was Sue Jordan, who chewed eighty pieces of Doublemint gum for five hours and twelve minutes! Clyde Steward McGehee, of North Carolina, broke that record by chewing 105 sticks of Juicy Fruit for six hours and Richard Walker broke that record by chewing 135 sticks of gum for eight hours.
6. The Topps company holds the record for having made the largest single piece of bubble gum. How many pieces of normal-sized Bazooka did it equal? C. 10,000
Topps presented the gum to baseball player Willie Mays in 1974. Mays then cut it into small chunks and gave it to children in nearby hospitals.
7. The 1952 Mickey Mantle rookie card is the most valuable Topps Company card. How much did it sell for at auction? Answer: B. $120,000
8. What is the Official Gum of Major League Baseball? Answer: A. Bubble Yum
9. When was the first successful bubble gum invented? Answer: C. 1928
The first known bubble gum, "Blibber Blubber," appeared in 1906. It failed to catch on because it was too sticky and too brittle so it didn't hold together when it was chewed. The first successful bubble gum was invented by Walter E. Diemer in the summer of 1928. A 23-year-old accountant who knew nothing about chemistry, Diemer created his invention in a tiny laboratory in Philadelphia. The only food coloring he had on hand was pink. "It was an accident," Mr. Diemer said in an interview with The Lancaster Intelligencer Journal in 1996. "I was doing something else and ended up with something with bubbles."
10. Susan Mont"Gum"ery Williams is the Guinness Record Holder Of the Worlds Largest Gum Bubble. How big was it? Answer: B. 23 Inches

Many of the facts for the questions were found at Bubble Gum Fact page at http://mmwww.northville.k12.mi.us/STUDENTS/2005/dugganla/Hpage4.htm. Scientific Inquiry Lab

Activity 11: Distances in the Solar System

Take one sheet of toilet paper as a test sheet for the pens. Make sure the ink is not too wet, that the pens don't easily tear the paper. Make a dot on the seam between the first two sheets of toilet paper. This is the Sun. Write the word Sun beside the dot.

Use the table of numbers to mark off the distances to each of the planets. The number in the table is the number of sheets of toilet paper needed to reach the orbit of each planet. It is important to realize that the counts in the table are starting from the Sun, not from the previous planet. (Thus, after you get to Mercury, you need 1.7 more sheets to get to Venus.) Make a dot and write the appropriate planet name on the toilet paper at the distance indicated. Ceres, the largest asteroid, is used to represent the asteroid belt.

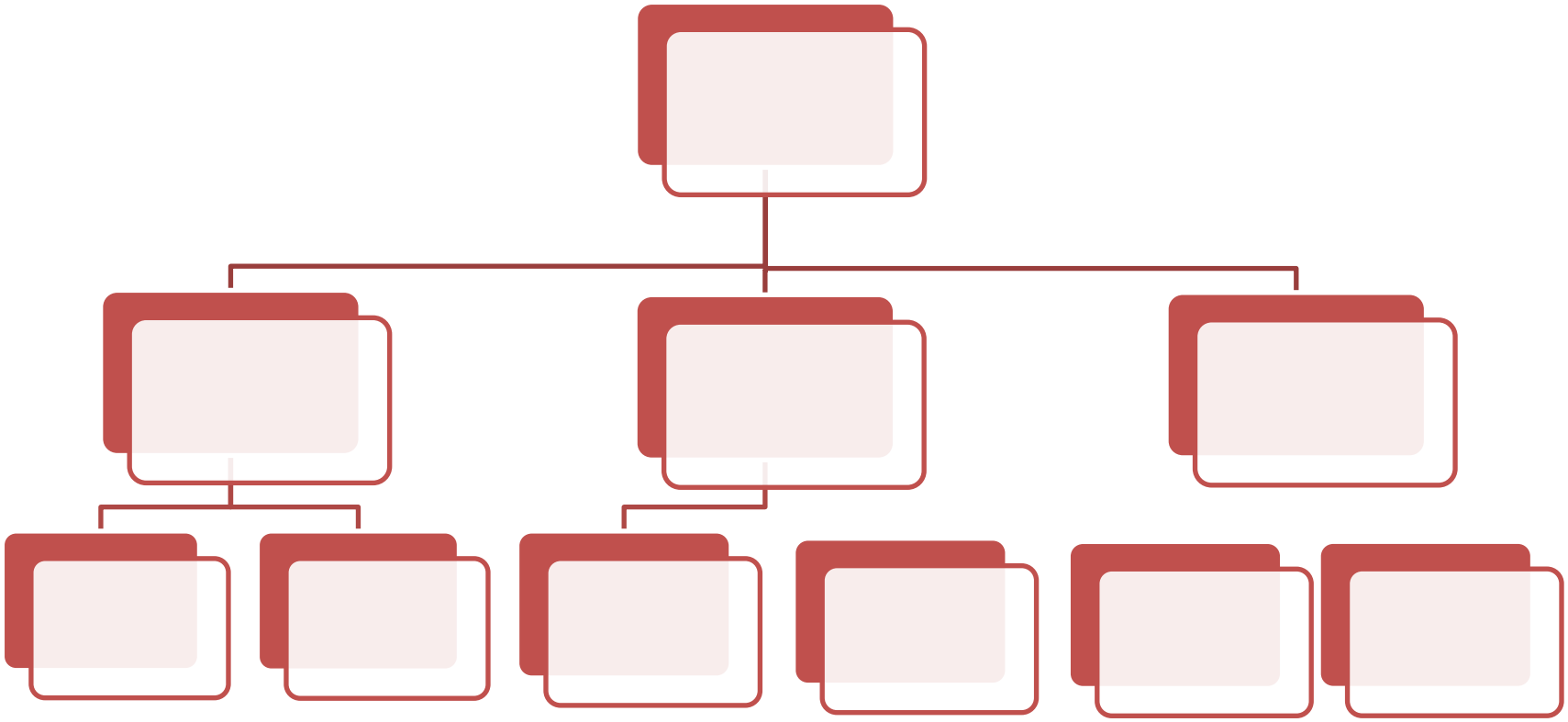
Note:

- Keep a running count as you work on this. Each distance is from your starting point, the Sun
- 200 sheets of toilet paper stretch out to nearly 84 feet. Make sure you have room for your model before you start.
- Use colored pens to mark the distance to the planet's orbit from the Sun and label the orbit with the planet's name on the toilet paper.

Planet	Distance from the Sun (km)	Squares of Toilet Paper from the Sun
Mercury	57,910,000 km	2.0
Venus	108,200,000 km	3.7
Earth	149,600,000 km	5.1
Mars	227,940,000 km	7.7
Ceres	414,436,363 km	14.0
Jupiter	778,330,000 km	26.4
Saturn	1,429,400,000 km	48.4
Uranus	2,870,990,000 km	97.3
Neptune	4,504,000,000 km	152.5
Pluto	5,913,520,000 km	200

Resources

Developing Thematic Lessons



Introduction to Science and the Scientific Method

I. What is Science?

A. The goal of science is to investigate and understand the natural world, to explain events in the natural world, and to use those explanations to make useful predictions.

B. Science:

1. Science deals only with the natural world.
2. Scientists collect and organize information in a careful, orderly way, looking for patterns and connections between events.
3. Scientists propose explanations that can be tested by examining evidence.
4. Science is an organized way of using evidence to learn about the natural world.

C. How is science done?

1. Science begins with an observation. This is the process of gathering information about events or processes in a careful, orderly way. Data is the information gathered from making observations.
2. There are two types of data:
   a) Quantitative data are numbers and are obtained by counting or measuring.
   b) Qualitative data are descriptions and involve characteristics that cannot be counted.

3. Hypothesis

   a) A hypothesis is a scientific explanation for a set of observations.
   b) A hypothesis must be stated in a way that makes it “testable”. The hypothesis is just a possible answer to a question, and it must be thoroughly tested.

II. Scientific Methods

A. The scientific method is a series of steps used by scientists to solve a problem or answer a question.
B. The Steps to the Scientific Method

Step 1: Observation / Asking a Question

1. A problem or a question must first be identified.
2. Examples: How much water can a root hair absorb? Why does a plant stem bend toward the light? What effect does temperature have on heart rate?

Step 2: Form a Hypothesis

1. Hypothesis: A possible explanation to the question or problem. It is simply a prediction and has not yet been proven or disproven.
2. It must be stated in a way that is testable. A statement is considered “testable” if evidence can be collected that either does or does not support it.

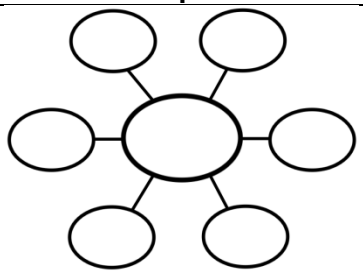
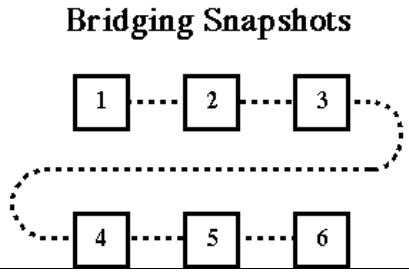
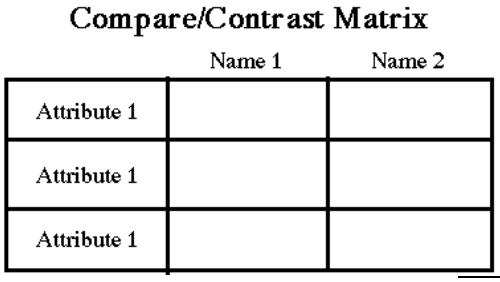
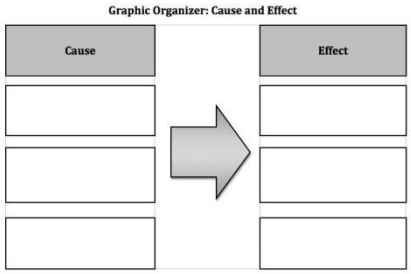
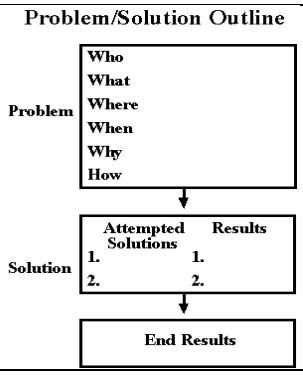
Step 3: Designing a Controlled Experiment

1. The factors in an experiment that can be changed are called variables. Some example of variables would be: changing the temperature, the amount of light present, time, concentration of solutions used.
2. A controlled experiment works with one variable at a time. If several variables were changed at the same time, the scientist would not know which variable was responsible for the observed results.
3. In a “controlled experiment” only one variable is changed at a time. All other variables should be unchanged or “controlled”.

Inquiry Method Recording Sheet

Step 1 – Observations, Questions, and Hypotheses	
Observations	Questions
Hypothesis	
Step 2 – Scientific Testing	
Investigation & Data	
Step 3 – Analysis and Conclusion	
Discuss data & draw conclusion	
Step 4 - Communication	
We communicated our results by	

Nonfiction Text Structures

Text Structure	Definition	Signal Words	Graphic
Description	Provides main ideas and supports them with descriptive details.	for example, in describing, properties of, for instance, characteristics include, specifically, in addition, in particular	
Sequence and Order	Gives information in a specific order.	before, in the beginning, to start, first, next, during, after, then, finally, last, in the middle, in the end	
Compare and Contrast	Presents ideas and examines how they are alike/different	similar, alike, same, just like, both, different, unlike, in contrast, on the other hand, whereas, although	
Cause and Effect	Provides reasons for why or how something happens.	because, so, so that, if… then, consequently, thus, since, for, for this reason, as a result of, therefore, due to, this is how, leads to, nevertheless, and accordingly.	
Problem and Solution	Identifies a problem and offers solutions	problem, dilemma, solution, issue, cause, since, consequently, therefore, as a result, because of, leads to, due to, solve, so, then	

Steps for Drafting a Constructed Response

Although the steps for drafting a constructed response may look simple, the process requires numerous skills (and strategies) to produce effective writing. Often, instructors use a graphic organizer to assist students in drafting the information necessary to complete their answer.

1. **Read** the passage and question
2. **Unpack** the prompt (identify key words)
3. **Rewrite** the question and turn the question into a thesis statement or hypothesis statement
4. **Collect** relevant details from passage
5. **Organize** details into a logical order. Use a graphic organizer if that helps.
6. **Draft** an answer
7. **Re-read** and **edit/revise** the answer making sure all parts of the question are answered

Adapted from WritingFix - http://writingfix.com

Unpack the Prompt

Do	What

Do	What

Sample Thesis Frames

A thesis is an answer to a specific question. A thesis statement makes a claim or proposition that reflects a specific point of view. The thesis statement should recognize both sides of a question, yet focus on two to three specific points (discussion points) sometimes called points of analyses. A thesis statement is the roadmap for the written response. The placement of the thesis statement is generally located in the introduction and summarized in the conclusion of a writing sample.

Start with sample thesis frames.

The general argument made by _____ in his/her work _____ is that _____.

Although _____ (believes, demonstrates, argues) that _____, _____ supports/provides the clearest evidence _____.

A key factor in both _____ can be attributed to _____.

When comparing the two positions in this article, _____ provides the clearest evidence that _____.

Looking at the arguments regarding _____, it is clear that _____.

In discussion of _____, one controversial issue has been _____. _____ believes that _____. On the other hand, _____ asserts that _____. _____ is clearly the best supported argument on the issue of _____.

Explaining the Evidence

Teach students how to identify evidence through direct quotes, paraphrase the information, and explain how the evidence supports the claim/thesis.

Claim	**Using a Direct Quote** (What direct quote supports the claim?)	**Paraphrasing** (How can you rewrite the direct quote in your own words?)	**Explanation** (How does the evidence support the claim?)

Ideas to Teach Vocabulary

Understanding the diverse vocabulary of social studies and science is extremely important to the comprehension of text and word problems. Activate your students' knowledge of terms by having them brainstorm words they know about each subject area or to use the words in a narrative chain. Some basic activities to get you started in teaching vocabulary are provided.

ABC Brainstorm

ABC Brainstorm asks students to come up with a word about a specified topic for each letter of the alphabet. This technique can be used prior to the beginning of the actual lesson or reading to assess a student's current knowledge or as a quick assessment at the end of the lesson to see what the student has learned.

Topic _____

A

B

C

D

E

F

G

H

I

J

K

L

M

N

O

P

Q

R

S

T

U

V

W

X

Y

Z

Summary Paragraph

KWLH

Another technique is KWLH. The first column is completed prior to the lesson being taught. A student is asked to list what he/she knows about a topic. Next, the student writes in what he/she would like to know about the topic from the lesson, and finally, after the lesson is completed, the student writes down what he/she has learned.

K What I **Know** for Sure About This Topic	**W** **What** I Think I Know, But Am Not Sure About This Topic	**L** What I would Like to **Learn** About This Topic	**H** **How** I Can Form Connections Between This Topic and Other Things I Know

Before and After Vocabulary Grids

Give each student a list of key words with two blank columns. In the first column, the students write the meaning of each word or what they guess the meaning is for each word. As they come across the word later during the lesson, the students can revise their original definition. At this point, the answers can be discussed and clarified in the whole class.

The benefits of Before and After Vocabulary Grids are that they:

- Focus attention onto key words
- Provide opportunities for students to actively work out word meaning
- Help students become independent learners of new words by using strategies such as context clues

Before and After Vocabulary Grid Template

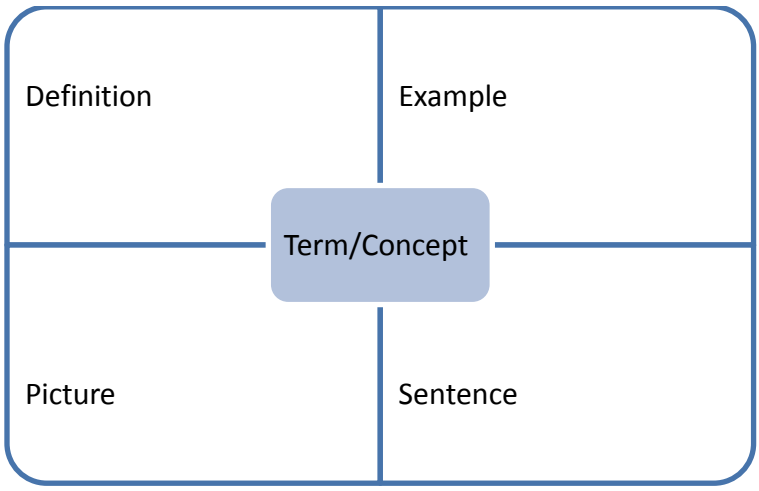
Word List	What I think the word means	Revised definition

Building Word Lists

Locate lists of words from each of the areas that you will be teaching. You may also wish to have students build their own word lists by having students write unfamiliar terms on a chart that is posted in the room

Word Map

A word map allows students to provide knowledge of a word or concept through different formats.



Find the Words

Provide students with specific letters of the alphabet. Tell them that their task is to create as many words as possible with the letters provided in the area in which they are studying. If challenged, students should be prepared to state how the word is related to the selected topic.

Science Vocabulary Example

Provide a group of students with the letters: a, c, e, h, j, i, l, m, n, o, p, r, s, t, u. Have them come up with as many vocabulary words in the area of the solar system as possible from the list of letters provided. Remember, they cannot use other letters, but they can repeat letters within words as often as necessary. If challenged, they should be prepared to state how the word is related to the solar system.

Sample Words: solar, planet, sun, star, Jupiter, Uranus, Saturn, Mars, Pluto, earth, moon.

The Narrative Chain

A narrative chain requires that students link words in a list together into a sentence or paragraph. By using the words and associating them they create a firmer connection between the new words and those already stored in their memory.

Science Narrative Chain Example

Provide students with the words: temperatures, southern, glacier, earth, tropical, rainforest, jungle, ice cap, moderate

A sample narrative chain might be as follows:

Although some of the places on the earth experience moderate temperature changes throughout the year, there are also areas where the temperatures are quite drastic. In some of the southern regions, one might experience a tropical rainforest or jungle-like atmosphere which is very hot and humid. Some parts of the earth are very cold all year long and are composed of glaciers or ice caps.

K. I. M. (Key Idea – Information - Memory Clue)

K. I. M. is a great strategy for new words or concepts. Write the term or key idea (K) in the left column, the information (I) that goes along with it in the center column, and draw a picture of the idea, a memory clue, (M) in the right column.

K (Key Idea)	I (Information)	M (Memory Clue)
drought	Little or no rain over a period of time	

Sample Questions for Guiding Scientific Thinking

Question Type	Sample Question Starters
Recalling	Who, what, when, where, how ____?
Comparing	How is _____ similar to/different from_____?
Identifying Attributes and Components	What are the characteristics/parts of _____?
Classifying	How might we organize _____ into categories?
Ordering	Arrange _____ into sequence according to _____.
Identifying Relationships and Patterns	Develop an outline/diagram/web of _____.
Representing	In what other ways might we show/illustrate _____?
Identifying Main Ideas	What is the key concept/issue in _____? Retell the main idea of _____ in your own words.
Identifying Errors	What is wrong with _____?
Inferring	What might we infer from _____? What conclusions might be drawn from _____?
Predicting	What might happen if _____?
Elaborating	What ideas/details can you add to _____? Give an example of _____. Summarizing Can you summarize _____?
Establishing Criteria	What criteria would you use to judge/evaluate _____?
Verifying	What evidence supports _____? How might we prove/confirm _____?

Using Task Cards

One technique for initiating technology-enhanced lessons is to develop task cards for each activity. A task card is simply a developed activity for a specific website that is to be used with the class.

Task cards can be used:

- As a resource for teaching using technology
- For a classroom activity
- For individualized instruction
- For students who were absent for a lesson
- To differentiate instruction

Although there are many ways to integrate technology, developing task cards can get you started. The following is an example of a simple task card in the area of science.

Task Card – GED® Science: Physics

Topic: Recognize simple machines (i.e., inclined plane, lever, and pulley)

Website URL: http://www.edheads.org/activities/simple-machines/index.htm

Activity: You will need a pencil and paper for this activity. To begin, click on the button that looks like this picture: Move your mouse on the House. Select one of the places to visit. Click on the *Start* button to begin. Identify the Simple Machines by clicking on them. Answer the questions that go along with the items you clicked. Click on the *Continue* button at the bottom until all questions are answered. Now click on another item. Take notes of the different types of machines and objects that you identify.

Follow-Up Activity: Go back to your seat and draw three types of simple machines that you found in the lesson. Make a list of the six different simple machine types. Name three items in your own home that are simple machines. When you are done, place your work into the work basket.

Sample Lessons and a Few Classroom Ideas to Get Started

Forensic Science

Students will do the following:

1. Learn how science is used to help solve mysteries and crimes.
2. Become familiar with two chemical tests that can be used to identify unknown substances.
3. Draw deductions based upon observations and the results of two scientific experiments.

Materials:

- Baking soda and cornstarch (1 measured cup of each should suffice)
- Water and vinegar
- Paper cups (six for each pair of students)
- Teaspoons (one for each pair of students)
- Coffee stirrers or toothpicks
- Paper towels
- Internet access (optional but very helpful)

Procedures:

Tell students that they have been asked to help the local crime-fighting unit solve a fictional mystery. Here's what happened:

The chef at a prize-winning restaurant found his kitchen ransacked. He was furious, especially because he had been preparing for a big banquet. In fact, he had been working so frantically that he had spilled flour and baking soda all over the counter. As soon as the chef reported the crime, the police got right on the job. They have narrowed the search to two suspects. One suspect is the local caterer, a man who is competitive with the chef. He was known to be baking a cake for the banquet to try to steer some attention away from the chef. The second suspect is the woman who owns the banquet hall. Even though she hired the chef, she has never really liked him for reasons no one really knows.

The police have collected important evidence: samples of different white substances found throughout each suspect's house. Police officers think that whoever committed this crime tracked the substance home. For this reason, police want to determine what the substances are and deduce whether they might have come from the chef's kitchen. They have labeled the substance at the caterer's house "substance 1" and the substance at the banquet hall owner's house "substance 2."

Tell students that they will help figure out what each substance is by performing tests to identify the substances. Have students work in pairs to conduct the tests. You will need to prepare for the lesson as follows:

- Do not reveal to the class that substance 1 is baking soda and substance 2 is cornstarch. Before class, fill one cup with baking soda and another cup with

cornstarch. Label the baking soda “substance 1” and the cornstarch “substance 2.”

- Put in a prominent place two paper cups for each pair of students, a jug of water, vinegar, measuring cups, and coffee stirrers or toothpicks.
- Have one person from each pair come to the table, measure 2 tablespoons of each substance, and put them in separate paper cups. Then tell students to take a few moments to observe both substances. Suggest that they note the color of the substances, the textures, and the odors. (When smelling an unknown substance, students should move their hands over the top of the container to create a diluted but distinguishable odor.) Make sure that students do not taste the substances. After observing the substances, students can record their findings on a chart such as this one:

Substance	Color	Texture	Odor
Substance 1			
Substance 2			

After students have completed their charts, tell them to mix each substance with water. Have one student from each pair measure 2-1/2 tablespoons of water to pour into a small cup. Then tell students to put 2 tablespoons of substance 1 into the water. Have students stir the mixture with a coffee stirrer or a toothpick.

Have students repeat the steps for the second substance. Then have them record their findings on a chart such as this one:

Substance	What Happens When Mixed with Water
Substance 1	
Substance 2	

(Substance 1 (baking soda) dissolves in water; the liquid turns white, but there are no particles in the water. Substance 2 (cornstarch) does not dissolve in water; the liquid is thick, white, and cloudy.)

Explain to students that this test reveals physical properties of the substances. In this case, physical properties refer to what happens when the two substances are mixed together; the basic composition of each has not been changed. Tell students that the next test will reveal chemical properties of the two substances. The basic composition of

one substance will change when it is mixed with another material. An example of this occurs when iron comes into contact with oxygen and a new substance—rust—forms. Rusting is a chemical property of iron. For the next test, explain that students will mix vinegar with the unknown substances to reveal something about their chemical composition.

Have students follow these steps:

- Measure 2-1/2 tablespoons of vinegar into a small paper cup.
- Add 2 tablespoons of substance 1 to the cup.
- Stir the mixture.
- Repeat these steps for substance 2.

After students have completed the test for both substances, have them record their findings on a chart such as this one:

Substance	**What Happens When Mixed with Vinegar**
Substance 1	
Substance 2	

(Substance 1 (baking soda) fizzes and bubbles while dissolving in vinegar. Substance 2 (cornstarch) does not dissolve; the liquid becomes cloudy.)

After students have completed both tests, tell the class to examine two tables: “Physical Properties of Three Materials” and “Chemical Properties of Three Materials.” Using the tables and their own test results, students should be able to determine the identity of each substance. Print out the following tables or put them on an overhead projector.

PHYSICAL PROPERTIES OF THREE MATERIALS

Substance	**What Happens When Mixed with Water**
Sugar	Dissolves; liquid is clear
Baking soda	Dissolves; liquid is clear
Cornstarch	Does not dissolve; liquid is milky

CHEMICAL PROPERTIES OF THREE MATERIALS

Substance	What Happens When Mixed with Vinegar
Sugar	Dissolves
Baking soda	Dissolves; makes fizzing and bubbling sounds
Cornstarch	Does not dissolve; liquid is cloudy

Ask students whether they can identify each substance. Using their own observations and both tests, students should deduce that substance 1 is baking soda and substance 2 is cornstarch. With this information, ask students who ransacked the chef's kitchen. *(The local caterer. He had a motive; he wanted to outshine the chef. Also, the police said the chef had spilled flour and baking soda, so the person who ransacked the kitchen would have tracked either one of those substances into his or her own house. Signs of baking soda were found in the caterer's home, while cornstarch was found in the banquet hall owner's house. It is not exactly clear why the banquet hall owner was using cornstarch, but one theory is that she mixes it with baby powder and puts it on after taking a bath. Even though the caterer had baking soda in his kitchen, too, the fact that it was found throughout the house, even at the front door, indicates that he tracked it in after ransacking the chef's kitchen. The presence of baking soda in his house is strong evidence that the caterer most likely committed the crime.)*

Discussion Questions

1. Were you able to deduce what the substances were and who ransacked the chef's kitchen? If so, what evidence did you find the most compelling? Would you have been able to make an educated deduction without performing the two tests?

2. How do you think police detectives use chemical tests to help them solve crimes? Try to give at least two examples. *They analyze residue from gunpowder and determine a suspect's blood type from a small sample of blood.*

3. Based on what you learned about how liquids and solids interact, what do you think performing the tests used in this lesson with any solid or liquid would tell you about the properties of the substance? Do you think such a test is a good way to identify a substance?

Extension Areas

How else would you use this activity to expand students' knowledge of science?

Understanding the Forces of Flight: An Integrated Lesson

Throughout history, man has longed to fly. We can run, jump, crawl, and even swim, but our bodies are not made to soar with the birds. That did not stop inventors from trying. They created human-sized wings and flapped as hard as they could. Some even jumped from very high places, but human muscles are not strong enough to keep us in the air. Today we still cannot fly as freely as birds, but we can travel in airplanes, helicopters, and hang gliders. It took hundreds of years, and much experimenting before scientists learned that there are four forces that affect flight. Scientists call the study of flight and its forces aerodynamics. Without these forces working together, we would never get off the ground.

Travelers who must go long distances often prefer airplanes, because planes are much faster than cars. However, planes do not move quickly just to keep airline customers happy. A plane must move forward at a very fast rate in order to take off and stay in the air. The high speed of a moving airplane is caused by the first force of flight, thrust. **Thrust** is the force that keeps the plane moving forward. It can be created by a powerful jet engine, airplane propellers, or rocket engine.

Drag is the second force of flight. **Drag** is the force that pushes against the plane and slows it down. It may look like planes are flying through empty space, but that space is full of air. Like everything else on Earth, air has weight. Air creates drag, because the plane has to work to push through it. If the drag created by the air is greater than the thrust, the plane will not be able to fly.

The third force of flight has a name you may know very well-gravity. **Gravity** is the force that holds everything to the Earth. Gravity is what causes people and things to fall down, toward the Earth, instead of floating up and away. Without it, we would have a hard time keeping our feet on the ground! Gravity also affects airplanes. Like any object, airplanes are held on the surface of the planet by gravity. In order to take off, the plane must overcome this force.

Fighting against gravity takes a lot of thrust. It also requires the fourth force of flight. **Lift** is the force that allows a plane to *lift* off the ground and stay in the air. Lift is created when air passes very quickly over and under the wings of the airplane. Airplane wings are perfectly shaped so that air passes over a wing much faster than it passes under. This creates low air pressure above the wing, and high pressure below the wing. The result is lift.

Summing Up

Airplanes are complex machines. Despite their size and thousands of parts, they only need four forces to get lift off and stay in flight. Thrust moves a plane forward. Drag slows it down. Gravity pulls a plane down toward the Earth, and lift raises it up into the sky. To stay in the air, the plane must have enough thrust to fight against the drag. It must also have enough lift to overcome the Earth's gravity. To slow down and land, the plane will need more drag than thrust, and the lift must be weaker than gravity. Thrust, drag, gravity, and lift all work together to get heavy airplanes- and their passengers- safely around the world.

Understanding the Four Forces of Flight Questions

Read the questions below and circle the letter of the correct answer.

1. How does thrust help a plane fly?

a. Thrust lifts the plane up.
b. Thrust gives the plane speed.
c. Thrust slows the plane down so it can land.
d. Thrust lifts air beneath the wings.

2. If drag is greater than thrust, what will happen to the plane?

a. The plane will go faster.
b. The plane will travel slower and higher.
c. The plane will go faster and higher.
d. The plane will go slower and be unable to fly.

3. How do wings help airplanes fly?

a. The shape of airplane wings helps create lift.
b. Wings create thrust, which speeds the plane up.
c. Wings fight drag and keep the plane moving forward.
d. Wings slow the plane down.

4. If lift is greater than gravity, what will happen to the airplane?

a. The plane will fly downward.
b. The plane will fly upward.
c. The plane's flight will not change.
d. The plane will not be able to fly.

5. Where does an airplane get its thrust?

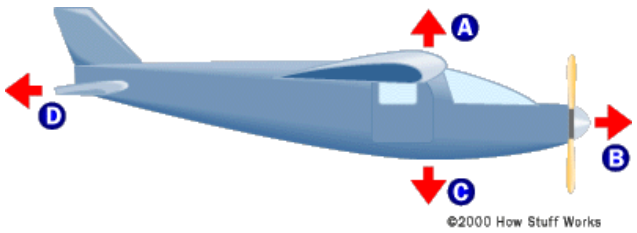
a. wings
b. tail
c. wheels
d. engine or propeller

Draw a line to connect the name of the force to its definition.

Gravity	keeps the plane moving forward
Thrust	pushes against the plane and slows it down
Lift	pulls everything toward the Earth
Drag	raises the airplane and keeps it in the air

Understanding the Four Forces of Flight Questions

Pilots are able to steer a plane by moving flaps on the wings up and down. These flaps are called elevators. For example, if the elevator on the right wing is up, and the elevator on the left wing is down, the right wing will have more drag. The plane will slow down on the right side. The left side of the plane will stay at the same speed, causing the plane to turn to the right. What do you think will happen if the elevators on both wings are in the up position? Use the space below to answer.



How Stuff Works. Retrieved from the World Wide Web at: Howstuffworks.com

Understanding the Four Forces of Flight Answers

Multiple Choice

1. B
2. D
3. A
4. B
5. D

Matching

Gravity	pulls everything toward the Earth
Thrust	keeps the plane moving forward
Lift	raises the airplane and keeps it in the air
Drag	pushes against the plane and slows it down

Short Answer

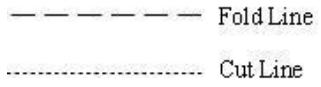
(Answers will vary. Points can be awarded based on reasoning and accuracy.)

If the flaps (or elevators) are bent up, there will be more drag on the top of the wing. If the drag is greater on top, the plane will be “slower” on top than it is on the bottom, the nose will point up and the plane will travel higher. For older students, this can also be explained in terms of air pressure. Elevators in the up position create lower pressure under the wings and greater pressure on top. The higher air pressure on top pushes down on the rear of the wings and causes the nose of the plane to turn upward.

Directions for Paper Airplanes

Folding Technique - Folding technique is **very** important for successful flights. Make each of the folds carefully and accurately according to the instructions. Creases should be made by applying pressure to the fold with the edge of your thumbnail. This is best achieved by holding your thumbnail on the fold, applying pressure, and pulling your thumb along the fold line toward you. This will produce clean, crisp folds that will allow for accurate paper planes. If you make a mistake on a fold that you cannot correct, don't be discouraged! Just print another template.

Line Types – There are two main types of lines referenced by the instructions: fold lines and cut lines. Fold lines are dashed and cut lines are dotted.



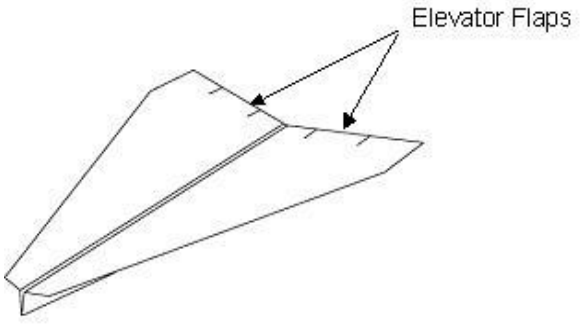
Model Adjustments – No matter what anyone tells you, EVERY paper airplane needs fine-tuning to achieve its best performance. There are several things you should keep in mind while making adjustments to your planes.

Dihedral – Dihedral is a slight upward tilt of the wing tips with respect to the fuselage or body of the airplane. This produces a slight V-shape to the wings when viewed from the front of the plane. Dihedral provides aerodynamic stability to your models by making them want to self-center during flight. Paper airplanes have no intelligent flight controls after they leave your hand, so the plane needs to be naturally stable or else it will crash. All designs on this site perform better when some dihedral is added to the wings.

Front View
With Dihedral, Good

Front View
No Dihedral, Bad

Elevator – Elevator is the aeronautical term for the hinged flap at the tail section of a plane that causes it to either climb (gain altitude) or dive (lose altitude). In paper airplanes these flaps are generally located on the trailing edge of the wings themselves, since there is rarely a separate tail. They are formed by making parallel cuts about 1 inch apart. This produces a small flap that can be folded slightly up or down. Tilting the elevator flaps up will cause the plane to climb. Tilting them down will make the plane want to dive. If you find that your models are heading nose-down toward the ground shortly after launch, you may need to add some up elevator. Likewise, if they are looping-up too quickly or stalling, you may need to add some down elevator. Adding slightly more elevator to one wing than the other will cause the plane to either turn to the right or left.



Fun Paper Airplanes. Retrieved from the World Wide Web at: http://www.funpaperairplanes.com/Plane%20Downloads.html

Sample Videos for the Classroom

How Airplanes Fly. Retrieved from the World Wide Web at: http://www.youtube.com/watch?v=gk6rNFVc1Gs

How Do Airplanes Fly? Retrieved from the World Wide Web at: http://www.youtube.com/watch?v=bv3m57u6ViE

History of Transportation: How Do Airplanes Work? Retrieved from the World Wide Web: http://videos.howstuffworks.com/hsw/18134-history-of-transportation-how-airplanes-work-video.htm

Flight Data Sheet

Build your airplane and complete the following flight data sheet.

Team Name:

Team Members:

Trial	**Distance**
Trial 1	
Trial 2	
Trial 3	
Trial 4	
Trial 5	

Graph your results.

Shortest Trial:

Next:

Next:

Next:

Longest Trial:

Average of the Five Trials:

Design Description:

Notes:

Time Out for Flight Math!

1. If Charles Lindbergh got nine people to sponsor his flight across the Atlantic Ocean and the Spirit of Saint Louis cost $27,000 how much would each person give to C.L.?

2. If an average small commercial jet airplane carries 73 people that all weigh 125 pounds, and has 1,967 pounds of gas, how much weight is the plan carrying?

3. If an airplane's wing span is 200 feet long, and an eagle's wing span is 7 feet, how many eagle's wing spans equal the wing span of an airplane?

4. If I fly 2000 miles in an airplane a day, how many miles will I fly in a year?

5. To fly around the world the trip would take 12000 miles. If you're plane travels at a top speed of 200 MPH how long would it take to fly around the world 5 times?

6. The missile fired 5750 miles down the Pacific to hit an island target. It was traveling at 250 miles a minute. How long did it take to reach its target?

7. There are 17 planes in a hangar on a small field. If 6 planes are missing from each of 2 hangars, and there are 27 hangars, how many planes are there in all?

8. There were 600 planes in an air show. 35 crash and 26 get lost. How many are left?

9. There are 40 kids on the island of Krakatoa and there are 20 husbands and 20 wives and Professor Sherman. There are also three mines of diamonds and in each mine there are 3965 diamonds. If every person on the island is entitled to an equal share of diamonds, how many will each person get?

10. Octave Chanute glided 927 feet, but Olga Klepkova has the record of 465 miles. How much farther did Klepkova go than Chanute? (1 mile = 5,280 feet)

11. Charles A. Lindbergh had 3 tanks in his plane. Each tank was filled with 160 gallons of gas. Amelia Earhart had 2 gas tanks. Each had 200 gallons of gas. How many gallons did everyone have?

Experiments for the Classroom

Earth and Space Science

Oil Spill! Clean It Up

When oil tankers accidentally spill their cargo of oil into the ocean they cause a huge environmental danger. Oil is extremely hard to remove from the water and the beaches, and the whole environment is damaged. In this experiment, you can see how hard it is to remove oil from sand. You will need:

- Large plastic cup
- Sand
- 2 tablespoons of vegetable oil

(This experiment can be messy, so you might want to do it outdoors.)

Step 1 – Observe - Fill a plastic cup with sand and oil and mix well. Observe the problem that you have.

Step 2 – Hypothesize - Based on your observations, make a guess at what tools you could use to get the oil off the sand.

Step 3 – Test the Hypothesis - Conduct an experiment. Use a spoon, a straw, paper towel, an old toothbrush, a sponge – anything that you can think of to get the oil off the sand and help save the environment!

Look Out, She's Gonna Blow! – Building a Volcano

Let's build a real working volcano. After mixing just the right amount of ingredients together, we'll add the final item to make our volcano 'blow its top' spewing red lava down the sides.

First, create the "salt dough". Mix 6 cups flour, 2 cups salt, 4 tablespoons cooking oil, and 2 cups of water in a large bowl. Work the ingredients with your hands until smooth and firm. Add more water to the mixture if needed.

Stand the soda bottle in the baking pan. Mold the salt dough around the bottle making sure you don't cover up the bottle mouth or drop any dough into the bottle. Take your time on this step and build your volcano with as much detail as you like.

- Fill the bottle most of the way with warm water mixed with a little of the red food coloring.
- Put 6 drops of the liquid detergent into the bottle.
- Add 2 tablespoons of baking soda.
- Slowly pour vinegar into the bottle and jump back quick!

Notice the red 'lava' that flows out of your volcano. This happens because of the baking soda and vinegar mixture. Mixing baking soda and vinegar produces a chemical reaction in which carbon dioxide gas is created - the same gas that bubbles in a real volcano. The gas bubbles build in the bottle, forcing the liquid 'lava' mixture of the bottle and down the sides of your volcano.

Distances in the Solar System

Even in our own "cosmic neighborhood," distances in space are so vast that they are difficult to imagine. In this activity, we will build a scale model of the solar system using a roll of toilet paper.

Materials

- Planetary distances table
- Roll of toilet paper
- Gel pen or felt tip pen to write on toilet paper

Doing the Activity

Take one sheet of toilet paper as a test sheet for the pens. Make sure the ink is not too wet, that the pens don't easily tear the paper. Make a dot on the seam between the first two sheets of toilet paper. This is the Sun. Write the word Sun beside the dot.

Use the table of numbers to mark off the distances to each of the planets. The number in the table is the number of sheets of toilet paper needed to reach the orbit of each planet. It is important to realize that the counts in the table are starting from the Sun, not from the previous planet. (Thus, after you get to Mercury, you need 1.7 more sheets to get to Venus.) Make a dot and write the appropriate planet name on the toilet paper at the distance indicated. Ceres, the largest asteroid, is used to represent the asteroid belt.

Note:

- Keep a running count as you work on this. Each distance is from your starting point, the Sun
- 200 sheets of toilet paper stretch out to nearly 84 feet. Make sure you have room for your model before you start.
- Use colored pens to mark the distance to the planet's orbit from the Sun and label the orbit with the planet's name on the toilet paper.

Planet	Distance from the Sun (km)	Squares of Toilet Paper from the Sun
Mercury	57,910,000 km	2.0
Venus	108,200,000 km	3.7
Earth	149,600,000 km	5.1
Mars	227,940,000 km	7.7
Ceres	414,436,363 km	14.0
Jupiter	778,330,000 km	26.4
Saturn	1,429,400,000 km	48.4
Uranus	2,870,990,000 km	97.3
Neptune	4,504,000,000 km	152.5
Pluto	5,913,520,000 km	200

Life Science

How Strong Are You?
The following is an experiment that shows how crumpling paper is not always as easy as it seems and how the disuse of muscles affects the human body.

- Get five full sheets of newspaper.
- Hold your arm out straight and hold one piece of newspaper in just one hand. If you're right-handed, use your left hand. If you're left handed, use your right hand.
- Now crumple up the paper into a tiny ball, using just one hand.
- Do it again with the next piece of paper, until you've crumpled up all five pieces of newspaper.
- What do you notice?

Pretzel Predictions
Students are challenged to predict how many pretzels they can eat in a minute.

Materials:
- Pretzels, bow-tie shaped
- Stop watch

Instructions:
Ask several students to stand in front of the class. Ask them to predict how many pretzels they can eat in a minute. Write the predicted number of pretzels after each student's name.
Before starting the "contest," give each contestant and audience member a small (1") piece of pretzel. Ask them to chew it slowly. After the experience, ask the contestants whether or not they want to change their prediction. Give each student five pretzels. Tell them that you will give them more after the first five are chewed. Start the timer and see if the students met their predictions.

Discussion: Certain chemicals are added to pretzels during the manufacturing process to assure the complete dryness of the interior of the pretzel. Also, only a portion of one pretzel is needed to absorb all of the saliva in one's mouth.

Taking a Pulse
- Take your heart beat for one minute while sitting quietly. Jot down your heart rate.
- Next, walk in place for a minute and then take your heart rate for a minute. Jot this number down.
- Now, speed walk around the room. Stop and take your heart rate. Jot this number down.
- Finally, jog in place or do jumping jacks for a brief period of time. Stop and take your heart rate. Jot this number down.
- Using the four rates, create a graph, chart, or table that best depicts the different heart rates. Share the graphic information with the class and discuss the pros and cons of

each type of graphic. Discuss that the heart beats faster after exercise in order to pump more blood (oxygen) to the working muscles.

Physical Science

Raw or Cooked?

Find out which spins the longest, a raw egg or a cooked egg. For this experiment, you will need:

- 1 cooked egg
- 1 raw egg
- 1 plate

Step 1 – Observe the two eggs.

Step 2 – Hypothesize - Based on your observations, make a guess as to which egg will spin the longest and why.

Step 3 – Test the Hypothesis - Spin each egg in turn on a plate. The egg that continues to spin for a longer time is the cooked one. Now spin the eggs again, and then quickly stop both of them. Then let go of both eggs. You will see that the cooked egg stays still but the raw one starts spinning again.

Why does this happen? The contents of the egg have more inertia when they are raw, because they are in the form of a liquid. This inertia slows down the raw egg and that is why it stopped spinning before the cooked egg. In step 2, the liquid in the raw egg was still moving when you stopped both eggs, so that movement made the raw egg begin to spin again.

Friction

Which is easier to spin – a smoother ball or a less smooth ball? For this experiment, you will need:

- A bowl of water
- Smooth rubber ball
- Tennis ball

Step 1 – Observe the two types of balls.

Step 2 – Hypothesize - Based on your observations, make a guess as to which ball will spin the longest and why.

Step 3 – Test the Hypothesis - Try spinning the rubber ball in the water. Next spin the tennis ball in the water. Which one is easier to spin? The smoother ball is easier to spin because the smooth surface causes less friction with the water.

Copper Caper – Teaching Chemical Reactions

- 20 dull, dirty pennies
- ¼ cup white vinegar
- 1 teaspoon salt
- Clear shallow bowl (not metal)
- 2 clean steel nails

- Clean steel screw or bolt
- Paper towels

1. Put the salt and vinegar in the bowl. Stir until the salt dissolves.
2. Dip one penny halfway into the liquid. Hold it there for about 10 seconds, and then pull it out. Ask students what they see.
3. Dump all of the pennies into the liquid. You can watch them change for the first few seconds. After that you won't see anything happen.
4. After 5 minutes, take half of the pennies out of the liquid. Put them on a paper towel to dry.
5. Take the rest of the pennies out of the liquid. Rinse them really well under running water and put them on a paper towel to dry. Write "rinsed" on the second paper towel.
6. Put a nail and a screw into the liquid. Lean another nail against the side of the bowl so that only part of it is in the liquid.
7. After 10 minutes, take a look at the nails. Are they a different color than they were before? Is the leaning nail 2 different colors? If not, leave the nails in the bowl and check on them again in an hour or so.
8. What's happening to the screw? You may see lots and lots of fizzing bubbles coming from the threads. Leave it in the liquid for a while and see what happens.
9. After about an hour, look at the pennies on the paper towels. Ask students what happened to the rinsed ones. What happened to the others? What color is the paper towel under the unrinsed pennies?

Discuss with students that everything is made up of tiny particles called atoms. Some things are made up of one type of atom, such as the copper of a penny is made up of copper atoms. However, sometimes atoms join to make molecules. Copper atoms can combine with oxygen atoms from the air to make a molecule called copper oxide. The pennies looked dull and dirty because they were covered with copper oxide.

Vinegar and salt cleaned the pennies because copper oxide dissolves in acid. The unrinsed pennies turned green because the copper atoms joined oxygen from the air and chlorine from the salt to make a blue-green compound called malachite. The nail and screw got coated with copper because of the action of protons, neutrons, and electrons or to put it another way – the action of positively and negatively charged particles. The bubbles are the result of hydrogen gas – another chemical reaction.

Galileo's Free Fall – The Power of Gravity

Place newspapers on the floor around a chair.

Stand on the chair while your partner lies on the floor peering at the newspaper.

Hold 2 oranges in each hand. Extend your arms straight out in front of your body (and over the newspapers) so that each orange is the same height from the floor. Let go of both oranges at the same time. Did they hit the newspaper at roughly the same time?

Now stand in the same position but this time hold an orange in one hand and a grape (or some other small object) in the other hand. Let go of both of these objects at the same time. Hypothesize which will hit the newspaper first.

Most people would have guessed that the orange would hit the floor first, but gravity pulls all objects at the same speed regardless of their weight. Note: Air resistance influences this somewhat so for more accurate results you would need to do this experiment in a vacuum.

How Large Is an Atom?

Creating life-size models is an excellent strategy for teaching science concepts. To assist students in comprehending the size of atoms, have them complete the following activity.

Materials:

- 1 strip of paper 28 centimeters (11 inches long)
- 1 pair of scissors

Have students take the strip of paper and cut it into equal halves. Have them cut one of the remaining pieces of the paper into equal halves. Have students continue to cut the strip into equal halves as many times as they can. Make sure that all cuts are parallel to the first one. When the width gets longer than the length, they can cut off the excess, but that does not count as a cut.

How far did they get? Is there anything smaller than an atom? Yes, the size of an atom nucleus would take about 41 cuts. We can not see anything smaller than an atom with our eyes, even with the electron microscope. Yet, scientists use advanced technology to explore the world of electrons and quarks that are 9,000 times smaller than a nucleus.

How Far Did You Get? Here are some comparisons to think about as you are cutting.			
Cut 1	14.0 cm	5.5”	Child’s hand, pockets
Cut 2	7.0 cm	2.75”	Fingers, ears, toes
Cut 3	3.5 cm	1.38”	Watch, mushroom, eye
Cut 4	1.75 cm	.69”	Keyboard keys, rings, insects
Cut 6	.44 cm	.17”	Poppy seeds
Cut 8	1mm	.04”	Thread. Congratulations if you are still in!
Cut 10	.25 mm	.01”	Still cutting? Most have quit by now.
Cut 12	.06 mm	.002”	Microscopic range, human hair
Cut 14	.015 mm	.006”	Width of paper, microchip components
Cut 18	1 micron	.0004”	Water purification openings, bacteria
Cut 19	.5 micron	.000018”	Visible light waves
Cut 24	.015 micron	.0000006”	Electron microscope range, membranes
Cut 31	.0001 micron	.0000000045”	The size of an atom!

Retrieved from the World Wide Web at: http://www.miamisci.org/af/.

Independent and Dependent Variable Examples

Generally speaking, in any given model or equation, variables can be divided into two categories:

- Independent variables are the variables that are changed in a given model or equation. One can also think of them as the 'input' which is then modified by the model to change the 'output' or dependent variable.
- Dependent variables are considered to be functions of the independent variables, changing only as the independent variable does.

Using Independent and Dependent Variables

While the definition is more-or-less universal, the application varies slightly between statistical experiments and mathematics.

For example:

- If a scientist conducts an experiment to test the theory that a vitamin could extend a person's life-expectancy, then the independent variable is the amount of vitamin that is given to the subjects within the experiment. This is controlled by the experimenting scientist.
- The dependent variable, or the variable being affected by the independent variable in this case, is life span.

It varies from person to person within each group, and is what is being tested; that is, whether or not the people given the vitamin live, on average, longer than the people not given the vitamin. The scientist might then conduct further experiments to increase the number of independent variables -- gender, ethnicity, overall health, etc. -- in order to narrow down the specific effects of the vitamin.

Here are some other examples of dependent and independent variables in science:

- A scientist studies the impact of a drug on cancer. The independent variable is the administration of the drug. The dependent variable is the impact the drug has on cancer.
- A scientist studies the impact of withholding affection on rats. The independent variable is the affection. The dependent variable is the reaction of the rats.
- A scientist studies how many days people can eat soup until they get sick. The independent variable is the number of days of consuming soup. The dependent variable is the onset of illness.

Coke vs. Pepsi Taste Test: Experiments and Inference about Cause

This lesson plan and activity are based on material from the NSF-funded AIMS Project (Garfield, delMas and Zieffler, 2007). http://serc.carleton.edu/sp/index.html

Summary

The Coke vs. Pepsi Taste Test Challenge has students design and carry out an experiment to determine whether or not students are able to correctly identify two brands of cola in a blind taste test. In the first stage of the activity students design and conduct the experiment. In the second part of the activity students use Sampling SIM software (freely downloadable from http://www.tc.umn.edu/~delma001/stat_tools/) to simulate and gather information on what would be expected under chance conditions (i.e., if students obtained correct answers only by guessing). The students then compare the observed results to the chance results and make an inference about whether a given student can in fact correctly identify Coke and Pepsi in a blind taste test. Finally, the experiment is critiqued in terms of how well it met the standards for a good experiment.

This activity allows students to gain a better understanding of the experimental process and causality through considering control, random assignment, and possible confounding variables. The activity also allows students to begin to understand the process of hypothesis testing by comparing their observed results of the taste test to the results obtained through Sampling SIM (which model would be obtained by chance). Students make an inference about whether particular students in their class can truly tell the difference between Coke and Pepsi by reasoning about how surprising the observed results are compared to the simulated distribution of correct identifications by guessing. The activity also provides an opportunity for discussing generalizability to a population.

Learning Goals

- To learn the characteristics of a well-defined experiment.
- To learn the difference between an experiment and an observational study.\To learn to recognize instances of confounding.
- To learn to understand and recognize instances of experimental control.
- To learn that randomizing the assignment of treatments protects against confounding and makes cause and effect statements possible.
- To build the underpinnings of inference.
- To understand the process of hypothesis testing by comparing the observed results to the results obtained under chance conditions.

Description and Teaching Materials

This activity takes place in two stages as described below.

Roles: Within each group of four students, assign each student to one of the following roles.

- Tasters--those who think they can tell the difference (blind to test).

- Runners--those who run cups of cola from room to hall (blind to test).
- Recorders--they record results of tasters decisions about whether they are tasting Coke or Pepsi.
- Pourers--remain in the classroom as pourers/observers.

The following materials are needed:

- 10 Dixie cups per group for taste testing
- 8 additional Dixie cups for clearing the palate
- Coke and Pepsi (4 cans of each is enough for 8 groups)
- Recorder slips for each group
- Coke/Pepsi pourer slips, where each group is given a random order of Coke and Pepsi over 10 trials
- Sampling SIM software loaded on the computer or another simulation program or applet (see Available Technologies)
- Copy of Student Handout (included as part of this lesson)

Stage One of Activity: Designing and Conducting the Experiment

First, students are asked to consider how to design an experiment that will allow them to determine if anyone can correctly identify two different brands of cola in a blind taste test. After a discussion of various methods, a plan is introduced to use in conducting a taste test.

Students are asked to self identify who can correctly identify Coke or Pepsi in a blind taste test. Groups are then formed with one of these students in each group to be the tester. Groups of four work best. Each group member has one of the following roles:

First, the tasters, the recorders, and the runners will leave the room. The pourers are produce random series of Coke or Pepsi using a coin to determine what the tasters would taste. The pourers will be the only members of the group knowledgeable of the condition. The pourers will pour the appropriate drinks into paper cups, and leave them in a row to be tasted at their table. These people may switch groups when the taste testing begins so they will not know the order of colas to be tested.

Next, the runners will bring the first Dixie cups with cola to their group taster. The tasters will taste the drink and make a decision about whether they think it is Coke or Pepsi that they are drinking. The recorder will keep track of the taster's decision. The tasters will cleanse their palettes in between trials by taking a drink of water.

Repeat the above process 4 more times for a total of 5 trials. At the end, the results are revealed, and the number of correctly identified colas is tallied for each taster.

Stage Two of Activity: Analyzing the class data

First, students discuss the results, being asked if they think any of the results suggest that a student is doing better than just guessing. They are asked what kind of data would be expected if they were just guessing. This leads to simulating data for the situation of guessing ($p = .5$, $n = 5$ trials). Use Sampling SIM (or another simulation program or applet) to simulate the Coke/Pepsi activity, simulating data for 500 trials. Then students can compare the number of correct guesses to this distribution to see if their score is due to chance (in the middle) or

surprising (in one of the tails). A final discussion involves critiquing the experiment and talking about what could have made it better (e.g., more tastes).

Teaching Notes and Tips

Try to make sure that you have one person in each group that thinks they can distinguish between Coke and Pepsi. Try to have students make conjectures about what they would expect before gathering or simulating data.

Assessment

Have students discuss or write answers to the following questions:

- How were three elements of a good experiment (random assignment, control, and replication) included or not included in this experiment?
- Describe any possible sources of confounding in the experiment.
- Can you generalize the findings of this experiment to all students at this university? Why or why not?

References and Resources

NSF-Funded AIMS Project (J. Garfield, R. delMas, and A. Zieffler, University of Minnesota)

Coke/Pepsi Taste Test – Student Handout

Part I: Designing the Study

How could you design a study that would determine if someone could actually tell the difference between Coke and Pepsi? Discuss a plan for this and write it down.

Carrying out the study

The class will share ideas and come up with one design to use in carrying out a taste test. One person in your group will be selected to taste colas and try to identify them correctly.

How many times did the taster in your group correctly identify the colas? _____

Part II: Critiquing the Study

1. Was this taste test an experiment or an observational study? Explain.

2. Critique the study on each of the three elements of a good experiment (random assignment, control, and replication). Which were met in our study? Which were not? Explain.

3. What are three ways in which we could improve our study for next time? How would each of these suggestions improve the study?

Part III: The Guessing Model

1. What if your taster really couldn't tell the difference between Coke and Pepsi, but was just guessing? How many times would you expect him/her to correctly guess the correct cola brand? Why?

2. If we replicated the experiment many times, and each time a taster was guessing, then each time the number of correct guesses would be due to change. On average, how many correct guesses would you expect?

3. What would the distribution of correct identifications look like? Sketch a possible picture of these results using dots to represent each total number of correct guesses out of five tastes.

4. Could a student correctly identify all five tastes just by guessing? Why or why not?

Use Sampling Sim to produce a graph of data for the kinds of results we would get just due to chance (if a person was just guessing).

5. How does the graph of the results that *SamplingSIM* produced compare with the sketch you created earlier?

6. According to the graph, what it he most likely number of correct responses a taster could come up with just be guessing?

7. What are some unlikely values (the number of correct identifications that don't occur as often if a student was only guessing)?

8. Where does your taster's actual result fit on the graph produced by *SamplingSIM*? In the tails? In the middle?

9. Based on your answer to Question 11, is it likely or unlikely that your taster would have gotten the result he/she did if he/she was just guessing? Explain.

Reese's Pieces Activity: Sampling from a Population

Summary

This activity uses simulation to help students understand sampling variability and reason about whether a particular sample result is unusual, given a particular hypothesis. By using first candies, then a web applet, and varying sample size, students learn that larger samples give more stable and better estimates of a population parameter and develop an appreciation for factors affecting sampling variability.

First, students estimate the proportion of orange Reese's pieces in a random sample of 25 candies. Students then use an actual sample of Reese's pieces candy to calculate a sample proportion, and then compare results for different samples, taken by each student in the class. Next, students will use the Web Applet Reese's Pieces (at rossmanchance.com) to gather information on the sample proportions of orange candies in random samples of 25. During this stage of the activity students will compare their group and the class results to the actual parameters. In the final part of the activity, the students will use the Applet to investigate the effect of sample size on correctly estimating parameters.

Learning Goals

- To understand variability between samples
- To build and describe distributions of sample proportions
- To understand the effect of sample size on how well a sample resembles a population
- To develop an understanding of a sample distribution
- To develop an understanding of a sampling distribution
- To develop an understanding of a population distribution
- To develop an understanding of the differences between sample, sampling, and population distributions

Pre-instructional Decisions

Materials:

- One Dixie cup per group (each with 40 Reeses Pieces in it)
- Reeses Pieces (enough for 40 per group)
- Reeses Pieces Web Applet - URL: www.Rossmanchance.com/applets/Reeses/ReesesPieces.html (see Available Technologies)
- Copy of Student Handout (included at the end of this lesson)

Description and Teaching Materials

Stage One of Activity: Studying the variability of orange candies

- Inform students that Reese's Pieces candies have three colors: orange, brown, and yellow. Ask them: Which color do you think has more candies in a package: orange, brown or yellow?
- Have students guess the proportion of each color (orange, brown, and yellow) in a bag and record their answers.
- Next ask students...If each student in the class takes a sample of 25 Reeses pieces, would you expect every student to have the same number of oranges in their sample?
- Next have students pretend that 10 students each took samples of 25 Reese's pieces. Ask them to write down the number of oranges they might expect for these 10 samples. Tell them these numbers represent the variability you would expect to see in the number of orange candies in 10 samples of 25 pieces.
- Next tell students...You will be given a cup that is a random sample of Reeses pieces. Count out 25 candies from this cup without paying attention to color. In fact, try to IGNORE the colors as you do this.
- Inform students...Now, count the colors for your sample and record the number of each color as well as the proportion of each color sampled from the 25.
- Have students write the number AND the proportion of orange candies in their sample on the board. Mark where each value should be on the two dotplots your teacher constructs (construct dotplots - one for number of oranges, one for proportion of oranges).

Stage Two of Activity: simulating samples using an applet

- Access the Reese's Pieces Applet at Rossmanchance.com
- Tell students...Instead of trying this activity again with fewer or more candies, simulate the activity using a web applet. Go to www.rossmanchance.com/applets/, and look at the bottom of the far right column to find Java Applets. Click on Java Applets and look for Sampling Distributions, and click on Reese's Pieces. You will see a big container of colored candies: that represents the POPULATION.
- Ask students: How many orange candies are in the population? You will see that the proportion of orange is already set at .45, so that is the population parameter. (People who have counted lots of Reese's pieces came up with this number).
- Ask...How does .45 compare to the proportion of orange candies in your sample?
- Ask students: .How does it compare to the center of the class distribution?
- Click on the draw samples button. One sample of 25 candies will be taken and the proportion of means for this sample is plotted on the graph. Repeat this again.
- Ask students: Do you get the same or different values for each sample?
- Ask students...How do these numbers compare to the ones our class obtained?
- Ask students: How close is each sample statistic (proportion) to the POPULATION PARAMETER?
- Have students turn off the animation and change the number of samples to 100. Click on draw samples, and see the distribution of sample statistics built. Describe its shape, center and spread.
- Ask students: How does this compare to the one our class constructed on the board?

Stage Three of Activity: studying the effect of sample size

- Ask students: What happens to this distribution of sample statistics if they change the number of candies in each sample (sample size)?
- Have them change the sample size to 10 and draw 100 samples. Ask them: How close is each sample statistic (proportion) to the POPULATION PARAMETER?
- Next, have them change the sample size to 100 and draw 100 samples. How close is each sample statistic (proportion) to the POPULATION PARAMETER?

Teaching Notes and Tips

- It is helpful for the teacher to go through the entire activity using the web applet themselves, before having students do the activity.
- Be sure to let students make and discuss their conjectures before looking at real or simulated data.
- Be sure to have students turn off the animation on the web applet after they have taken a few samples.
- Be sure to ask students to compare their results and discuss the amount of sampling variability.

Assessment

Here are some questions that can be given to students to discuss or write answers to:

- Distinguish between how samples vary from each other, and variability of data WITHIN one sample of data.
- Why do larger samples better represent the population from which they were sampled than small samples?
- Based on the class activity, would you be surprised to get a sample that had only 5 orange candies? Why or why not?

References and Resources

Rossman, A. J., & Chance, B. L. (2000). Workshop Statistics: Discovery with Data, 2nd Edition. Key College Publishing.

Garfield, J., & Ben-Zvi, D. (in preparation) Developing students statistical reasoning connecting research and teaching practice. Key College Press

Sampling Reese's Pieces – Student Handout

1. Reese's Pieces candies have three colors: orange, brown, and yellow. Which color do you think has more candies in a package: orange, brown or yellow?

2. Guess the proportion of each color in a bag:

   Orange____ Brown____ Yellow_____

3. If each student in the class takes a sample of 25 Reese's pieces, would you expect every student to have the same number of orange candies in their sample? Explain.

4. Pretend that 10 students each took samples of 25 Reese's pieces. Write down the number of orange candies you might expect for these 10 samples:

   ___ ___ ___ ___ ___ ___ ___ ___ ___ ___

These numbers represent the **variability** you would expect to see in the number of orange candies in 10 **samples** of 25 pieces.

You will be given a cup that is a **random sample** of Reese's pieces. Count out 25 candies from this cup without paying attention to color. In fact, try to IGNORE the colors as you do this.

5. Now, count the colors for your sample and fill in the chart below:

	Orange	Yellow	Brown
Number of candies	_____	_____	_____
Proportion of candies **(**divide each NUMBER **by 25)**	_____	_____	_____

Write the number AND the proportion of orange candies in your sample on the board.
Mark where each value should be on the two dotplots your teacher constructs (one for number of oranges, one for proportion of oranges).

I. Discussion: The proportions are the **sample statistics**. For example, the proportion of orange candies in your sample is the statistic that summarizes your sample.

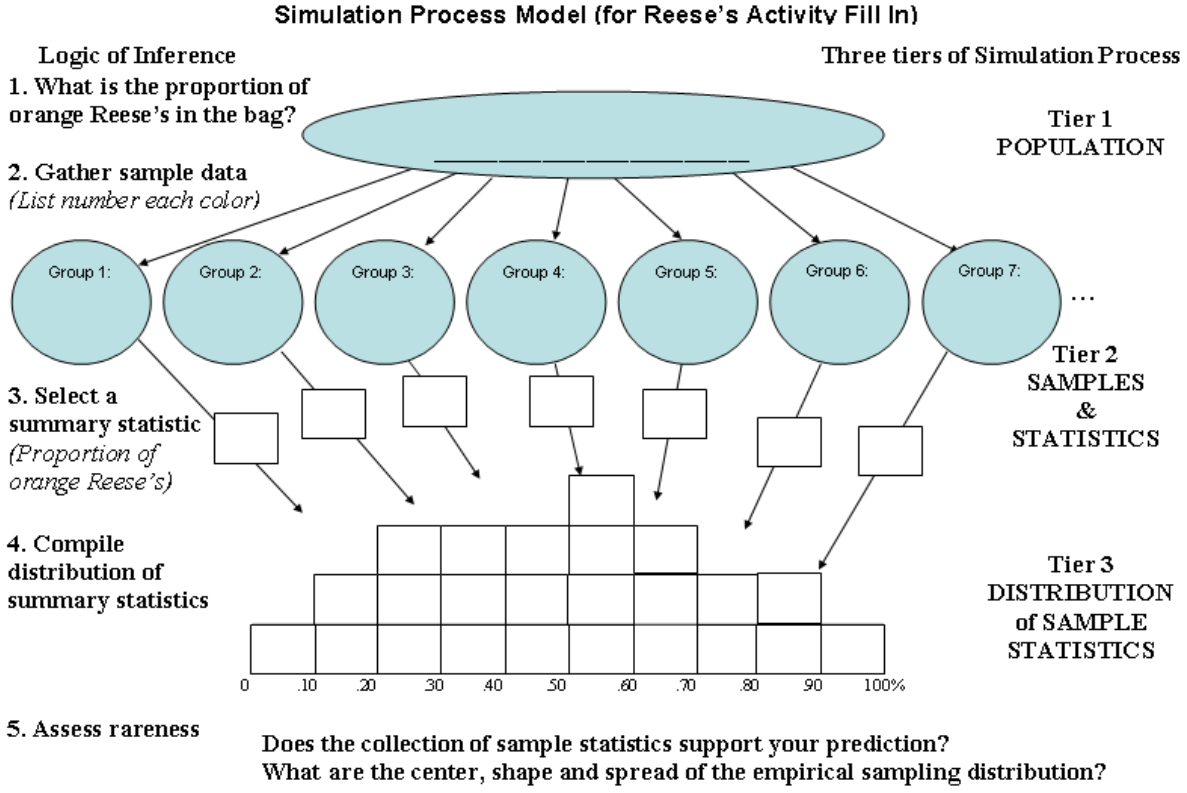
- How does this relate to the population **parameter** (the proportion of all orange Reese's Pieces produced by Hershey Co.)?
- Do you know the value of the parameter?
- Do you know the values of the statistics?
- Does the value of the <u>parameter</u> change, each time you take a sample?

- Does the value of the statistic change each time you take a sample?
- Did everyone in the class have the same number of orange candies?
- How do the actual sample values compare to the ones you estimated earlier?
- Did everyone have the same proportion of orange?
- Describe the variability of the **distribution of sample proportions** on the board in terms of shape, center, and spread.

II. Focus on the proportion of orange candies.
Simulate data and tie this activity to the Three-Tier Simulation Process Model (SPM). Use the SPM to fill in information for the three tiers:

- Population:
- Samples and sample statistics:
- Distribution of sample statistics:

Fill in the details of the distribution that was put of the board in the SPM below:



Based on the distribution we obtained (on the board), what would you ESTIMATE to be the population parameter, the proportion of orange Reese's pieces produced by Hershey?

What if everyone in the class only took 10 candies, in their sample instead of 25? Do you think the graphs on the board would look the same? If not, how would they be different?

What if everyone in the class took 100 candies? Would the distributions on the board change at all? If so, how?

III. The Reese's Pieces Applet

Instead of trying this activity again with fewer or more candies, simulate the activity using a web applet. Go to www.rossmanchance.com/applets/, and look at the bottom of the far right column to find Java Applets. Click on **Java Applets** and look for Sampling Distributions, and click on **Reese's Pieces**. You will see a big container of colored candies: that represents the POPULATION.

- How many orange candies are in the population?

You will see that the proportion of orange is already set at .45, so that is the **population parameter**. (People who have counted lots of Reese's pieces came up with this number).

- How does .45 compare to the proportion of orange candies in your sample?
- How does it compare to the center of the class' distribution?

Click on the "draw samples" button. One sample of 25 candies will be taken and the proportion of means for this sample is plotted on the graph. Repeat this again.

- Do you get the same or different values for each sample?
- How do these numbers compare to the ones our class obtained?
- How close is each **sample statistic** (proportion) to the **POPULATION PARAMETER**?

Turn off the animation and change the number of samples to 100.
Click on draw samples, and see the distribution of sample statistics built.

- Describe its **shape, center and spread**.
- How does this compare to the one our class constructed on the board?

IV. Test your conjectures

What happens to this distribution of sample statistics as we change the number of candies in each sample (sample size).

First, change the sample size to 10 and draw 100 samples

- How close is each **sample statistic** (proportion) to the **POPULATION PARAMETER**?

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Next, change the sample size to 100 and draw 100 samples.

- How close is each **sample statistic** (proportion) to the **POPULATION PARAMETER**?

V. Sample Size

As the sample size increases, what happens to how well the sample statistics resemble the population parameter?

Now, describe the effect of sample size on the distributions of sample statistics.

Note: When we generate sample statistics and graph them we are generating an estimated SAMPLING DISTRIBUTION, or a distribution of the sample statistics. It looks like other distributions we have seen of raw data. What's different about this?

We now need to distinguish between THREE kinds of distributions of data:

- Distribution of population
- Distribution of one sample of data
- Distribution of sample statistics for many samples.

Show where each of the distributions are represented on the **SIMULATION PROCESS MODEL**.

Thinking Like a Scientist Handout

Seeking Solutions Scenarios

Read through the observations below and choose one scenario that interests you. Brainstorm explanations for the observations and use the explanations to form several possible hypotheses. Then develop one or more experiments to test your hypotheses.

Scenario 1

You have often noticed that ants follow one another in a trail to food. How do they know to follow each other in the trail? Do they have a form of communication that we can't hear or see? Or do they follow the trail because they see other ants following the trail?

Make several hypotheses that could explain why ants follow one another in a trail to food. Then design an experiment to test one of your hypotheses. What results would you observe if your hypothesis is true? What results would you observe if your hypothesis is false?

Scenario 2

When opening a container of cranberry juice, you noticed the label "refrigerate after opening." You also notice this label on a variety of other food containers, such as mayonnaise bottles and tuna cans. Why does the food have to be refrigerated once the can or bottle is opened, but not before? What would happen if the food were not refrigerated after opening? What does refrigeration do?

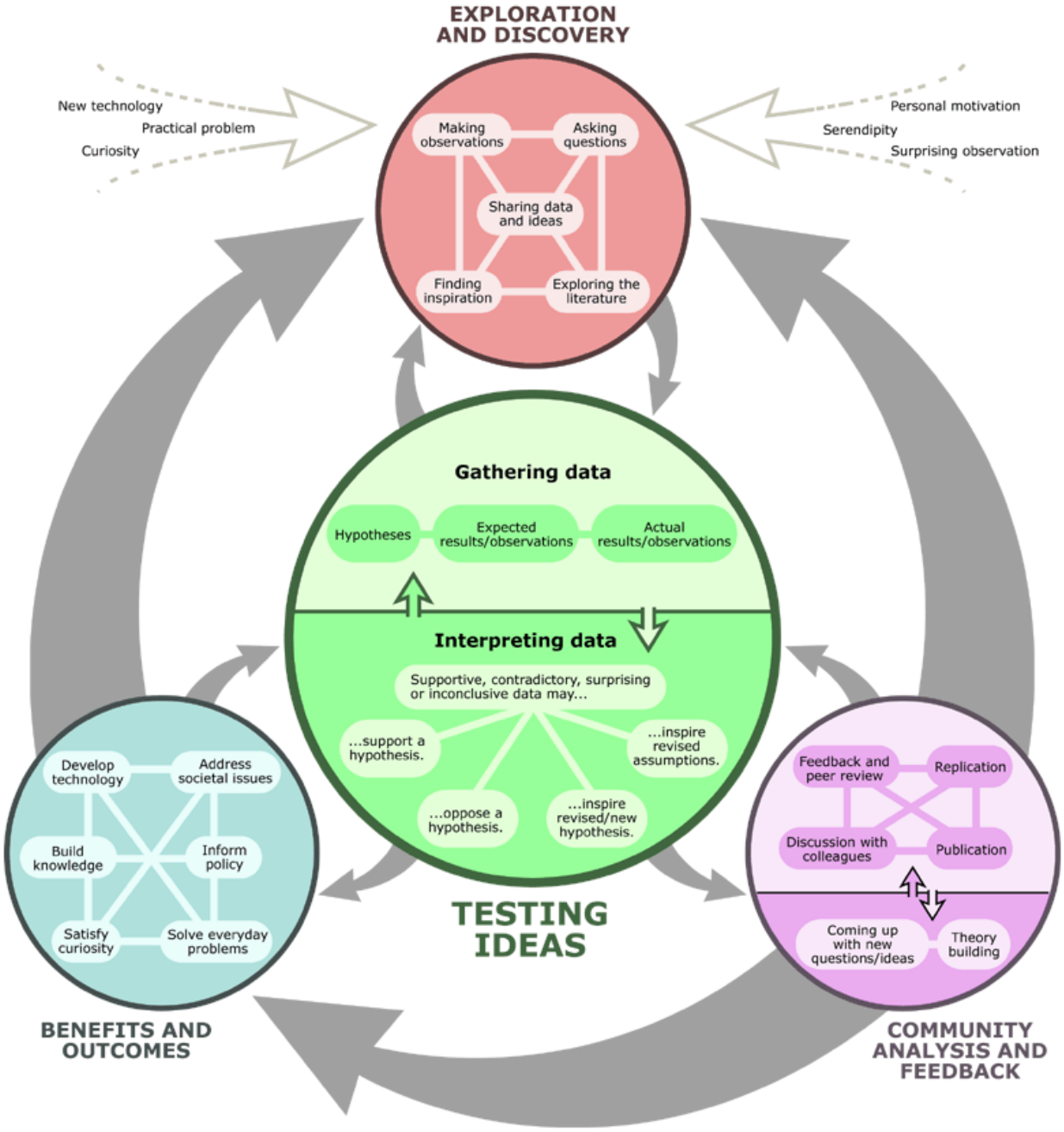
Make several hypotheses that could explain why certain foods can remain unrefrigerated before opening, but not after opening. Then design an experiment to test one of your hypotheses. What results would you observe if your hypothesis is true? What results would you observe if your hypothesis is false?

Scenario 3

You are at the top of Mt. Haleakala, a dormant volcano that rises over 10,000 feet above the island of Maui in Hawaii. You noticed that a person nearby is talking about starting to feel dizzy, while someone else is complaining about a sudden headache. You feel fine. Why are some people feeling sick when others are not? Is it the air around the volcano? Is it the altitude? Or are the problems completely unrelated to the location?

Make several hypotheses that could explain why certain people feel sick at the top of Mt. Haleakala while others do not. Then design an experiment to test one of your hypotheses. What results would you observe if your hypothesis is true? What results would you observe if your hypothesis is false?

http://www.accessexcellence.org/RC/AB/WYW/wkbooks/OBAS/thinkhand2.phpA



How Science Works
http://undsci.berkeley.edu/flowchart_noninteractive.php

A Few Websites in Science to Get You Started!

ABC Science. News, video clips, games, and lots of activities for the science classroom from the American Broadcasting Company. http://www.abc.net.au/science/

Annenberg: The Habitable Planet. The Habitable Planet is a multimedia course for high school teachers and adult learners interested in studying environmental science. The Web site provides access to course content and activities developed by leading scientists and researchers in the field. http://www.learner.org/channel/courses/envsci/index.html

Annenberg Science in Focus: Force and Motion. Explore science concepts in force and motion and come away with a deeper understanding that will help you engage your students in their own explorations. With science and education experts as your guides, learn more about gravity, friction, air resistance, magnetism, and tension through activities, discussions, and demonstrations. http://www.learner.org/channel/workshops/force/

BBC Science. From space to the human body to, this interactive site allows learners to discover many different facets of science. http://www.bbc.co.uk/sn/

Cells Alive. This site can be used by teachers and students. Lots of great interactivity and resources on the basics of cells. http://www.cellsalive.com/toc.htm

Discovery Channel. The website has lots more information than even the channel. Lots of interactivity with excellent videos, interactivity, and high-level games. http://www.discovery.com/

Exploratorium Online. Since 1993, the Exploratorium was one of the first science museums to build a site on the World Wide Web. The site contains over 15,000 articles and displays including interactivity regarding science. http://www.exploratorium.edu/

Franklin Institute. Excellent collection of online resources and activities designed to create curiosity and promote science in everyday life. http://www.fi.edu/explore.html

How Stuff Works. Ever wondered why a cd works? How about the ten myths about the brain? How about what would happen if you put sugar in your gas tank? An interesting science site filled with real-world information. http://www.howstuffworks.com/

Interactive Websites for Teaching Science. Just click on one of the topics and explore the myriad of resources on the World Wide Web. http://interactivesites.weebly.com/science.html

National Science Teachers Association. Don't forget the professional organization for science teachers. This site has lots of ideas, lessons, and scientific updates. http://www.nsta.org/

Newton's Apple. NEWTON'S APPLE is a production of Twin Cities Public Television from a grant from the 3M Foundation. The site is filled with free videos for use in many different areas. http://www.newtonsapple.tv/

Nye Labs.com This is indeed "Bill Nye, the science guy" with lots of activities and applications for science. http://www.billnye.com

PBS: Science & Nature. Highlights and background information on every Science-based PBS program on the air; check out the Science for the Classroom link. http://www.pbs.org/science/

Steve Spangler. This site has lots of free experiments and videos for use in the classroom. http://www.stevespanglerscience.com/lab

The Why Files. University of Wisconsin, Board of Regents. Real world articles to support all areas of science. Click on the "Why Files in Education." http://whyfiles.org/teach/

Understanding Science. The Understanding Science website is a fun, free resource that aims to accurately communicate what science is and how it really works. It provides "an inside look at the general principles, methods, and motivations that underlie all of science." http://undsci.berkeley.edu/

Weather Classroom. The Weather Classroom presents all kinds of online interactive resources for students and teachers; worth investigating. http://www.weatherclassroom.com/index.php

Stay in Touch!

- **Florida GED® 2014 Preparation Program Frameworks** – http://www.fldoe.org/workforce/dwdframe/ad_frame.asp
- **GED Testing Service®** – www.GEDtestingservice.com
- **Twitter at @GEDTesting®** – https://twitter.com/gedtesting
- **GED® Facebook** – https://www.facebook.com/GEDTesting
- **YouTube channel** – http://www.youtube.com/gedtestingservice
- **Common Core State Standards** – http://corestandards.org
- **College and Career Readiness Standards for Adult Education** – http://lincs.ed.gov/publications/pdf/CCRStandardsAdultEd.pdf

  https://www.ed.gov/edblogs/ovae/2013/04/22/college-and-career-readiness-ccr-standards-for-adult-education/