INDEPENDENT OR DEPENDENT? THAT IS THE QUESTION

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Tazewell Middle School, Tazewell, VA

GRADE LEVELS:
4^{th} – 8^{th} grades

TIME ALLOTMENT:
3- 45 minute blocks

SUBJECT MATTER:
Science, Math

OVERVIEW:
This lesson will focus on the scientific method and the parts of the scientific method. Students will identify the different parts of a scientific inquiry as they work with an experiment. Students will graph data gathered during experiments, identifying the independent variable, which goes on the x-axis, and the dependent variable, which goes on the y-axis of the graph. Students will enjoy playing a game with teammates as they learn to identify the independent (manipulated) variable, the dependent (responding) variable, the hypothesis, the control, and the constants in scientific inquires.

LEARNING OBJECTIVES:
Students will be able to:
- identify the independent and dependent variable of an experiment.
- identify the control and constants of an experiment.
- describe how to set up an experiment to test one variable.
- use data to draw a conclusion when identifying an unknown substance.
- identify independent and dependent variable from a graph.
- graph collected data from an experiment.

STANDARDS:

Virginia State Standards:
The objectives listed may be used in part to address the Virginia Standards of Learning at http://www.pen.k12.va.us
VA SOL Science (4.1, 5.1, 6.1, LS.1, PS.1)
- ★ 4.1 b Hypotheses are formulated based on cause and effect relationships
- ★ 4.1 c Variables that must be held constant in an experimental situation are defined
- ★ 4.1 f Data are displayed using bar and basic line graphs
- ★ 5.1 e Data are collected, recorded, and reported using the appropriate graphical representation (graphs, charts, diagrams)
- ★ 5.1 g Manipulated and responding variables are identified

- ★ 6.1 e Hypotheses are stated in ways that identify the independent (manipulated) and dependent (responding) variables
- ★ 6.1 i Data are organized and communicated through graphical representation (graphs, charts, and diagrams
- ★ LS.1 b Variables are defined
- ★ LS.1 f Dependent variables, independent variables, and constants are identified
- ★ LS.1 h Continuous line graphs are constructed, interpreted, and used to make predictions
- ★ PS.1 g Independent and dependent variables, constants, controls, and repeated trials are identified
- ★ PS.1 h Data tables showing the independent and dependent variables, derived quantities, and the number of trials are constructed and interpreted
- ★ PS.1 k Valid conclusions are made after analyzing data
- ★ 6.1 k, LS.1 j, PS.1 n An understanding of the nature of science is developed and reinforced

VA SOL Math (5.18, 6.18, 7.17, 8.12)

- ♦ 5.18 The student will, given a problem situation, collect, organize, and display a set of numerical data in a variety of forms, using bar graphs and line graphs to draw conclusions and make predictions
- ♦ 6.18 a The student, given a problem situation, will collect, analyze, display, and interpret data in a variety of graphical methods, including line, bar, and circle graphs
- ♦ 7.17 b The student, given a problem situation, will collect, analyze, display, and interpret data in a variety of graphical methods, including line plots
- ♦ 8.12 The student will make comparisons, predictions, and inferences, using information displayed in frequency distributions, line, and bar graphs

MEDIA COMPONENTS:

- Video: United Streaming- *How Scientists Work- What is the Scientific Method?* http://unitedstreaming.com
- Computer
- TV
- SMART Board -optional

MATERIALS:

Materials needed for Introductory Activity:

- Test tubes
- 2 weak acids :
  - 10 mL of boric acid
  - 10 mL of lemon juice
- 2 weak bases:
  - 10 mL of baking soda with water

10 mL of liquid soap or detergent (clear or light)

- bottle of phenolphthalein (indicator for bases)
- 1- Test tube holder

Materials needed for Learning Activity:

- Computer(s)
- Television
- CD with United Streaming video (if downloaded onto CD)
- Graph paper
- Pencil
- Cards or poster boards for Key terms

Materials needed for Culminating Activity:

- SMART Board or
- Game Board with Game pieces for each group of 4
  (See back of lesson to prepare a game board and game pieces)
- 1- dice

PREPARATION FOR TEACHERS:

- ✓ Download the United Streaming videos to your desktop or download the United Streaming videos to a CD.
- ✓ Make sure you go through the instructions from the student materials handouts so that you understand and are familiar with the lesson format and what the students need to do or understand for the lesson.
- ✓ When using media, always provide the students with a ***Focus for Media Interaction***, which is a specific task to complete during or after viewing video segments, Web sites, or other media material.
- ✓ Prepare the game boards (The game board and game pieces can be used over and over.) and game pieces.

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Introductory Activity:

Tell the students that today they are going to learn more about the scientific method and the way that scientists work. **Ask**: "What is scientific inquiry?" (Expect to get different kinds of answers.) **Say**, "We're going to learn about the different steps of the scientific method and the different parts of scientific inquiry." (Have the 4 test tubes in their container. In one test tube, put about 10 mL of the boric acid. Do not tell the students what it is. In the second test tube, put about 10 mL of soap. In the third test tube, put in the 10 mL of baking soda mixed with water and label the test tube as Substance #1. In the fourth test tube, put in the 10mL of lemon juice and label the test tube as Substance #2.) **Say**, "In these two test tubes we have two unidentified substances." What question can we ask to start our scientific inquiry?" (Questions might include: What is the substance? What is the difference between the two substances?) **Say**, "I have an

indicator here called phenolphthalein. An indicator is a substance that reacts with an acid or a base. So, the phenolphthalein will react with either an acid or a base. Now, what question might we ask about each substance?" (Is the substance an acid or a base?) Put two or three drops of phenolphthalein in the boric acid and then put two or three drops in the soap. **Say**, "What is our question?" (Is the substance an acid or a base?) **Say**, "The question is the first step in our scientific inquiry. I have a video that will help us to remember the steps in the scientific method and will lead us through our inquiry about our unknown substances."

LEARNING ACTIVITIES

*Note to teacher: Have the United Streaming video, *How Scientists Work-What is the Scientific Method,* downloaded to desktop or on CD ready for viewing before class starts.

Part 1

1. **Focus for Media Interaction**: **Say**, "Today, we are going to watch a video on how scientists work. I want you to watch and be able to tell me what the scientific method is and why it is outstanding." **Start (1:23)** video at the beginning and **Pause (2:42)** when you **see** the words "How Scientists Work" and **hear** "Using the prism here to show what light is made up of, is a relatively simple experiment." **Ask,** "What is the scientific method?" (A procedure to uncover the secrets of nature.) "Why is the scientific method outstanding?" (When you use the scientific method's 5 steps to solve a problem, this procedure can be repeated by anyone to check out the results firsthand.)

2. **Focus for Media Interaction**: **Say**, "We know that experiments are part of the scientific method but what does the video say that experiments are?" **Resume** and **pause (3:08)** when you **see** a large hose and a lady working in the background and **hear** "Let's look in a general way at the steps that make up the scientific method." **Ask**, "What does the video say that experiments are?" (Experiments are an everyday part of science and the cornerstone of the scientific method. An experiment is why we don't have to take it on faith or believe it because some very well known person said he or she knew it was true.)

3. **Focus for Media Interaction: Say**, "Now we are going to watch the video describe the Pre-Experimental Stage or stage one. I want you to tell me the two parts of stage one and what is a hypothesis?" **Fast forward (6:10)** to where you **see** a girl drink from a cup and **hear** "…one way to look at the basic steps of the scientific method is to divide them up into three stages." **Play** and **Pause (7:45)** when you **see** Sam holding up two pieces of metal and **hear,** "Let's look at some different questions and see what hypotheses might be proposed to answer them." **Ask**, "What are the two parts of stage one?" (Finding a question and forming a hypothesis.) "(Name of a student in class), would you go to the board and write the 2 parts of the scientific method." (Have the student write the 2 parts and if he/she needs help remembering, ask the class again what the 2 parts are.) "Do we already have a question with our substances in the test tubes? " (Yes) "What is a hypothesis?" (an educated guess as to

what the cause of the problem they were experiencing was.) "Do we have a hypothesis?" (No) **Say**, "Let's form a hypothesis now." Using the board or a chart, form a hypothesis with the students.

4. **Focus for Media Interaction**: **Say**, "I want you to watch and be able to tell me one of the different questions proposed by Sam and what Sam said about hypotheses." **Resume** and **Pause (8:44)** when you **see** a sky with the sun and clouds in it and **hear** "…that if this hypothesis was true the consequences would change our understanding of how light behaves." **Ask**: "What was one of the questions proposed on the video by Sam?" (Where did the candlestick come from and why did it tarnish?) "What did Sam say about hypotheses?" (There are many hypotheses that can be offered to answer his questions.)

5. **Focus for Media Interaction**: **Say**, "Next, I want you to watch the video on Stage two that is called the Experimental Stage. I want you to be able to tell me the first 2 parts of the Experimental Stage and see how these parts relate to our experiment with the unknown substances." **Resume** and **Pause (9:15)** when you **see** a young man with a stop watch and **hear** "You will have to learn how to use a tool, such as a graduated cylinder or a stop watch." **Ask**: "What is the first part of the Experimental Stage?" (Gather materials.) "What materials do we need to investigate these unknown substances?" (Two or more known substances, the indicator, test tubes, test tube holder, pencil, paper) "What is the second part of the Experimental Stage?" (Know how to use a piece of equipment.) "What tools are we using that you need to know how to use correctly?" (graduated cylinder) "What units are we using?" (milliliters) "I am going to put an acid, which is lemon juice, in a test tube and put in 2 or 3 drops of phenolphthalein. I want you to watch what happens." Pour the 10 mL of lemon juice in a test tube, using a funnel. Place 2 or 3 drops of phenolphthalein into the test tube. **Ask**, "How did the phenolphthalein react to the lemon juice?" (It turned it milky looking.) "What do you know about lemon juice?" (It is an acid.) "Which of our unknown solutions do you think is an acid?" (The one that is milky looking or Substance #2.)

6. **Focus for Media Interaction**: **Say,** "We're going to see what the third and fourth parts of the Experimental Stage are and how they relate to our investigation." **Resume** and **Pause (10:06)** when you **see** a light meter and **hear** "As we can see, light intensity increases as we approach the light." **Ask**: "What is the third part of the Experimental Stage?"(Observe and record data) "How are we going to observe and record our data?" (Have a chart and write down our observations of the reaction of the indicator to known substances and then to the unknown substances.) "What is the forth part of the Experimental Stage?" (identify a single test variable and control other variables) "How many variables can be tested at one time?" (One and only one) "What are we testing in our investigation?" (if a substance is an acid or base) "What are variables that we need to control in our experiment?" (Same amount of each substance and same amount of indicator used each time) See if students can find other controls, like the same equipment. Now, have another student in class go to the board and write the next two steps in the scientific method. (gather materials and do the experiment, observe and record data) **Ask**, "What should we do when we tested

the lemon juice and saw the results?" (Recorded our observations) Have another student write "lemon juice – appears milky" on the board.

7. **Focus for Media Interaction**: **Say**, "Now we're going to watch for the last two parts of the Experimental Stage. Again, I want you to tell me what they are and how they relate to our investigation." **Resume** and **Pause (10:54)** when you **see** a girl and the words 'Perform Measurements' written on the screen and **hear "**...how the preceding six components of the experiment play a role in each experiment." **Ask**: "What are the last two parts of the Experimental Stage?" (Perform measurements and use mathematics) "What measurements do we need to do?" (measure the amount of each substance) "What other types of measurement did the video name?" (timing with a stop watch, measuring distance with a meter stick, and reading a temperature on a thermometer) "Do we need to use mathematics with out investigation?" (not necessarily) "Now, can you tell me the 6 different parts of the Experimental Stage?" (#1- gather materials, #2 – know how to use a piece of equipment, #3 – observe and record data, #4 – identify a single test variable and control other variables, #5- perform measurements, and #6 – use mathematics)

8. **Focus for Media Interaction: Say**, "Now, I want you to watch to see what experiment is performed, what is the question the girl asks, and what is her hypothesis." **Resume** and **Pause (11:24)** when you **see** an ant hill on concrete with the girl's hypothesis written on the screen and **hear** "…greatest number of ants will be observed at that time of day." **Ask**: "What experiment is the girl performing?" (She is investigating ant activity.) "What is her question?" (How does the level of ant activity outside of an ant hole change from sunrise to sunset?) "What is her hypothesis?" (If the air temperature is the warmest then the greatest number of ants will be observed at that time of day.)

9. **Focus for Media Interaction: Say**, "This time I want you to tell me what the girl says that she does in the first two steps of the experimental stage after we view the next part of the video." **Resume** and **Pause (11:42)** when you **see** the girl lying on the concrete and **hear** "…will be taken each time the ants are counted." **Ask**: "What will the girl do first?" (She will count the number of ants that come out of the hole for a period of 1 minute at the beginning of each hour. She will start at 8:00 in the morning and stop at 8:00 in the evening.) "What else will the girl do?" (She will take the temperature each time the ants are counted.)

10. **Focus for Media Interaction: Say, "**In the next portion of video I want you to find out what the young man is going to investigate, what is his question, and what is his hypothesis." **Resume** and **Pause (11:57)** when you **see** a young man with a water hose in his hand and **hear** "Dark organic soil will absorb water the best." **Ask**, "What is the young man going to investigate?" (He wants to know what material, or soil, will absorb water the best.) "What is his question?" (What is the best kind of material for absorbing water?) "What is his hypothesis?" (Dark organic soil will absorb water the best.)

11. **Focus for Media Interaction: Say, "**Now, I want you to watch how the young man sets up his experiment and see what kind of materials he is using for his investigation." **Resume** and **Pause (12:41)** when you **see** the young man writing down his data and hear "After 5 minutes, collect the water that has not been absorbed." **Ask**, "What materials are used to test the experiment?" (organic soil, fine sand, and coarse gravel.) "How does the young man set up his experiment?" (He uses three funnels and in each funnel he puts in a coffee filter. In the coffee filter he puts in 200 mL of one kind of material, or soil. He sets the funnel into the top of a graduated cylinder. He does the same for each kind of soil and pours 100mL of water into each funnel of soil. After 5 minutes he will collect the water that has not been absorbed.)

12. **Focus for Media Interaction: Say,** "We are going to watch how the two experiments are compared. Be ready to tell me how the experiments are compared in the video." **Resume** and **Pause (13:43)** when you **see** a young man writing down data collected and **hear** "...the water volume, which had not been absorbed by the different soils, were recorded." **Ask**, "What are the first 3 steps of the Experimental Stage?" (1. Gather materials. 2. Know how to use the equipment. 3. Observe and record data.) "Were these steps followed in both experiments?" (Yes) "Which of the two experiments did you think was the most complex?" (The student may say that the first or the second is the most complex) "Why do you think that?" (Expect a reasonable answer. An example of a reasonable answer is that the second experiment seemed more precise.)

13. **Focus for Media Interaction: Say,** "I want you to watch this next portion of the video and then tell me what the fourth step is in the Experimental Stage and what are the test variables in each of the experiments that we have observed." **Resume** and **Pause (13:57)** when you **see** the 3 bags of different soil and **hear** "…the kind of soil is the test variable." **Ask**, "What is the fourth step in the Experimental Stage?" (Identify a single test variable and control other variables.) "What does the video say is the test variable in the ant experiment?" (air temperature) **"**What did she test?" (ant activity) "If her test variable was air temperature, what were her controls?" (same ant hill, on every hour, same limited time) "But, what about the time of day? It was different each time she counted the ant activity and the air temperature was different? Can she have two variables?" (No) "That's right. You can test only one variable at a time. What could she do to correct this?" (Test the ant activity at the same time for a period of a week or test the ant activity at different times with the temperature being constant, which might be difficult) "What is the test variable for the water and soil experiment?" (the kind of soil)

14. **Focus for Media Interaction: Say,** "As we watch the fifth step in the Experimental Stage, I want you to be ready to tell me what the fifth step is, what tools were used for measurement in each experiment and what was measured." **Resume** and **Pause (14:20)** when you **see** the young man reading the measurement of the volume of liquid in the graduated cylinder and **hear** "…water poured in soil samples and volume of water not absorbed." **Ask**, "What is the fifth step?" (Perform measurements) "What tools did the girl use?" (Clock and thermometer) "What did

she measure?" (time and temperature) "What tools did the young man use?" (graduated cylinder and beaker) "What did the he measure?" (volume) "How many different volumes did he measure and what were they?" (volume of the different soils, volume of water poured into the soils, and volume of the water not absorbed.)

15. **Focus for Media Interaction: Say,** "Next, I want you to be able to tell me the last step in the Experimental Stage and the two steps in the Post-Experimental Stage. Also, I want you to tell me what conclusions were drawn by each person and did it confirm their hypotheses?" **Resume and Pause (16:06)** when you **see** a line graph with a yellow and a green line and **hear** "…temperature is not affecting ant activity as much as the time of day." **Ask**, "What is the last step in the Experimental Stage?" (Use mathematics) "What are the two steps in the Post-Experimental Stage?" (Organize and analyze results and draw a conclusion) "What conclusion did the young man draw?" (Organic soil most readily passed water through it.) "Did it confirm his hypothesis?" (No) "Why?" (The organic soil contained a large amount of mica, which is put in the soil for the purpose of draining water.) "What conclusion did the girl draw?" (Temperature did not affect the ant activity as much as the time of day.) "Did her conclusion confirm her hypothesis?" (No) "Do you think her data is valid?" (Yes or no) "Why?" (A possible answer might be that she tested 2 variables and only one variable can be tested at a time.) Have another student write the last two steps of the scientific method on the board. (Organize and analyze results and draw conclusion)

16. **Focus for Media Interaction: Say,** "In this last portion of video, listen and be able to tell me why the hypotheses was not confirmed in each experiment and what is the most important part of the Scientific Method?" **Resume** and **Pause (16:39)** when you **see** the young man looking at his data and **hear** "…explaining or finding the cause of the experimental results is the most important part of the Scientific Method." **Ask**, "Why was the hypothesis not confirmed in the soil experiment?" (He had to learn about soil content in order to understand and explain about his results.) "Why was the hypothesis not confirmed in the ant experiment?" (She found that during spring, the time of day was the determining factor as an indicator of ant activity and not temperature. And, she tested two variables when she should have tested only one.) "What was the most important part of the scientific method?" (the explaining or finding the cause of the experimental results) "What were the first two steps in the Pre-Experimental Stage?" (the question and the hypothesis) "What were the steps in the Experimental Stage?" (gather material, know how to use the equipment, observe and record data, identify the variable tested, perform measurements, and use mathematics) "What are the 2 steps in the Post-Experimental Stage?" (analyze results and draw conclusions) **Say**, "Now, let's finish our experiment with the unknown substances. If the lemon juice was an acid, what substance that we tested in the Introductory Activity do you think is an acid, also?" (Substance #2) "I want you to watch what happens as I put the indicator in this substance." (In the 10mL of soap or detergent, place 2 or 3 drops of phenolphthalein into the test tube.) **Ask**, "Is this the same as with the lemon juice, which we know is an acid?" (No) "Do you think this is an acid or a base?" (base) **Say**, "Yes, this is soap, which is a base." **Ask**, "What should we do now?" (record our observations) Have a student go to the board and

record the observations. (Soap – magenta in color) "Now, that you know that phenolphthalein turns acids milky-looking and turns bases into a magenta color, which unknown substance is a base?" (Substance #1) Have another student record the observations on the board. (Substance #1 – magenta in color – base and Substance #2 – milky in appearance- acid) **Ask**, "What conclusion can we draw?" (Phenolphthalein turns acids milky in appearance and bases to magenta in color. We can identify acids and bases by the indicator. Substance #1 is a base and Substance #2 is an acid."

Before going to the next part of the lesson, r*eview with the students the steps of the scientific method. Have the definitions and the key terms for the Scientific Method on cards. (Key terms: independent variable, dependent variable, hypothesis, constants, conclusion) Have the students match the key terms to the correct definition.)*

Part 2

1. **Say,** "Today you are going to graph data gathered from two different experiments. Before we graph, we are going to look at a graph on the SMART Board. (Have two graphs saved on computer to be used on the SMART Board. This can be put on an overhead projector, also. See back of lesson for graphs that can be used.)
2. **Say**, "I want you to take some time to consider this graph. Think about the title of the graph. What is the graph telling you?" (Student should read the title. Solubility of Potassium Nitrate in Water) "Look at the x- and y-axis. What is written down for the x-axis?" (Temperature) "What is written down for the y-axis?" (Solubility of g/100g of water) "Which one did the experimenter manipulate or change?" (Temperature) "Which one changed or responded to what the experimenter did?" (the amount of solubility) "Looking at the key terms that we matched, which is the independent variable?" (temperature) "Which is the dependent variable?" (the amount of solubility) "What conclusion might you state using this data?" (as the temperature increased, the amount of solubility increased)
3. **Say**, "Let's look at another graph. What is the title of this graph?" (Benchmark Test Rate) "What is on the x-axis?" (the # of the Benchmark Tests) "What is on the y-axis?" (the percentage of boys and girls that passed) "Which is the independent variable?" (the number of the Benchmark tests) "Which is the dependent variable?" (the percentage of boys and girls that passed)
4. **Say,** "Now, we are going to use data that has already been gathered from two experiments. You will graph the data from the first experiment first. After graphing this data, I want you to identify the hypothesis, independent variable, dependent variable, constants, and conclusion."
5. Pass out the data sheet (See back of lesson) and graph paper. Remind students that they have already discovered that the independent variable goes on the x-axis and the dependent variable goes on the y-axis. Give students time to graph the first set of data and answer the questions at the bottom of the page. (Show the graph on the overhead or the Smart Board and discuss the graph with the students.)
6. **Ask**, "What did you title the graph? Did you title the graph? If you have not, title the graph now. What did you put on the x-axis?" (Temperature) "What did you put on the y-axis?" (Chemical Reaction Time) "So, what is the independent variable?"

(temperature) “What is the dependent variable?” (Chemical reaction time) “What is the hypothesis?” (If temperature is added to the substances in a reaction, the chemical reaction time will decrease.) “What are the constants?” (same amount of each substance and same kind of equipment) “What do you think the conclusion is?” (When heat is added to a substance that is going through a chemical change, it will decrease the time it takes for the reaction to happen.)

7. **Say, “**Now, I am going to give you the second set of data from the second experiment. I want you to do the same as you did to the first set of data.”
8. Give out the second set of data and allow the students time to complete the graph and questions. Remind students that if they do a line graph, there will be three lines. They may do a bar graph if they can.
9. Again, **ask**, “What did you title the graph? What did you put on the x-axis? (Time the plants were measured -weeks) “What did you put on the y-axis?” (height of plants) “So, what is the independent variable?” (time - weeks) “What is the dependent variable?” (height of plants) “What is the hypothesis?” (if fertilizer is added to the plant, then the plant will grow taller.) “What are the constants?” (identical pots, identical amount of potting soil, nearly identical tomato plants, root ends planted one inch below surface, identical amount of sun and shade, and identical amounts of water.) “What is the control in this experiment?” (the plant without the fertilizer) “What do you think the conclusion is for this data?” (When fertilizer is added to plants, it will increase the growth of the plant.)

CULMINATING ACTIVITY

This activity will provide students with experience in identifying independent variables, dependent variables, hypotheses, and other parts of the scientific method.

1. Have the students get in groups of two or four. (Group the students in a way that they will work the best. If you group 4 students together, two will play against two. You can play this on the Smart Board by using the game board. You would divide your class into 2, 3, or 4 groups.)
2. **Say**, “You are going to try to be the Grand Investigator. Each group will be given a game board, game cards, a die, and a token for each player. Do not eat your token. I will explain how to play the game, but I will give each group the rules for the game.” Read the rules to the students.
3. **Rules:**
   - ✓ Each player will place his token (M&M, Skittle, or other small object) on the Start position.
   - ✓ Each player on both teams will roll the die. The player with the highest roll, Player 1, will begin the play.
   - ✓ Player 1 will roll the die again for his number of steps if he answers the question correctly.
   - ✓ Player 2 will pick up the top card and read the question and multiple choice answers. (Be sure to keep the answer, which is on the back of the game card, hidden.)

- ✓ If Player 1 correctly answers the question, he/she will move his/her token the number of "steps" determined by the number rolled on the die and the game card is placed at the bottom of the stack of game cards. (Only 1 chance is given to answer the question correctly.)
- ✓ More than one token can occupy the same box or "step".
- ✓ If Player 1 does not answer the question correctly, the game card is placed at the bottom of the stack of game cards and Player 1's token remains in the same position he/she was when the die was rolled.
- ✓ Player 2 will roll the die next and Player 1 will read the question and multiple choice answers. If Player 2 answers correctly, he/she will move his/her token along the "steps" determined by the number rolled on the die. If Player 2 answers incorrectly, he/she will remain in the same position when they rolled the die.
- ✓ Player 1 will be next. This will continue until one of the players has moved into the Grand Investigator box. That player has won the game and is The Grand Investigator.
- ✓ If teams are playing against each other, then it will be Team 1 and Team 2. Each team will be given one token, one game board, one set of game cards, and one die. When the question and multiple choice answers are read to the opposing team, the players on that team can talk together to decide the answer, but only one person (the team should designate one person as the speaker of the team) can give an answer. (Only one chance is given for a correct answer.)
- ✓ Time limit for giving an answer is 1 to 2 minutes.

4. Pass out the game boards. (This can be copied from the back of the lesson and enlarged. It can be glued to card board to be used many times. Or the game board can be laminated and then glued to card board for longer lasting life.)
5. **Say**, "At the lower left corner of the board is the Start "step" or box. As you can see, the boxes or "steps" lead to the end box that says 'Grand Investigator'. The player or team that reaches that end box will be The Grand Investigator(s)."
6. **Say,** "Now, look at the large rectangle on the board. This is where the game cards are stacked. As each game card is read and answered, place at the bottom of the stack. Since the answers are on the back of the cards, be sure to pick up the card so that the answer is hidden.
7. Let the students begin and walk around the room as each group plays "Grand Investigations". See if students are playing correctly and if they seem to be answering most questions correctly. If all the game cards have been used, then the students will start over on the game cards. It should get easier in identifying the different parts of the scientific method.

CROSS-CURRICULAR EXTENSIONS

Math:

1. Students can collect data by polling the student body and graph the data. Such questions that students could ask in the poll:
   A). Which soft drink is your preference?
   B). What size shoe do you wear?
   C). How many siblings do you have?
   D). What chore do you do the most at home?

2. Students can collect data from experimentation and graph the data. After graphing the data, the students can use the graphing calculator and check their graphs.

Web Sites:

http://nces.ed.gov/nceskids/graphing

Students can create bar, line, area, or pie graphs online! They submit the data and the Web site does the rest.

http://math.rice.edu/~lanius/Lessons/graph.html

At this site the student can change the values in the table for the graph and then click and they will see a new graph. Also, the students can do their own survey and make their own graphs

Language Arts:

Students can write the procedures to make a paper airplane. To show the importance of being very precise when writing procedures, have the students pass their written procedures to other students. Then have the students use the procedures to make a paper airplane. Express to the students that they are not to do anything that the written procedures does not say. If students are finding it impossible to follow the procedures, have all procedures given back to the students who wrote them. The students will then revise their procedures. The students will try to follow the procedures again.

Science or Math:

1. Students can be given data and told to do a graph to show comparison or a trend. The student will have the choice of which kind of graph he/she will do. They are to use the same data and try to use it in a different kind of graph.
2. Students can use data from graphs to find percentages of a total.
3. Use the following Web sites for making graphs. They can use data they have collected or data that has been given to them for the purpose of creating a graph.

   Web Sites:

   http://nces.ed.gov/nceskids/graphing

   Students can create bar, line, area, or pie graphs online! They submit the data and the Web site does the rest.

   http://math.rice.edu/~lanius/Lessons/graph.html

   At this site the student can change the values in the table for the graph and then click and they will see a new graph. Also, the students can do their own survey and make their own graphs.

Social Studies

Students can use maps to write directions from one place to another. Other students will then try to find the place following the directions.

COMMUNITY CONNECTIONS

1. Have a person from the Soil and Water Department visit the classroom to talk to the students about the process that is followed to determine the turbidity of water and/or the process that is followed to determine what is in a sample of soil.
2. Have the students do a small project on the procedures followed at the Water and Sewage Plant to clean and purify the water used for drinking.

In a controlled experiment, the variable that is changed to test the hypothesis is called the – A. controlled variable B. responding variable C. dependent variable D. independent variable	A student has a wagon of a certain mass. He plans to investigate how the acceleration of the wagon changes as the force he exerts on it increases. In his investigation, the independent variable is – A. the acceleration of the wagon B. the force acting on the wagon C. the mass of the wagon D. the mass of the student
What happens to the dependent variable in a controlled experiment? A. It changes as the independent variable changes. B. It changes as the responding variable changes. C. It does not change. D. It is supported or disproved.	In an experiment to find out how the height from which a student drops a ball affects how high the ball bounces, the independent variable is the – A. diameter of the ball B. force acting on the ball C. height that the ball bounces D. height from which the ball is dropped
A student wants to conduct an experiment to find out how pulse rate changes as the length of tine spent exercising increases. The dependent variable will be - A. breathing rate B. pulse rate C. time spent exercising D. the kind of exercise	A student hypothesized that the amount of sunlight a sunflower plant receives determines the number of sunflower seeds the plant produces. In her experiment, the number of seeds produces is the – A. dependent variable B. independent variable C. controlled variable D. manipulated variable
A student is planning an experiment to find out how the height from which he drops a ball affects how high the ball bounces. The dependent variable is the A. diameter of the ball B. force acting on the ball C. height that the ball bounces D. height from which the ball is dropped	In an experiment studying how increasing amounts of acid rain affect pond water, which of the following would be the dependent variable? A. number of organisms in pond water B. acid rain and non-acid rain C. a mixture of pond water and acid D. organisms in rainwater
In a scientific investigation, conclusions are drawn directly after - A. the hypothesis is revised B. results have been communicated to other scientists C. data have been interpreted D. the hypothesis has been stated	In a controlled experiment, the independent variable is – A. the results of the experiment B. the variable that stays the same C. changed to test the hypothesis D. always time

B	D
D	A
A	B
A	C
C	C

(left side of game board)

12
13
11
16
14
17
10
15
9
7
6
8
5
4
3
1
2
Start

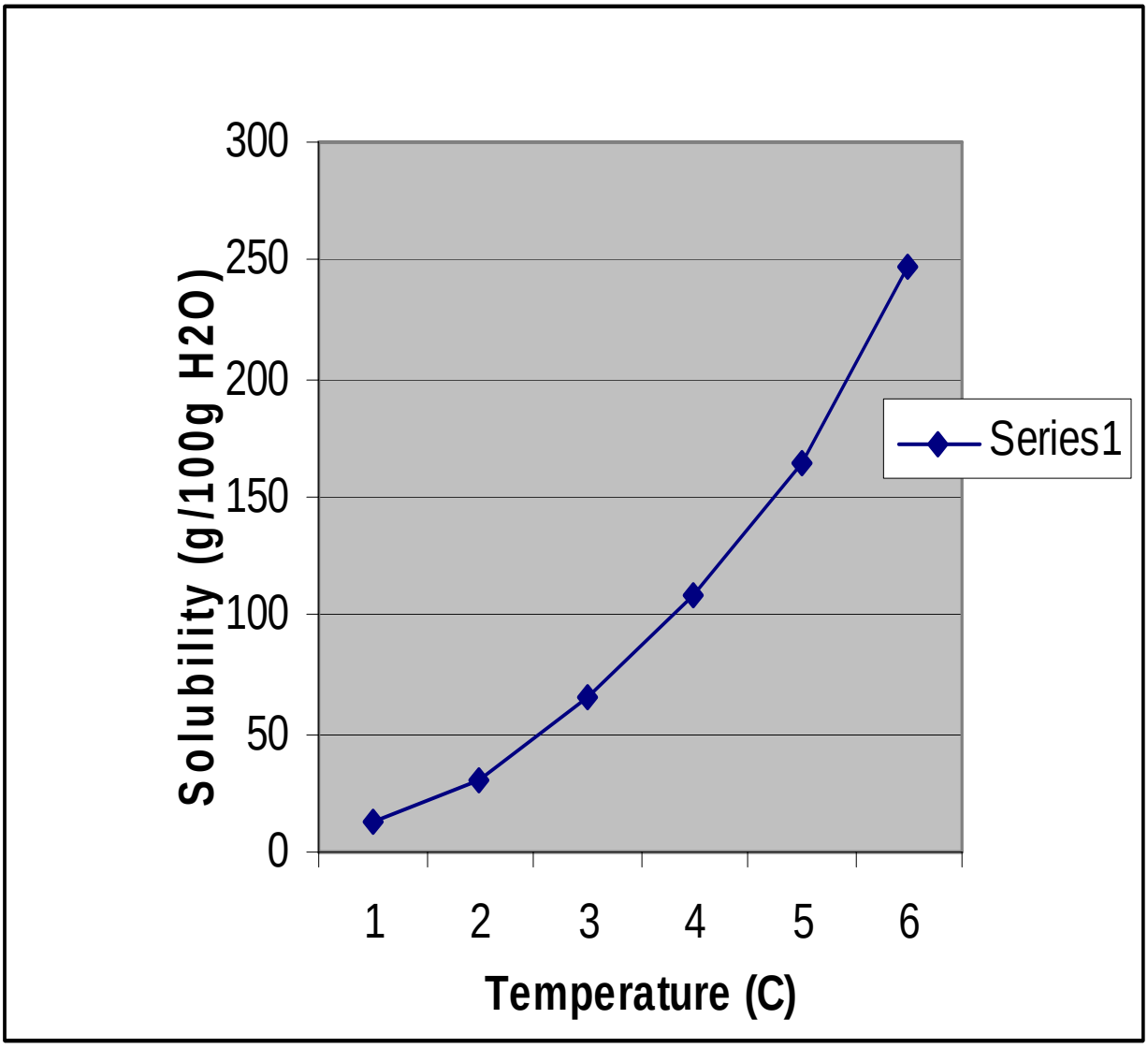
Place game cards here

Grand Investigator

(Right side of board)

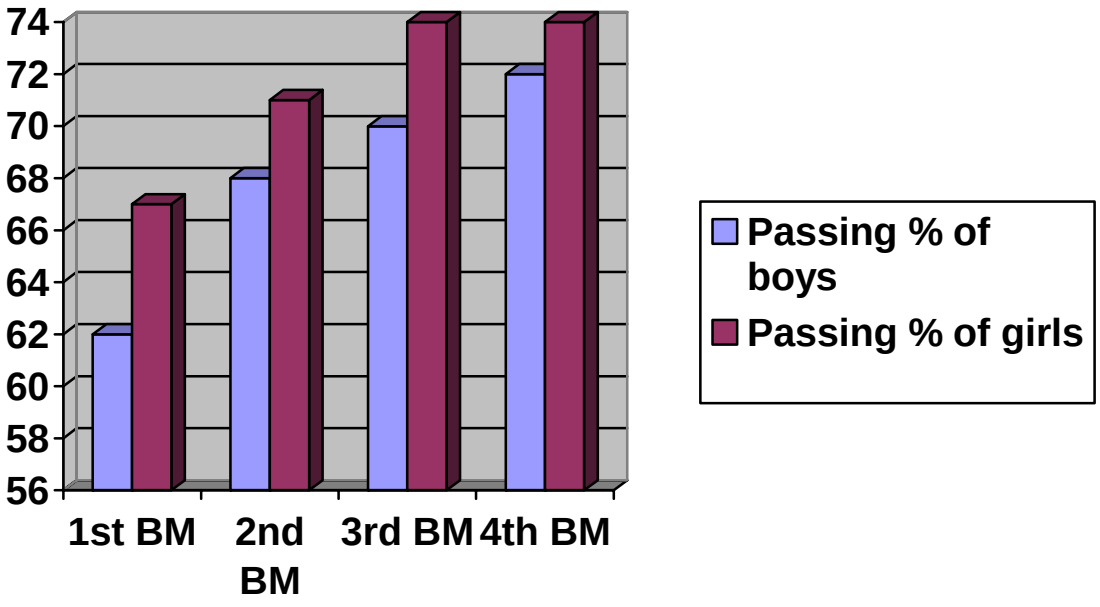
GRAPH 1

SOLUBILITY OF POTASSIUM NITRATE IN WATER



GRAPH 2

BENCHMARK TESTS RATE



Benchmark Test Number

Experiment 1

A student learned in chemistry class that temperature is a major factor in determining the rate of a chemical reaction. He thought that the temperature would increase the chemical reaction time. To investigate the effect of temperature on a chemical reaction, the student decided to time a chemical reaction at several temperatures.

The student gathered his materials: a hot plate, 3- 100ml beakers, a stirring rod, 30mL of 3%hydrogen peroxide, 15mL of water, 5 grams of yeast, a stop watch, paper, and pencil. The student measured and used 10mL of 3% hydrogen peroxide for each trial. He measured and mixed 5 grams of yeast with 15mL of water. In his first trial he heated the water and yeast to 20^0C and added it to the 10mL of hydrogen peroxide. He timed the reaction and found that the time for completion of reaction was 80 seconds.

In his second trial he heated 5mL of the yeast and water mixture to 30^0C. He added this to 10mL of 3% hydrogen peroxide. He timed the reaction again and found that the time for completion of reaction was 40 seconds.

In his third trial he heated 5mL of the yeast and water mixture to 40^0C. He added this heated mixture to another 10mL of hydrogen peroxide. He timed the reaction and found that the time for completion of reaction was 20 seconds.

Directions:

1. Make a table with 3 columns; one for the trial number, one for the temperature, and one for the time for completion of reaction.
2. Use graphing paper and graph your data. Title the graph. Write what values are on the x-axis and what are on the y-axis.
3. Answer the following questions:
    - What is the student's question for the experiment?
    - What is the student's hypothesis?
    - What factors remained constant in the experiment?
    - What is the independent variable in the experiment?
    - What is the dependent variable in the experiment?
    - What conclusion do you think the student reached?

Experiment 2

Alicia is interested in how plants grow. She wants to investigate plant growth and how it is affected by fertilizer. She thinks that giving a plant fertilizer will affect the growth by increasing its height. She prepares two identical pots with identical amounts of potting soil. She measures both their mass and volume to be sure their densities are the same. Then she finds two nearly identical tomato plants and places the root ends one inch below the surface of the soil in each pot. Next she adds identical amounts of water and sets the plants next to each other on an outside platform where each will receive the same amount of sun and shade. For the next several weeks she measures the height of each plant. She continues to water each plant with identical amounts of water daily. For one plant she added a small amount of fertilizer solution each day, but not to the other plant. She did add an amount of water to the plant equal to the amount used to make the fertilizer solution.

The following table shows her results:

Plant Height

Trial 1	Week 1	Week 2	Week 3	Week 4	Week 5
Plant 1 Without fertilizer	11 cm	13 cm	18 cm	24 cm	28 cm
Plant 2 With fertilizer	11 cm	14 cm	22 cm	29 cm	24 cm

Plant Height

Trial 2	Week 1	Week 2	Week 3	Week 4	Week 5
Plant 1 Without fertilizer	10 cm	13 cm	16 cm	23 cm	29 cm
Plant 2 With fertilizer	10 cm	16 cm	24 cm	32 cm	36 cm

Plant Height

Trial 3	Week 1	Week 2	Week 3	Week 4	Week 5
Plant 1 Without fertilizer	13 cm	15 cm	20 cm	25 cm	37 cm
Plant 2 With fertilizer	13 cm	20 cm	26 cm	34 cm	40 cm

Directions:

1. Graph the data from the tables. A reminder to students is that there will be three lines on the graph. Each line can be a different color.
2. Title the graph.
3. Write what your values are on the x-axis and on the y-axis.
4. Answer the following questions:
    - What is the student's question for the experiment?
    - What is the student's hypothesis?
    - What factors remained constant in the experiment?
    - What is the independent variable in the experiment?
    - What is the dependent variable in the experiment?
    - What is the control in this experiment?
    - What conclusion do you think the student reached?