Subject: Chemistry   **Grade**: 10-12

Dates: Week 1: Introduction to the Scientific Method

Overview: This lesson is used to reteach the scientific method. It looks at the relationship between number of hours of sleep and performance on a cognitive letter memory task. Teachers' can use it to teach how we design a scientific experiment. Also this lesson can be used to teach the fundamentals of graphing. Finally a discussion of cause and effect versus correlation between variables is spotlighted.

Standards:
SCSh1. Students will evaluate the importance of curiosity, honesty, openness, and skepticism in science.
        a. Exhibit the above traits in their own scientific activities.
        b. Recognize that different explanations often can be given for the same evidence.
        c. Explain that further understanding of scientific problems relies on the design and execution of new experiments
            which may reinforce or weaken opposing explanations.
SCSh2. Students will use standard safety practices for all classroom laboratory and field investigations.
        a. Follow correct procedures for use of scientific apparatus.
        b. Demonstrate appropriate techniques in all laboratory situations.
        c. Follow correct protocol for identifying and reporting safety problems and violations.
SCSh3. Students will identify and investigate problems scientifically.
        a. Suggest reasonable hypotheses for identified problems.
        b. Develop procedures for solving scientific problems.
        c. Collect, organize and record appropriate data.
        d. Graphically compare and analyze data points and/or summary statistics.
        e. Develop reasonable conclusions based on data collected.
        f. Evaluate whether conclusions are reasonable by reviewing the process and checking against other available
           information.
SCSh4. Students will use tools and instruments for observing, measuring, and manipulating scientific equipment and
        materials.
        a. Develop and use systematic procedures for recording and organizing information.
        b. Use technology to produce tables and graphs.
SCSh5. Students will demonstrate the computation and estimation skills necessary for analyzing data and developing
reasonable scientific explanations.
        a. Trace the source on any large disparity between estimated and calculated answers to problems.
        b. Consider possible effects of measurement errors on calculations.
        c. Recognize the relationship between accuracy and precision.
        e. Solve scientific problems by substituting quantitative values, using dimensional analysis and/or simple algebraic
           formulas as appropriate.
SCSh6. Students will communicate scientific investigations and information clearly.
        a. Write clear, coherent laboratory reports related to scientific investigations.
        b. Write clear, coherent accounts of current scientific issues, including possible alternative interpretations of the data
        c. Use data as evidence to support scientific arguments and claims in written or oral presentations.
        d. Participate in group discussions of scientific investigation and current scientific issues.
The Nature of Science
SCSh7. Students will analyze how scientific knowledge is developed.
        Students recognize that:
        d. Hypotheses often cause scientists to develop new experiments that produce additional data.
        e. Testing, revising, and occasionally rejecting new and old theories never ends.
SCSh8.
Students will understand important features of the process of scientific inquiry.
        Students will apply the following to inquiry learning practices:
        a. Scientific investigators control the conditions of their experiments in order to produce valuable data.
        b. Scientific researchers are expected to critically assess the quality of data including possible sources of bias in their
           investigations' hypotheses, observations, data analyses, and interpretations.
        c. Scientists use practices such as peer review and publication to reinforce the integrity of scientific activity and
           reporting.
        d. The merit of a new theory is judged by how well scientific data are explained by the new theory.
        e. The ultimate goal of science is to develop an understanding of the natural universe which is free of biases.
        f. Science disciplines and traditions differ from one another in what is studied, techniques used, and outcomes
           sought.
Common Core Standards for Literacy in Science:
L-10RH2: Determine the central ideas or information of a primary or secondary source; provide an accurate summary of how key events or ideas develop over the course of the text

L9-10RST3: Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks attending to special cases or exceptions defined in the text.

L9-10RST4: Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 9–10 texts and topics*

L9-10WHST7: Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.
L9-10WHST8: Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the usefulness of each source in answering the research question; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and following a standard format for citation.
L9-10WHST9: Draw evidence from informational texts to support analysis, reflection, and research.

d. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.

e. Provide a concluding statement or section that follows from or supports the argument presented.

L9-10WHST2: Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.

a. Introduce a topic and organize ideas, concepts, and information to make important connections and distinctions; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension.

b. Develop the topic with well-chosen, relevant, and sufficient facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic.

c. Use varied transitions and sentence structures to link the major sections of the text, create cohesion, and clarify the relationships among ideas and concepts.

d. Use precise language and domain-specific vocabulary to manage the complexity of the topic and convey a style appropriate to the discipline and context as well as to the expertise of likely readers.

e. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.

L9-10RST2: Determine the central ideas or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon, or concept;

MCC9-12.A.CED.2 Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.

MC9-12.N.Q.1: Use units as a way to understand problems to guide the solution of multi-step problems; chose and interpret units consistently in formulas; chose and interpret the scale and the origins in graphs and data displays.

Next Generation Science Standards:
HS-LS3-3.   **Apply concepts of statistics and probability to explain the variation and distribution of expressed traits in a population.** [Clarification Statement: Emphasis is on the use of mathematics to describe the probability of traits as it relates to genetic and environmental factors in the expression of traits.] [*Assessment Boundary: Assessment does not include Hardy-Weinberg calculations.*]

Topic: Sleep Deprivation and Effect on Cognitive Skills/ Sleepy Slows

Essential Question: Does sleep deprivation effect cognitive skills?
What is sleep and how does it affect our daily lives?
What does a good formal laboratory report contain?

Essential Vocabulary:

Hypothesis	REM Sleep	Circadian rhythm
Independent variable	Non-REM Sleep	Superchiasmatic nucleus
Dependent variable	Thalamus	Electroencephalogram
Line graph	Hypothalamus	correlation
Best fit line	r-value	control
Outliers		

Misconceptions:
1. The scientific method starts with a hypothesis is follows the same five step process every time.
2. There is only one "right" way to structure a scientific inquiry.
3. Correlation indicates cause and effect.
4. A hypothesis is a wild guess.

Proper Conception:
1. The scientific method starts with observations.
2. Correlation does not indicate cause and effect. Another related variable could cause changes in both variables.
3. The scientific method generally follows the same format.
4. A hypothesis is an educated guess based on knowledge gathered from research.

Materials:
Survey for each student
Data Table for each student
Computer access to excel
Copy of Journal Article(s)

Sponge: Hand out code/Fill out survey

Opening: Have students review the parts of the scientific method.

Work Period: Run Short Term Memory Test @http://faculty.washington.edu/chudler/stm0.html/ or Google neuroscience for kids. Be aware that trial 6 goes directly to answer sheet; minimize window until all students have answered last question. Have students calculate % right and average of all percent right.

Have students put # right in to excel spreadsheet. While students are waiting for others to put data in spreadsheet, have them write down what they think they can use the data we collected at the beginning of the period to make a relationship between. Give students and article on memory and sleep deprivation. Have them read and discuss. (If you teach on 7 period day, you

can give the reading for homework and the discussion can be your opening). Some other possible articles are listed in the References section below.

 Have them read the article and then discuss how the activity we did, relates to learning and memory. (Explain that scientist normally research before developing experiment, but that because they were subjects this method would not work. I had the students Jigsaw on "Sleep deprivation: Impact on cognitive performance" by Paula Alhola and Paivi Polo-Kantola.

Have them determine if they are going to group data (6-8) hours of sleep and how many graphs they are going to have (One graph for each number of numbers, etc.…). Are they going to use all data collect or does it make sense to do an average of larger number of data (8,10 and 12 letters, etc…). Are they going to use bar graphs or line graphs, scatter plot? Discuss the parts of a graph with a student and why we chose one over another. Discuss best fit lines. Why do we use them? How do we draw them in excel or on TI-84s?

Discuss the correlation coefficient. Also the r value. Calculate the r value in excel.

Discuss the conclusion section of the lab report. Discuss correlation and the difference between it and cause and effect. Discuss how this one activity is different from the learning we do in the classroom.

Closing: Ticket out for the door. Have students answer the following question:
　　　　　　Where would you go next if you were a sleep researcher?

Extended Learning Activity: Have students complete the Ward's Scientific Inquiry in a Bag Exothermic Lab. Have them write a formal lab report.

Formative Assessments:

- Once Students decide how to represent data, have the write a formal laboratory report. See rubric attached.

  Students will develop an advertisement which relates to the laboratory activity.

Summative Assessment:

　　Test on General Science Principles: See below for potential test questions?

References:

      Articles:

"Certain Memories May Rest on Good Sleep" by B. Bower.   (Flesh-Kincaid Grade Level 4.6)

 "Neurocognitive Consequences of Sleep Deprivation" by Namni Goel, Ph.D., Hengyi Rao, Ph.D.,[1] Jeffrey S. Durmer, M.D., Ph.D.,and David F. Dinges, Ph.D. (Flesh-Kincaid Grade Level 13.3).

The Enduring Mystery of REM Sleep By Jim Schnabel

"Sleep deprivation: Impact on cognitive performance" by Paula Alhola and Paivi Polo-Kantola

Websites:

www.**sfn**.org

http://faculty.washington.edu/chudler/neurok.html
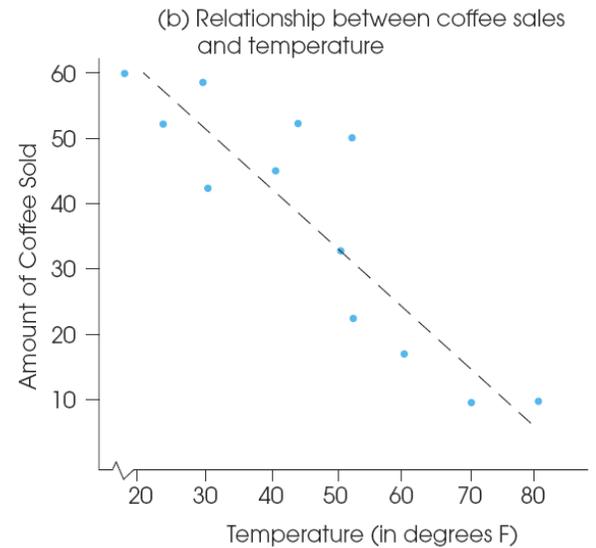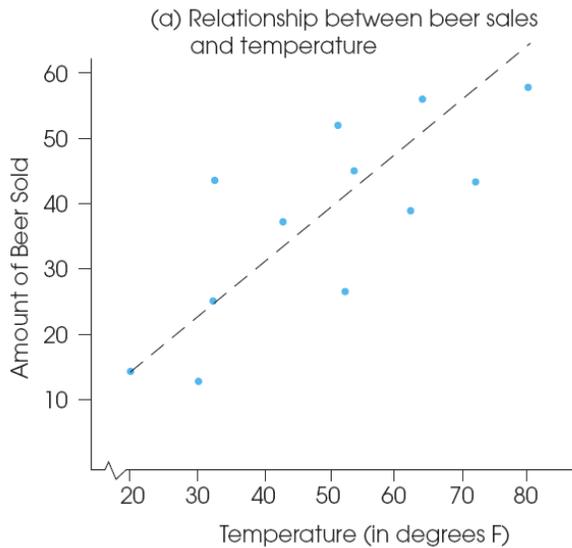
http://www.sleepfoundation.org

http://www.ninds.nih.gov/disorders/brain_basics/understanding_sleep.htm

Potential Test Question

1) A researcher is studying the effects of sleep deprivation on a student's ability to perform well on a cognitive test.   Which is the independent variable?
   a. Hours of sleep
   b. Score on cognitive test
   c. Caffeinated beverages consumed by students
   d. Number of students

2) A researcher is conducting a study on the effects of sleep deprivation on a student's ability to perform well on a cognitive test? What is the dependent variable?
   a. Hours of sleep
   b. Score on cognitive test
   c. Caffeinated beverages consumed by students
   d. Number of students

(a) Relationship between beer sales and temperature

(b) Relationship between coffee sales and temperature

3) Given the graph (a) above, the independent variable is
   a. Amount of beer sold
   b. Temperature
   c. Degrees Fahrenheit

4) Graph (b) shows
   a. A positive correlation between temperature and coffee sales
   b. A negative correlation between temperature and coffee sale
   c. A positive cause and effect
   d. A negative cause and effect

5) The correlation between monthly salary and yearly salary would have an r value near
   a) 0
   b) 1
   c) Between 0 and 0.5
   d) Less than 0
   e) -1

Short Answer:

Describe how you would structure an experiment to test the hypothesis adding salt to water increase the temperature at which water boils. Make sure to identify the independent and dependent variable and the control group.