# Hot Salsa

## Facilitator's Guide

## Cross-Cutting Subject Areas: Biology, Anatomy & Physiology, Chemistry, Math

## Grade: 10-12

**Dates:** Week 1: Introduction to the Scientific Method

**Overview:** This lesson helps to reteach the scientific method. Students are asked to consider possible reasons for sweating when eating spicy foods, and they can easily be guided to the possible answer that it is due to an increase in body temperature. This is easily testable, so the exercise gives students the opportunity to write a simple hypothesis, design an experiment to test it, graph and analyze their own data using statistics, and draw conclusions from their data set. Given that outcomes are often not significant (body temperature does not differ after consumption of spicy vs. mild foods), the importance of a so-called "negative data set" is highlighted. This lesson plan was published in the American Biology Teacher, and we expect facilitators will read that article before implementing the lesson. We have found that students should be made aware of the supplies available to them early in the process of designing an experiment; otherwise they venture down the path of testing for increased heart rate, hormone release, or other signs of stress. – ION/Teach

**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.

**Topic(s): Testing an explanatory hypothesis, designing an experiment, analyzing data.**

**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:**

| | |
|---|---|
| Experimental Question | Between Subjects Design |
| Hypothesis | Experimental Confounds |
| Independent Variable | Statistics |
| Dependent Variable | T-test |
| Experimental Design | Mean |
| Within Subjects Design | p value, alpha level |

**Misconceptions:**

**1.** The scientific method starts with a hypothesis and always follows the same 5-step process.
2. There is only one "right" way to structure a scientific inquiry.
3. A non-significant outcome is not meaningful.
4. A hypothesis is a wild guess.

**Proper Conception:**

1. The scientific method starts with observations.
2. The scientific method generally follows the same format, but with flexibility.
3. "Negative" outcomes can be valid and informative experimental outcomes.
4. A hypothesis is an educated guess based on knowledge gathered from research.

**Materials:**

| | |
|---|---|
| Powerpoint slide set | Salsa (can be two types, mild and hot) |
| Hot Salsa article | Spoons, Chips (or other serving instruments) |
| Facilitator's Guide | Thermometers |
| Student Guide | Graph Paper (for data collection/analysis) |
| | Access to Excel, T-test Formula, or other spreadsheet, graphing, and Stats Software |

**Hook:**

Start with the Powerpoint slides simply asking "What happens when you eat spicy foods?"

**Procedure (from Student Guide):**

1. Brainstorm answers to the question: "What happens when you eat spicy foods and why?"
2. Consider the materials provided in class, and develop a testable explanatory hypothesis for one of the effects of spicy foods on the body.
3. Divide into small groups of 3-4 and design an experiment to test the hypothesis. Write down each step in the protocol for the experiment. Be very specific. Define and include experimental control groups. Also consider sample size (number of subjects in each experimental group).
4. Share experimental designs with the whole class. As a group, decide on a single design to use.
5. Conduct the experiment.

6. Collect data and perform statistical analysis to help interpret the results.
7. Consider whether the results support the hypothesis.
8. Consider potential negative results and their value in science.
9. Consider potential design flaws in the experiment, or experimental confounds.
10. Generate at least two new experimental questions generated by the results.
11. Check your personal understanding of terms used in class today. If you are confused about anything, see your instructor immediately for clarification.

**Closing:** If you were a physiologist, what would you do next?

**Extended Learning Activity:** Independent student research on the effects of the "hot" ingredient in chili peppers, capsaicin, with focus on how this chemical interacts activates pain pathways in the tongue.

**Formative Assessments:**
Request a formal laboratory report from individual students or groups, with desired length and typical lab report elements, such as hypothesis, materials list, step-wise list of procedures, data, graph (title, axis labels, independent variable on x axis, dependent variable on y axis), summary of analysis, and clearly written conclusion(s). Use provided rubric for assessment of lab reports. If working in groups, provide students with opportunity to evaluate peer contributions using provided Peer Evaluation Rubric.

**Summative Assessment:**
Test on general science principles and vocabulary.

**-Match the following items by writing the letter of the relevant item in the blank beside it.**

| | |
|---|---|
| 1. Subjects who do not experience a manipulation: _____ | a. confounding factors |
| 2. Outcome that is measured. _____ | b. independent variable |
| 3. Educated guess explaining an observation. _____ | c. dependent variable |
| 4. Unintended differences between subject groups. _____ | d. control group |
| 5. Condition that is varied by the experimenter. _____ | e. hypothesis |

**-In 2-3 sentences, describe the scientific method.**

**References:**

Levri, E.P., levri, M.A. (2003) Hot Salsa: A Laboratory Exercise Exploring the Scientific Method. Amer Biol Teacher 65(5): 367-377.

Kinraide, T.B., Denison, R.F. (2003) Strong Inference: The Way of Science. Amer Biol Teacher 65(6): 409-418.