Lesson Title: Design an Experiment – Variables and Procedures

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Grade Level: 5th grade Subject Area: Science

Time Allotted for the Lesson: *Express in number of class meetings and/or number of hours.*

2 hours

Short Description of Lesson: *Write a brief, yet concise, description of what occurs in this lesson (50 words).*

In this lesson, students will learn how to identify *independent*, *dependent*, and *controlled variables*. Students will understand the purpose of each of these types of variables in an experiment, and will specify the constants and independent and dependent variables in their chosen experiments. Students then design the experimental procedure which will allow them to manipulate independent variables and observe dependent variables to analyze the results.

Classroom Layout and Grouping of Students: *Where will learning take place? How will the room be organized? How will students be grouped? (whole group, individuals, pairs, small groups, etc).*

Whole group instruction, pairs, small groups (4 students each)

State Curriculum Standards met in this lesson: *Go to the state curriculum standards at* http://www.isbe.net/ils/Default.htm *(use state standards where you are in preparation) and select the grade content/level appropriate standards that are being met in this lesson. Copy and paste below:*

Science Content Standards for California Public Schools – Investigation and Experimentation (5th Grade)

Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept and addressing the content in the other three strands, students should develop their own questions and perform investigations. Students will:

c. Plan and conduct a simple investigation based on a student-developed question and write instructions others can follow to carry out the procedure.

d. Identify the dependent and controlled variables in an investigation.

e. Identify a single independent variable in a scientific investigation and explain how this variable can be used to collect information to answer a question about the results of the experiment.

f. Select appropriate tools (e.g., thermometers, meter sticks, balances, and graduated cylinders) and make quantitative observations.

National Education Technology Standards for Students (NETS•S) met in this lesson: *Go to the* http://cnets.iste.org/index.html *and select NETS•S 2007 grade level profile (K-2, 3-5, 6-8, 9-12) the appropriate indicator(s) and standard) that are being met in this lesson. Copy and paste below.*

Research and Information Fluency

Students apply digital tools to gather, evaluate, and use information. Students:

a. plan strategies to guide inquiry.
b. locate, organize, analyze, evaluate, synthesize, and ethically use information from a variety of sources and media.
c. evaluate and select information sources and digital tools based on the appropriateness to specific tasks.

Digital Citizenship

Students understand human, cultural, and societal issues related to technology and practice legal and ethical behavior. Students:

a. advocate and practice safe, legal, and responsible use of information and technology.

Technology Operations and Concepts

Students demonstrate a sound understanding of technology concepts, systems, and operations. Students:

a. understand and use technology systems.
b. select and use applications effectively and productively.

Instructional Objective(s): *Each instructional objective [learning outcome] for this lesson should identify the A, B, C and D – Audience, Behavior, Condition, and Degree. (Activities are NOT learning outcomes).*

1. Students will correctly identify independent, dependent, and controlled variables for at least 3 3 hypotheses.
2. Students design an appropriate set of procedures that use controlled, independent, and dependent variables to test a hypothesis.

Materials, Resources and Technology:

List all materials (textbook, other books, maps, crayons, research guides) technology resources (computers, printer, scanner, internet connection, cameras, etc) and web addresses that are needed for this lesson. If you are using copyrighted materials, you must include title, author, date, city and publisher.

Materials and resources needed for this lesson (for each small group of 4 students)

1. Three identical plastic cups
2. 100 mL room-temperature water
3. 100 mL room-temperature Coke
4. 100 mL room-temperature distilled white vinegar
5. Lab goggles for each student

Technology resources needed for this lesson

1. Computers with internet access
2. Projector or other classroom display device

Web Addresses needed for this lesson:

Website name (e.g. Yahoo), followed by the site's complete web address (e.g. http://www.yahoo.com)

1. Conducting an Experiment video: http://player.discoveryeducation.com/index.cfm?guidAssetId=37D0B342-EA69-4543-BF7D-DD282440AF38
2. Scientific Method interactive with Glossary: http://edtech2.boisestate.edu/gudeniusm/506/method.swf
3. Experiment Design Visual (interactive): http://edtech2.boisestate.edu/gudeniusm/506/far_transfer/far_transfer.htm
4. Experiment Design Visual (printable): http://edtech2.boisestate.edu/gudeniusm/506/far_transfer/far_transfer.jpg
5. MixedInk (optional extension/review activity): http://www.mixedink.com/main.php

Student's Present level of Performance and Knowledge: *Do the students have the adequate knowledge to complete the lesson successfully? What pre-requisite skills must the students have to complete the lesson content? Include technology skills.*

Students must be able to use basic web browser navigation techniques and to write complete sentence responses to prompts/questions. Students must also have a list of 3 or more testable hypotheses.

Instructional Procedures

Lesson Set:

How will you open the lesson to motivate the students? How will you relate this lesson to previous learning & to real life experiences, to explain the importance of the learning to the students? (requires student involvement)

Introduce the process of doing an experiment using the "Conducting an Experiment" video (2 min. 51 sec.) After the video, conduct a discussion by prompting students to answer these questions: how is this experiment similar to what we would do if we wanted to test evaporation of Coke or vinegar? (It is a comparison of different experimental groups based on material.) How is it different? (She did not use any measurement tools for observation.) Did she make any observations? (Yes, using her fingers to check whether something felt warm; using her eyes to watch ice melt.) Could she have used any measurement tools to help make her observations more accurate or precise? (Yes; she could have measured the actual warmth of the different materials, and she could have used a stopwatch to measure the time for each ice cube to melt.)

Techniques and Activities:

List the step-by-step activities in sequential order as they occur in the lesson. They clearly identify what is to take place in the lesson. Within the procedures a variety of classroom ***teaching strategies (methods)*** *are identified.* ***Student centered activities*** *are included as well as* ***guided practice*** *of the learning is included.*

1. A *variable* is something that is *able* to *vary* or change. Ask students to make a list of all of the *variables* or factors that could affect the evaporation of the liquid in a cup. For example, the temperature could affect evaporation. What else could possibly affect the outcome – write down as many as you can think of. (Examples: cup shape; cup size; cup material; liquid used; amount of liquid; starting temperature of liquid; location where cup is placed)
2. If we want to determine whether a variable is the factor that is causing something to happen, we have to have that variable stand out by itself – to be *independent* – from the other variables. This will be the one variable that we manipulate in the experiment. If we changed more than one variable at a time, how could we tell which change caused the result? What if we put 100 mL of water in a clear cup in a cold place and compare it to 200 mL of vinegar in an opaque cup in a warm place? If more water evaporates, why did it happen? Is it because of less water? Because the cup was clear? Because of the temperature? Or because the liquid inside the cup was different? There is no way to tell which of these caused the result… it could be any of them, or a combination. There's no way for us to know, unless we keep only *one* variable independent and let that one variable change in our tests.
3. When you change that single, independent variable, you are trying to see if there is a result that *depends* on this variable. This is call the *dependent variable* – it is the one you measure or observe after making changes to the independent variable, to see if it changed the dependent variable.
4. Look at the hypothesis with students. Our hypothesis is: *If evaporation is related to the amount of water in a liquid, then liquids with less water in them will evaporate less.* What do we want to examine or observe to see if it changes? (Answer: the amount of evaporation – this is the dependent variable.) What are we going to change to see if it affects that? (A: Different liquids with different amounts of water in them – this is the independent variable.) Thus we know what our independent and dependent variables will be. To make sure nothing else changes and confuses us, we must *control* all of the other variables and keep them the same no matter what. We call these variables *controlled variables* because we control the fact that they stay the same for each trial. What would be the variables we need to *control* to keep constant? (A: cup shape, size, type, material; amount of liquid; temperature; location/placement)
5. So, now that we know what variables to control, which one to manipulate independently, and which

one is dependent on those manipulations to see results, we can design the test procedure. All we need to do is figure out how to manipulate the independent variable without changing any of the constants, and figure out how to measure how the dependent variable has been affected as a result. It's that simple.

6. Call on students (popcorn or random-call) to brainstorm and offer ideas for what the experiment setup/procedure could look like. Review the formalized hypothesis to note the independent and dependent variables stated directly in the hypothesis, to point out this: "We want to find out if different amounts of water affect evaporation. The independent variable is what we can change here… what can we change?" (A: amounts of water in a liquid – but be sure to point out this does *not* mean the overall volume of liquid in the container, but whether the liquid is 100% water, partially water, or no water) So we will write down and draw in our log book the setup that we will have equal volume in identical containers, but each will have different amounts of water. "What do we want to look at? This is the dependent variable. (A: evaporation that occurs. "How can we measure evaporation? We will need to design this in a way that the amount of evaporation can be observed or measured." – Note: there could be more than one correct answer for this! The simplest way will be to use graduated cylinders and note the volume measurement before and after.)
7. So now that we know what conditions we have to set up, this also tells us what materials and equipment we need. We need equal amounts of three different liquids… let's use water, vinegar, and Coke. Do they all contain water? If so, do they have different amounts? What has the highest percentage? What has the lowest? (If students do not know this, this is a learning opportunity! Show how to read the label and/or research using the Internet as a whole-group, small-group, paired or independent task.)
8. Finally, demonstrate how to record all of this information in your Log Book for the experiment, describing how the equipment will be set up, how the independent variable will be changed (and control variables unchanged), and how measurements or observations will be made and recorded.

Lesson Closure:

How will the lesson come to a close? The content should be summarized and related to future lessons, and actively involve the students.

Using the online tool, students will first review/assess their knowledge of *controlled, independent,* and *dependent variables*. Afterward, students will identify constants and variables for their own selected experiment and record this information in their log books. Finally, students will think-pair-share with a partner by swapping log books and providing constructive feedback (formative) before turning in the logbooks to be checked (summative) by the teacher.

Adaptations for Special Learners: *How will you adapt the learning/equipment for students with special needs?*

Audio-visual support will be provided via the video segment and website resource. Students with cognitive disabilities will benefit from peer feedback via think-pair-share and group-based lab work.

Supplemental Activities - Extension and Remediation: *Extensions are additional activities to expand learning on the lesson content. Remediation activities include methods to re-teach the learning for students who need more instruction/practice.*

Remediation is available via the online website resource. One extension activity is to find an example (using websites and/or library) of an experiment in which the hypothesis was *rejected* and the result of the experiment was still very useful.

Another optional extension activity (for the whole-class) is to create another question and students can work in pairs or small groups to come up with:

- testable hypothesis
- dependent, independent, and controlled variables
- experimental procedures and equipment

Students could create write up these hypothetical experimental designs using the MixedInk website, then read other teams' labs to rate/rank sections. MixedInk would then be used to allow you to identify and merge the best pieces from each experiment into one class experimental design.

Assessment/Evaluation: *How will you measure the student's success? Formally or informally? Formal evaluation of student work requires that a grade is taken while informal might be monitoring of work, or class discussion. This section should contain a description of the assessment process, the criteria for achievement, and performance levels. The criteria should directly align to objectives and instruction. Describe your plan for providing feedback to your students.*

Formative assessment will be student identification of control, independent, and dependent variables for 3 of their proposed hypotheses, checked by think-pair-share partners. Summative assessment will include both variables and experimental procedures designed to test one of those hypotheses, chosen by the student.

Student Products: What artifact(s) or products will result from the lesson? (such as a report, newsletter, diagram, slideshow, drawing, etc.)

Students identify controlled, dependent and independent variables in their logbooks. They also write their experimental procedures for the experiment.

Adapted from PDF: *Preparing to Use Technology: A Practical Guide to Curriculum Integration (2007)*