Yucky Water
A Lesson in the Nature of Science

Grade Level: 6-10
Duration: 3-5 periods **Subject:** Nature of Science **Prepared By:** Melissa Stolz and Kurt Whitford

Materials Needed

chart paper, beakers of water, markers, summer research ppt, filters, activated carbon, sand, kool-aid, graduated cylinders, beakers.

Analyze Learners

Overview & Purpose (STEMcinnati theme)	**Education Standards Addressed**
Overview: A: Students will be able to identify and evaluate processes of science that are used for research C: Students will be exposed to how scientists work S: Students will start to become critical consumers of scientific information	*KY SC-6-BC-U-3* *Students will understand that scientists vary widely in what they study and how they do their work. While there is no fixed set of steps they follow, the basic process of science involves collecting relevant evidence, logical reasoning and the use of imaginative thinking in constructing explanations for what they observe.* *Scientific Ways of Knowing – Grade 10* *OH Nature of Science* 3. Recognize that science is a systematic method of continuing investigation, based on observation, hypothesis testing, measurement, experimentation, and theory building, which leads to more adequate explanations of natural phenomena.

Select Goals and Objectives	**Teacher Guide**	**Assessments**

Goals and Objectives (Specify skills/information that will be learned.)	**Goals: Students will be able to identify methods of scientific investigation, distinguish between sound and flawed scientific research, and design/conduct their own sound research.** **Objectives:** **1. The class will correctly identify all steps of sound scientific research as evidenced by a complete class list.** **2. Working in groups, students will develop a working definition of each step and two examples.** **3. Students will work in small groups, then as a class, to create a rubric (high school) or checklist (middle school) to assess the presence of components of scientific research in projects.** **4. Students will cooperatively use their rubric/checklist to assess the soundness of a summer research project.** **5. Students will work individually to evaluate the soundness of the Redi/Pasteur research projects using their rubric/checklist and express their ideas in an open response.** **6. Students will design their own procedures for investigating filtration methods for kool-aid.** **7. Students will create a lab report to communicate their learning from the project, including a 1 page individual reflection on their use of the steps of science and application for scientific methods in the future.**	Assessements: 1. **Engage1** – *Formative* - assess the understanding of each group of experts on their assigned research component 2. **Explain1** – *Formative* - assess the group checklist 3. **Explore2** – *Formative* assess the group checklist for summer research 4. **Explain2** – *Formative* - assess deficits in understanding components of research 5. **Evaluate1** – *Summative* - assess student open responses and peer review sheets 6. **Explore3** – *Formative* - assess student procedures and use of science methods during project 7. **Evaluate3** – *Summative* - assess lab reports and individual reflections.

Select Instructional Strategies **Information** (Catch, give and/or demonstrate necessary information, misconceptions, etc…)	**Engage**: *Show* 1-minute video clip of "Beaker and Bunsen" using the "scientific method". Then have students discuss, as a class, the science seen in the video. Write the prompt, "Make a class list of one-word descriptions of how scientists do research ("Word Splash" activity). The teacher will facilitate the activity and record the words on the board. Words that need to be included are: Hypothesis, Background research, Independent and dependent variables, Controls, Replication, Data, Conclusion, Materials, Report, Communication, and New questions. (At the middle school level, the teacher may need to provide significant prompting to elicit these words.) *Place* students into groups of 4 and task them with developing a working definition, as well as two examples, for their group's assigned research words (e.g, the hypothesis group, the variables group, etc.) **Explore:** *Rearrange* students into groups in jigsaw fashion so that new students sit together, each one of them as an "expert" on one of the parts of research. Together, these new groups will create a rubric (checklist for middles school) of important components that make "good" science research, recording their product on chart paper. **Explain:** *Post* each group's chart paper. Have students do a gallery walk in shifts to identify deficits and changes to be made to improve their checklist/rubric. Have each group explain their intended changes. *Post* a generally accepted evaluation instrument, discuss and have groups revise their checklist/rubric. **Engage 2:** *Place* a glass of water on the table in front of each group. As a prompt for talking about contaminated water and water treatment, ask a student to drink the water, then discuss why they wouldn't drink after each other and why it's important to treat the water we have from earth's natural sources. *Lead* a discussion on how we could treat yucky water. **Explore 2:** *Introduce* the summer research project experience working with "real" scientists. If possible, provide each student with a copy of their group checklist/rubric, or if necessary, give each student a copy of a teacher created checklist/rubric developed from the "generally accepted evaluation instrument". Show the "Summer Research" PowerPoint presentation and have each student complete the checklist/rubric for that research example. They should be able to identify where they see each component and whether it was "good" science. Each group will develop a completed group checklist/rubric reaching consensus from their individual ones. Have groups record their results on chart paper. **Explain 2:** *Direct* students to share their group's findings with the rest of the class. *Clarify* any misunderstandings, formatively asses where students are having difficulties, and address issues before moving on. **Elaborate:** *Show* students an animation of the Redi/Pasteur research projects at http://www.sumanasinc.com/webcontent/animations/content/scientificmethod.html and copy of the open response. Students should work individually to complete this writing assignment. **Evaluate:** *Direct* students to trade their responses with a partner and provide peer review. The responses and peer review sheets should then be collected by the teacher, assessed for understanding, and returned with comments. **Engage 3:** *Demonstrate* Kool-aid filtration for students. *Present* the challenge – how can you get the greatest volume of kool-aid filtered? **Expore3:** *Provide* students with background information (Filtering FAQs). Students should then use what they have learned about the scientific method to create a project in which they research the challenge. Variables could include amount of carbon used, size of carbon used, amount of sand, filtration construction, type of kool-aid used, etc. Students should choose only one variable to test, gather data, and analyze results to get conclusions. **Explain3:** *Facilitate* student discussion with the rest of the class about their individual projects. **Elaborate3:** *Guide* students through creating laboratory reports to formally present their findings. The lab reports will be summatively assessed for understanding and application of the scientific method. **Evaluate 3:** *Assign* each student an individual 1-page reflection relating their growth in understanding the nature of science and how they can use scientific methods to solve problems.	

Utilize Technology	Summer Research Powerpoint Redi/Pastuer animation at http://www.sumanasinc.com/webcontent/animations/content/scientificmethod.html Computers for creating laboratory reports	**Other Resources** (e.g. Web, books, etc.) • Summer Research Handout • Standard Scientific Method rubric • Redi/Pastuer Research Project Synopsis • Research Open Response • Filtering FAQ's

Require Learner Participation **Activity** (Describe the independent activity to reinforce this lesson)	See Engage 3, Explore 3, Explain 3, Elaborate 3, Evaluate 3	
Evaluate (Assessment) (Steps to check for student understanding) – See Objectives above	See assessment column above.	**Additional Notes** Modifications: • Students create a checklist rather than an extensive rubric • Kool-aid filtration investigation can be more structured or open-ended • RET research powerpoint can be presented as a printed handout • Yellow Fever Research Synopsis for extension • Redi/Pasteur examples presented online as video or as printed handout • Accommodations for specific IEP – reader, scribe, extended time