CURRICULUM SUPPLEMENT

The Madness of Methods

Eider Research Highlights how Science Really Works

For use with the **Questions** section of *Eyes on Eiders*

Overview: By following the *Understanding Science Flowchart* students will learn that science really doesn't fit the traditional linear, step-by-step process of the old 'scientific method'. Students will identify phases of Eyes on Eiders that show real world scientific investigation involves unanswered questions, new problems and puzzles, reinterpretation of data, inclusion of multiple disciplines, and the unexpected.

Learning Objectives:

The student will:

- *Understand that:*[1]
  - *The process of* ***science involves testing ideas about the natural world*** *with data from the natural world.*
  - *Scientific understanding* ***improves as new evidence and perspectives emerge****.*
  - *The process of* ***science is non-linear****.*
  - *The process of science* ***involves observation, exploration, discovery, testing, communication, and application****.*
  - *Scientists test their ideas using* ***multiple lines of evidence****.*
  - *Test* ***results sometimes cause scientists to revise their hypotheses****.*
  - ***Scientists are creative and curious****.*
  - ***Scientists work together and share their ideas****.*
- *Using the Science Checklist students will be able to explain how Dr. Hollmen's team of researchers and associated colleagues who are* ***studying Steller's Eiders are 'doing' real science****.*

Standards Addressed:

Alaska Science GLES :
https://education.alaska.gov/akstandards/standards/standards.pdf
5th: SA1.1, SA1.2, SA3.1
6th: SA1.1, SA1.2, SA3.1
7th: SA1.1, SA1.2, SA3.1
8th: SA1.1, SA1.2, SA3.1

Next Generation Science Standards:
http://www.nextgenscience.org/search-standards-dci
5. Matter and Energy in organisms and Ecosystems
5-PS3-1, Core Ideas: LS1.C, LS2.A
MS Interdependent Relationships in Ecosystems
MS-L-S2-2, Core Ideas: LS2.A, LS2.C

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Materials/Location Needed:

- *This activity works in a classroom setting. Students can either work alone or groups for this activity.*
- *"Understanding Science, how science really works" website http://undsci.berkeley.edu/tour.php*
    - *Understanding Science 101 http://undsci.berkeley.edu/article/intro_01*
    - *How science works http://undsci.berkeley.edu/article/0_0_0/howscienceworks_01*
    - *The real process of science http://undsci.berkeley.edu/article/0_0_0/howscienceworks_02*
- *Large image of "How science works flowchart" (printable version here: http://undsci.berkeley.edu/lessons/pdfs/complex_flow_posterv.pdf) or projected large in digital format.*
- *Individual copies of the simplified version of the "How science works flowchart" for each student or group. (printable version here: http://undsci.berkeley.edu/lessons/pdfs/complex_flow_posterv.pdf)*
- *Pencils, journals or paper to record observations*
- *Student worksheet, found on page 6 of this lesson.*

Teaching Time: 90 minutes

Preparation Time: 60 minutes

Background:

The old "scientific method" is such an institution that is seems impossible to not learn it and live by it as a student. Every science fair project follows those tried and true steps: Observation, Question, Hypothesis, Test, Repeat, Results, and Conclusion. Many of us can remember the mnemonics we made up to help us recall the correct order even. While this method of breaking down the steps to form an ordered way of thinking about a question has it merits, in reality it's not how science actually gets done. It's just too simple and isolated.

A new way of approaching the fundamentals of how science works has been developed by the University of California Museum of Paleontology, Berkeley thanks in part to funding by the National Science Foundation. In their words the project at its heart is a:

> *"…**re-engagement with science that begins with teacher preparation and ends with broader public understanding.** Its immediate goals are to (1) improve teacher understanding of the nature of the scientific enterprise, (2) provide resources and strategies that encourage and enable K-16 teachers to reinforce the nature of science throughout their science teaching, and (3) provide a clear and informative reference for students and the general public that accurately portrays the scientific endeavor."*[2]

The Education Team here at the Alaska SeaLife Center is excited to utilize this "new" scientific method here in the Eyes on Eiders Virtual Field Trip. It is our first utilization of this program and we feel Dr. Hollman's work makes a perfect case for the way in which science actually works in the real world. Science is not a linear and simple processat all. It involves new questions at every turn, collaboration with different science disciplines, and in the words of the Understanding Science team, *"Science is an intensely human endeavor, but many portrayals*

gloss over the passion, curiosity, and even rivalries and pitfalls that characterize all human ventures."[3]

Spend some time on the *Understanding Science* website. Knowing that everyone gathers their internet information differently take your time to explore (there is a lot packed in!) you are sure to become inspired. Once you have finished poking around the site visit the short tutorial "*Understanding Science 101*" here: http://undsci.berkeley.edu/article/intro_01. Don't let the title insult you, this is just an overview of the entire approach and in just a few minutes you will have a good understanding of the basics.

Next, is another short tutorial entitled "What is Science?" here: http://undsci.berkeley.edu/article/article/0_0_0/whatisscience_01. As before, this won't take long but at the end you should come away with a more realistic definition for what it means to think, act, work and live with a scientific mindset. This can be a great revelation for your students to know that their already inquisitive personalities are in fact part of what it means to be scientific!

Finally, be sure to visit the *Teaching tools* page, found in the *For Teachers* tab at the top of every page. Here you will find the materials you need for this activity:

- *The Science Checklist* http://undsci.berkeley.edu/images/science_checklist.pdf
- The Simple Science Flowchart http://undsci.berkeley.edu/lessons/pdfs/simple_flow_handout.pdf
- The Complex Science Flowchart http://undsci.berkeley.edu/lessons/pdfs/complex_flow_handout.pdf

We realize that it may seem like a lot to ask of you to learn a new way of approaching science, in order to deliver a lesson on the processes that Dr. Hollman's team takes to learn all that they can about an obscure Arctic duck species. You will no doubt find that this is the way you already think of science anyway, but contrast it with the way we have traditionally taught it as a discipline to students. What kind of misconceptions are in the popular culture that often distorts the view of real-world scientific inquiry?

Of course it is up to you, how deep you get into the *Understanding Science* materials. However, it is possible to take a brief look at the mechanics of the new "method", which is now a more realistic flowchart versus the old "cookbook" list, and have your students look for areas in which the work of Dr. Hollman's team meshes with this chart perfectly. We are confident just an hour's worth of effort will provide you with a new appreciation for the way science works in the real world, and help you instill in your students a more realistic and personal relationship with scientific thought. You might even be inspired to modify your current lessons to incorporate these new ways of looking at the processes of science!

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Directions:

After completing the **Questions** section of *Eyes on Eiders*, explain to your class that you'd like to introduce the scientific method to them. To many this may come with a groan as they have already learned this in the past; however they are in for a surprise!

1. First it might serve well to have a quick discussion on science in general. Ask your students, what they think science is? Who can be a scientist? What does it mean to think in a scientific way?
    a. Introduce the Science checklist to your students. Tell them that while science isn't just a checklist there are definite things that science *is* and *is not*.
        i. Brainstorm some of the major scientific discoveries that are well known to your students (the moon landing, the dive to the bottom of the Mariana Trench, plate tectonics, climate change issues, medical breakthroughs, etc.)
            - Use the checklist to explore one of these discoveries. Does it check off the boxes?
        ii. To contrast, offer up a non scientific example (astrology is a great one). Explain how a lot of people used to believe, and some still do that this movement was indeed science.
            - Use the checklist to explore this idea. How does it stack up to the previous example?
2. On to the scientific method as we know it. Have a volunteer or two come up to the board and list out the steps of the old approach to the scientific method, Some variation of the following will likely emerge:
    i. Observe
    ii. Question
    iii. Hypothesize
    iv. Test
    v. Repeat
    vi. Results
    vii. Conclusion

    Leave this list up for the remainder of the lesson, but keep in mind future needs for your board! You might have to assign a student to copy it for use later.
3. Next have your students take a look at the *Simple How Science Works Flowchart*.[4]
    a. Dive into the wording on the simple flowchart, making sure there are no vocabulary problems.
        i. What is meant by Exploration & Discovery? Give examples?
        ii. Community Analysis & Feedback? Who are the communities?
        iii. Benefits & Outcomes? For whom?
    b. If your students are unfamiliar with flowcharts this could be a good opportunity for some group research or extra credit. Students can report back with what they have found about all the different ways flowcharts are used in the world.
    c. Ask your students why they think the arrows are going in the directions that they are.

4. Now it's on to the *Complex How Science Works* flowchart.
    a. How does this new information compare to the way in which the terms were defined on the last flowchart?
    b. Does this new information make sense? Does it provide a more complete picture of what it means to "do" science?
5. Think back to the questions posed by Dr. Hollman in her video interview. List them on the board and discuss all that it will take to answer those questions.
    a. What other kinds of scientists will she and her team have to work with?
    b. What will these discoveries mean to the people who live in the areas where these birds nest, or the areas where these birds migrate?
    c. Brainstorm some ideas of other questions Dr. Hollmen's team might come across as they answer their initial questions.
6. Finally advise your students that this is not the end of this activity. They will be keeping their copies of the spreadsheets and referring to them as other sections of the Eyes on Eiders virtual field trip are explored.
    a. As they explore they can fill in their worksheet and hand it in at the end of the unit.
    b. This ongoing work not only will review the sections of the unit already covered, but will allow students to see how both the *Science checklist* and *How Science Works* flowchart apply to the science presented in the remaining sections of the Virtual Field Trip.

Assessment:

Students can be assessed on participation in many aspects of the activity and/or their success at completion of the worksheet.

1, 4, The portion of this activity addressing the How science works flowchart has been influenced by an excellent activity found in the Understanding Science lessons, ''Introducing the Understanding Science Flowchart to middle school students'' by Deb Farkas. http://undsci.berkeley.edu/lessons/introducing_flow_ms.html

2,3, Understanding Science. 2015. University of California Museum of Paleontology. 3 January 2015 <http://www.understandingscience.org>.

STUDENT WORKSHEET - 2 Pages

Name _____ Date_____Class_____

1. Use the checklist below as you explore the Eyes on Eiders, Virtual Field Trip. Check the boxes as you discover "how scientific" the research Dr. Hollmen and her colleagues conduct is.

Science checklist:
How scientific is it?

- ☐ Focuses on the natural world
- ☐ Aims to explain the natural world
- ☐ Uses testable ideas
- ☐ Relies on evidence
- ☐ Involves the scientific community
- ☐ Leads to ongoing research
- ☐ Benefits from scientific behavior

2. If you found that Dr. Hollman's eider research uses testable ideas list two of those ideas here. Then write those ideas in the appropriate area on the *How science works* flowchart below.

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STUDENT WORKSHEET - 2 Pages

3. What other kinds of scientists might Dr. Hollman's team involve in their work? Why might it be beneficial for the eider team to interact with them? Write the types of scientists in the appropriate area on the *How science works* flowchart below.

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4. Do you think there will be benefits from the work Dr. Hollman's team is doing? If not, why? If so, what kind of benefits do you predict? Write those benefits in the appropriate area on the *How science works* flowchart below. _____

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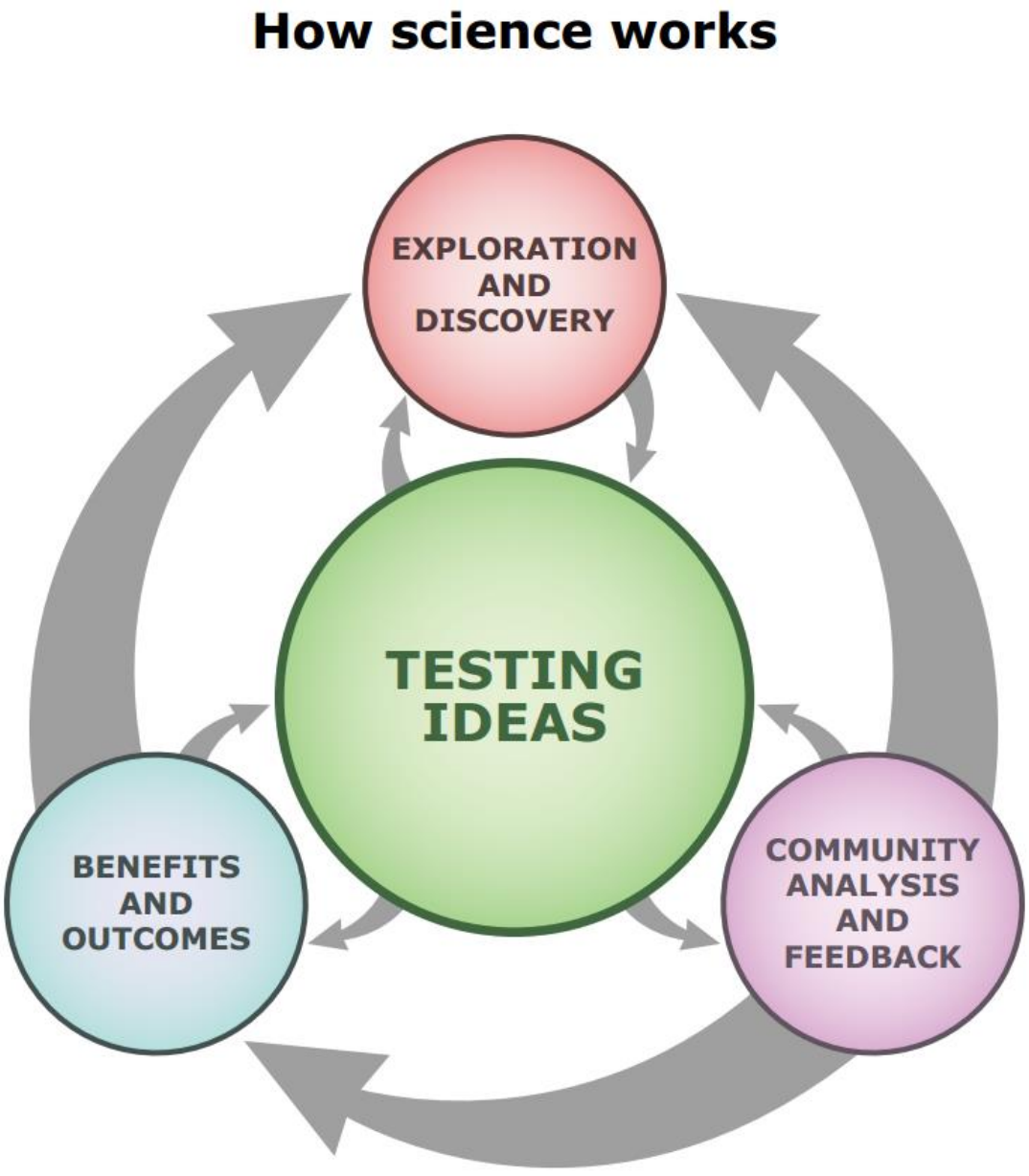

STUDENT WORKSHEET – TEACHERS COPY

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