Science in the Wild

The Nature of Science

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Grade Level	6th – 12th Grade	**Time Frame**	60 minutes
Subject	Science	**Duration**	1-2 periods
Course	Biology, Chemistry, Earth Science, Environmental Science, Physical Science, Physics		

Essential Question

How do scientists do their work?

Summary

In this lesson, students explore a variety of examples of how science is conducted in the world outside of the classroom. Examples come from a variety of Twitter trends where scientists share their mistakes, unexpected mishaps, and use of non-standard equipment in the course of their research. Additionally, students listen to excerpts from a TED Talk discussing how science generates more questions than answers. To conclude the lesson, students reflect on how their understanding of science has changed. This lesson addresses the nature of science itself, as outlined in the Next Generation Science Standards (NGSS), rather than any one content area. It can be used alone or in conjunction with specific science standards in any class.

Snapshot

Engage

Students discuss whether a study about classifying cats as liquids is really science.

Explore

Students complete a justified list about what counts as scientific equipment.

Explain

Students watch a video about how scientists ask questions and generate ideas.

Extend

Students explore examples of mishaps in scientific data collection and discuss the challenges associated with conducting science.

Evaluate

Students complete a reflection over how their understanding of the nature of science has changed.

Attachments

- Chat Stations—Science in the Wild - Spanish.docx
- Chat Stations—Science in the Wild - Spanish.pdf
- Chat Stations—Science in the Wild.docx
- Chat Stations—Science in the Wild.pdf
- Lesson Slides—Science in the Wild.pptx
- Science Equipment Justified List—Science in the Wild - Spanish.docx
- Science Equipment Justified List—Science in the Wild - Spanish.pdf
- Science Equipment Justified List—Science in the Wild.docx
- Science Equipment Justified List—Science in the Wild.pdf
- Science Equipment Uses—Science in the Wild.docx
- Science Equipment Uses—Science in the Wild.pdf

Materials

- Lesson slides (attached)
- Science Equipment Justified List handout (attached; cut in half; one per student)
- Science Equipment Uses handout (attached; one per teacher)
- Chat Stations handout (attached; one set per lesson; cut apart)
- Notebook/blank paper
- Poster paper (optional)
- Sticky notes (optional)

5 minutes

Engage

Teacher's Note: Nature of Science and Academic Standards

While there are not explicit Nature of Science standards in either the Next Generation Science Standards (NGSS) or Oklahoma Academic Standards for Science (OAS-S), the Nature of Science is intended to be taught within the context of classroom instruction. Appendix H off the NGSS (pdf) outlines eight tenets of the Nature of Science and describes a learning progression from K-12 for students' understanding of them. This lesson specifically addresses:

- Scientific Investigations Use a Variety of Methods
- Science is a Way of Knowing
- Science Addresses Questions About the Natural and Material World
- Science is a Human Endeavor

Go to **slide 3** and display the lesson's essential question. **Slide 4** (*hidden*) includes lesson objectives. You can unhide it if you feel it is necessary to review them with the class.

Go to **slide 5** to show the "cats are liquid" memes and ask the students "Is this science?" Ask students to discuss with their Elbow Partners whether this is "really science" or not. After they have a few minutes to discuss among themselves, have students share out their decision and explain their reasoning.

Next, go to **slide 6**, revealing the headline about the Ig Nobel Prize being awarded for studying whether cats should be classified as liquid or solid. Ask students if any of them have heard of the Ig Nobel Prize. If not, explain the concept to them. Explain to the class that this study that was awarded.

Teacher's Note: Ig Nobel Prize

> The Ig Nobel Prizes honor **achievements that make people LAUGH, then THINK**. The prizes are intended to celebrate the unusual, honor the imaginative — and spur people's interest in science, medicine, and technology. (Improbable Research: About the Igs)

Since 1991, 10 Ig Nobel Prizes have been awarded annually in various fields of science to research that is trivial, absurd, unusual, etc. Prizes are generally handed out by actual Nobel Prize laureates at the annual ceremony.

Teacher's Note: Rheology of Cats

Rheology is the scientific study of the flow of matter, primarily liquids and solids. However, it also includes "soft solids," which are solids that behave more like liquids under pressure, flowing rather than deforming. The author of the paper, "The Rheology of Cats," used equations and rheology theory to assess the flow behavior of cats in containers. While the paper itself is a Letter to the Editor of a reputable peer-reviewed journal, it is not a peer-reviewed study itself. Letters are a place for authors to share, among other things, insights into research that is not yet complete but is of interest to the journal audience. A copy of the original publication can be downloaded here.

Tell students that they will be learning about ways in which real science is conducted during this lesson.

10 minutes

Explore

Teacher's Note: Science Equipment Uses

All items in the Science Equipment Justified List have been used in scientific research. A selection of examples is provided and linked to their sources in the **Science Equipment Uses** document. All items on the list are shown on **slide 7** in order from left to right and top to bottom. Due to spacing issues, they are not aligned visually with the handout list.

Show **slide 7** and provide students with the half-sheet **Science Equipment Justified List** handout. Using the Justified List strategy, students should decide which items count as scientific equipment and explain the criteria or rule(s) for their decision. As you circulate through the room, keep an eye out for patterns in what students are selecting. Ask for volunteers to share out their answers and justifications. Depending on the number of items or specific items students are selecting overall, it might be quicker to ask students to share which items they *did not* select.

Teacher's Note: Student Responses

Students tend to select either just the traditional scientific equipment (e.g., beaker, microscope, etc.) or the entire list although some do get more creative. Justifications will vary, but you can anticipate at least a few students' making their decisions based on the word "equipment." These cases may lead to interesting list choices. Push for students to think big when they make rules or give reasons, encouraging them to go beyond their personal experience of seeing these items in classrooms.

After students have had a chance to share out and discuss with one another, tell them that every item on that list has been used in legitimate scientific research. The non-traditional items were found in reviews on Amazon and Twitter (#reviewforscience) where scientists described and rated products based on their use in research. A list of the specific uses is provided in the **Science Equipment Uses** teacher resource.

Before moving on, ask students to think about and share with the class what this activity has taught them about how scientists do research. As they share, guide them to consider how their thinking has changed or how their new understanding is different from what they thought before.

15 minutes

Explain

Ask students to watch excerpts of a TED Talk by Dr. Stuart Firestein titled *The Pursuit of Ignorance*. In this talk, Dr. Firestein discusses how the nature of science is to produce more questions than answers. Go to **slide 8** and play the video for students at the following timestamps:

- 0:10-1:12
- 4:05-11:25

The rest of the video is interesting and worthwhile to watch, but its details are not likely to hold student attention and are not necessary to the point being made here.

Embedded video
https://youtube.com/watch?v=nq0_zGzSc8g?t=10

Teacher's Note: Video Playback

You may need to go directly to YouTube or the TED website if the video will not play directly from the slide.

After the video, have a few volunteers share out what they thought was interesting about the video and whether anything was surprising to them.

25 minutes

Extend

Before beginning this activity, print the **Chat Stations** handout and arrange the seven Chat Stations around the classroom. Go to **slide 9** and explain the instructions to students. Divide the class into groups and send each one to a different station. At least one person in each group should have something with which to write. While at the stations, students will read a variety of tweets from scientists detailing mistakes or departures from standard procedures. Give students 2-3 minutes at each station to discuss what the tweets reveal about science and how it is done.

Teacher's Note: Sources

The tweets collected in these stations come from the #OverlyHonestMethods and #ScienceOopsies hashtags, which were trending primarily in 2018 and 2019. Some scientists still use them occasionally and a few tweets are more recent. Direct links to the tweets are provided in the handout. Over time, some tweets may no longer be available, as people on Twitter change their usernames, delete their accounts, delete tweets, etc.

When all the groups have visited each station, have them stay at the last station they visited. Ask a volunteer from each group to share what they learned about science at that specific station. Create a list as a physical or digital Anchor Chart that you can refer back to in future lessons, detailing what the class knows now about the nature of science.

5 minutes

Evaluate

To conclude the lesson, go to **slide 10** and ask students to use the I Used to Think... But Now I Know strategy to reflect on the essential question: *How do scientists do their work?* This can be done in whatever way is most convenient for you. You may want them to write their examples on notebook paper or sticky notes. Ask them to leave their examples at the end of class.

If there is time, ask for the class to share out their reflections. Add any new ideas from their "Now I Know" responses to the anchor chart.

Resources

- Improbable Research. (n.d.). About the Igs. https://improbable.com/ig/about-the-ig-nobel-prizes/
- Fardin, M. (2014). On the rheology of cats. https://api.semanticscholar.org/CorpusID:235386457
- Firestein, S. (2013). The pursuit of ignorance. [Video]. TED talk. https://www.ted.com/talks/stuart_firestein_the_pursuit_of_ignorance?autoplay=true&muted=true
- K20 Center. (2020). Anchor chart. Strategy https://learn.k20center.ou.edu/strategy/58
- K20 Center. (2021). Chat stations. Strategy. https://learn.k20center.ou.edu/strategy/944
- K20 Center. (2020). Elbow partners. Strategy. https://learn.k20center.ou.edu/strategy/116
- K20 Center. (2020). I used to think . . . But now I know. Strategy. https://learn.k20center.ou.edu/strategy/137
- K20 Center. (2020). Justified list. Strategy. https://learn.k20center.ou.edu/strategy/164
- Next Generation Science Standards. (2013). Appendix H. https://www.nextgenscience.org/sites/default/files/Appendix%20H%20-%20The%20Nature%20of%20Science%20in%20the%20Next%20Generation%20Science%20Standards%204.15.13