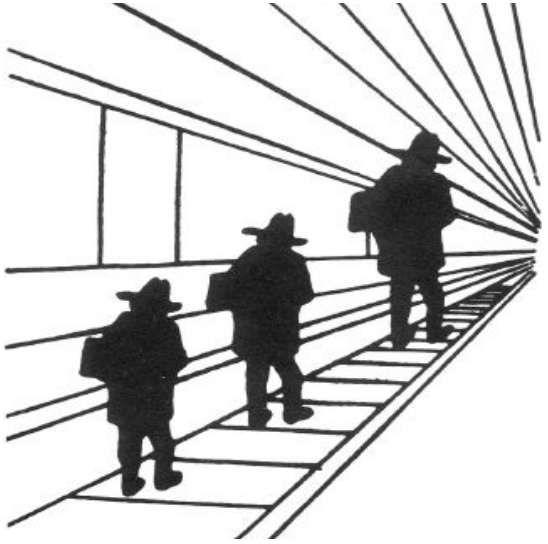
Science and Decision Making: How do we support our students in understanding complex socio-scientific issues in the media?

Hannah Miller & Andy Anderson



Agenda

- **Introductions**: People
- **Background**: Today's goals and questions
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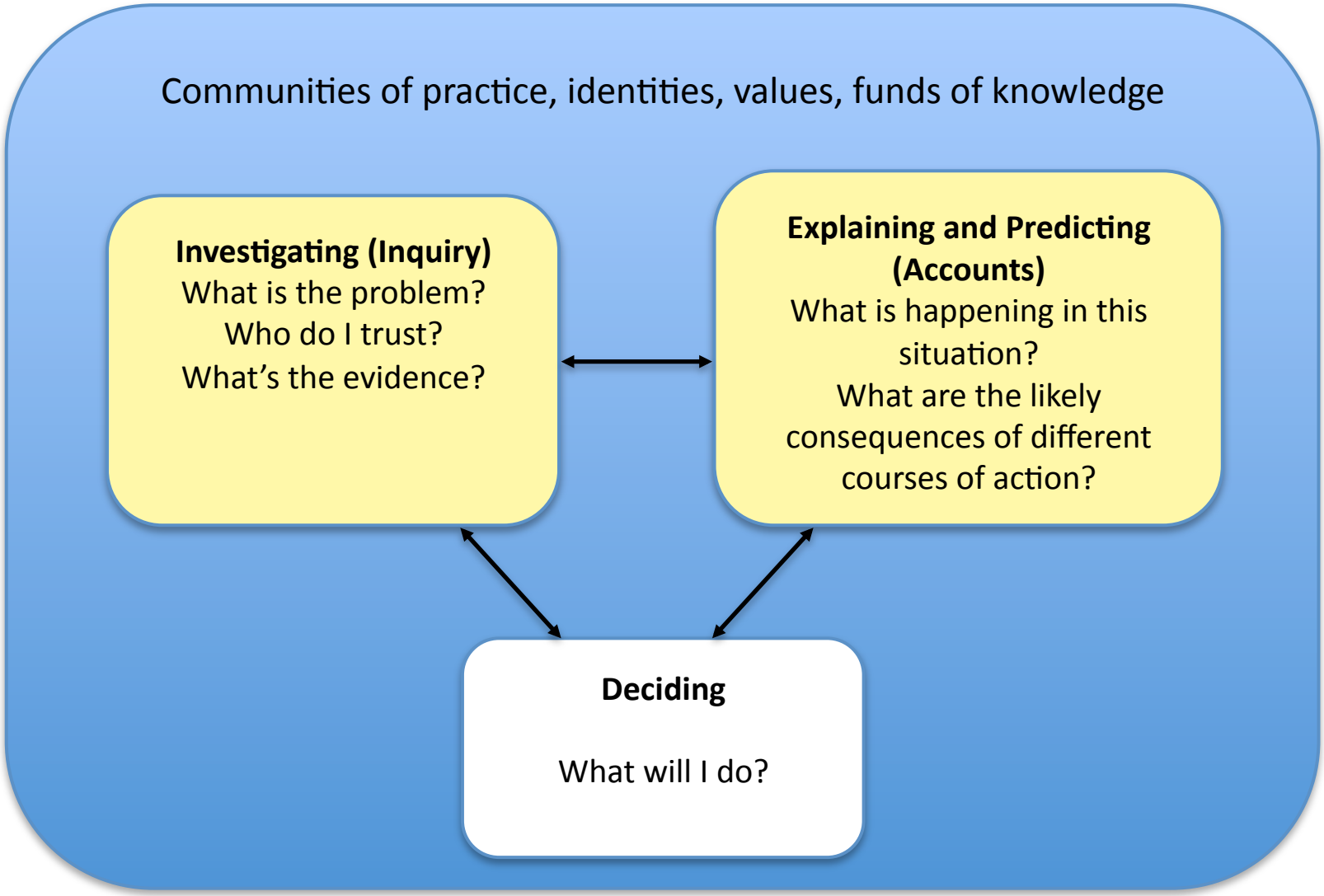
Carbon TIME …and decision making

How are decisions related to inquiry and application?



Curriculum

Carbon: Transformations in Matter and Energy (Carbon TIME)

Lessons in Carbon Transforming Processes

Photograph by Michael Nichols

Content Created by MICHIGAN STATE UNIVERSITY

Overview

The goal of the Carbon: TIME (Transformations in Matter and Energy) curriculum is to help students learn how to account for the chemical changes that are responsible for the structure and functions of all living systems and support our lifestyles—carbon transforming processes.

Read More

- To learn about the essentials of teaching Carbon TIME read What IS Carbon TIME Teaching?
- To learn about research-based Activity Sequences that provide the structure for Unit, read Carbon TIME Activity Sequences
- To learn about our research, read What Learning Progression on Carbon Transforming Processes Tell Us

Unit 1: Systems and Scale

Introduces students to key ideas that form the basis for al developing a scientific account of organic and inorganic m combustion transforms organic materials to inorganic mate to heat and light.

Unit 2: Animals

Animals cannot create organic materials like plants, so the materials—food—and break the complex organic molecule that their cells can use—the process of digestion. Animal that they can grow by making complex organic molecules biosynthesis again—and that they get energy by oxidizing organic materials—

Unit 3: Plants

Plant growth starts with a process of photosynthesis, usin to create an organic substance (glucose) from inorganic m and water. Plant cells grow by transforming glucose and s complex organic materials that plants are made of, includi complex carbohydrates—the process of biosynthesis. Finally, plants get the e by oxidizing glucose—the process of cellular respiration.

Unit 4: Decomposers

Although decomposers (fungi and aerobic bacteria) appear animals, aerobic decomposers (fungi and aerobic decomp biochemically very similar. Like animals, they rely on dige the case of decomposers) to break complex organic molec molecules. The cells of decomposers also grow through biosynthesis and obta respiration.

Unit 5: Ecosystems

These processes, photosynthesis, biosynthesis, digestion are constantly occurring in every ecosystem. In combinati chains, food webs, and energy and biomass pyramids—al ecological carbon cycle, which cycles matter between inor organic materials.

Unit 6: Human Energy Systems

Many aspects of our lifestyles, from driving cars to turning energy that can be traced back to combustion of fossil fue understand how our lifestyles affect the balance between materials on Earth.

Key Practices in Preparation for Future Learning about Sustainability

- **Learning from mass media**
  - What claims can we trust?
  - When has accuracy been compromised in order to simplify, entertain, or persuade?
- **Asking the right questions**
  - How does the system work?
  - What are the core issues?
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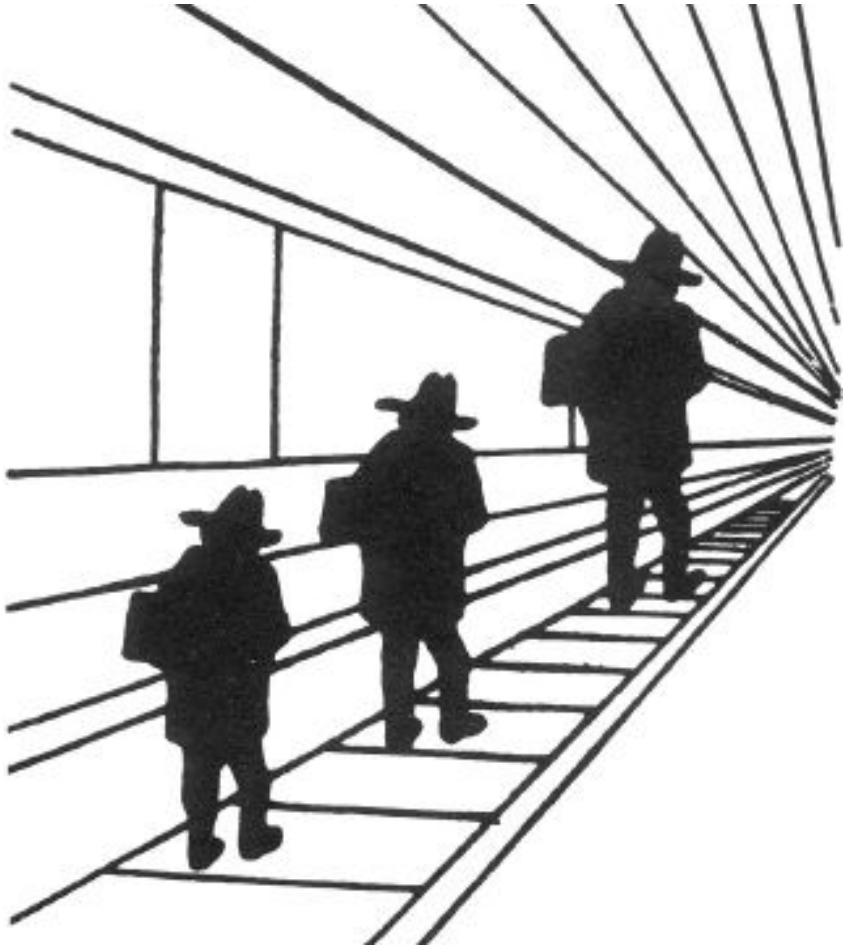
Advantages of System 1

- Enables quick, decisive action based on incomplete data
- Enables us to persist when the odds are against us

Problems with System 1



- Sometimes wrong
- Is just as certain when we are wrong as when we are right
- Generates answers, not questions

FIGURE 1 Features of System 1 and System 2 thinking (adapted from Haidt 2001)

System 1 thinking	System 2 thinking
Fast and effortless	Slow and effortful
Unintentional, runs automatically	Intentional and controllable
Process is inaccessible, we're only aware of results	Process is consciously accessible

FIGURE 2 Characteristics of System 1 thinking that lead to errors in judgment

WYSIATI (what you see is all there is)	System 1 makes use of information at hand to construct perceptions and stories, without asking whether other critical information might be missing.
Substituting an easier question	When confronted with a complex, difficult question, System 1 supplies an answer to an easier, related question.
Stories, not statistics	System 1 is very good at fitting patterns we see around us into story lines but is not able to see and interpret statistical patterns in data. In other words, we see the world in stories, not statistics.
Confirmation bias	We give greater credence to sources, information, and arguments that agree with our personal perceptions and narratives.
False certainty	System 1 does not recognize uncertainty. It produces instant conclusions that seem wholly true based on available information without evaluating the quality of the information. Only System 2 involves doubting, hesitating, or qualifying.
Source amnesia	System 1 makes use of available information without questioning whether the source it came from is reliable, and quickly forgets the source entirely.

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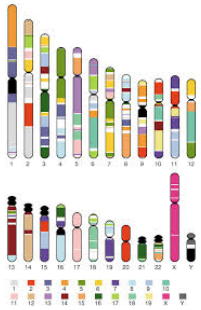
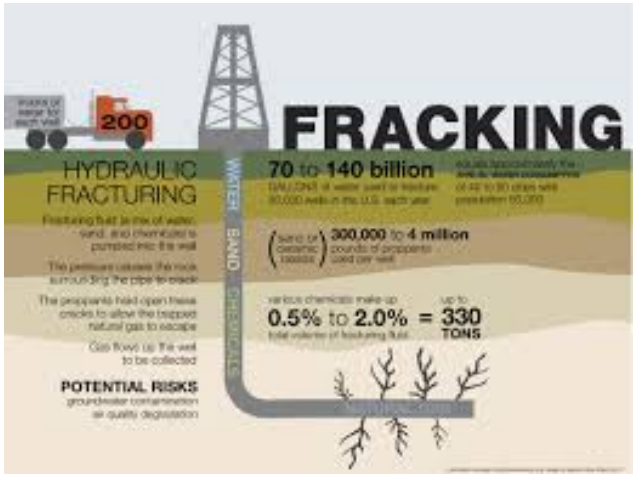
Controversial Socio-Scientific Issues

- Human population control
- Renewable energy
- Anti-vaccine
- Astrology, UFOs, pseudo-science
- Climate change
- Evolution
- GMOs
- School lunches

Sharing Classroom Experiences

- What happened?
- How did it go?
- How did students respond?
- Challenges or successes? (or what do you predict might be challenges or successes?)





GMOs?

School Traditions

- Fact: definitely right or wrong, based on what people in authority tell us.
  - It's fair to grade based on whether you know the correct facts.
- Opinion: we can't know for sure who is right and who is wrong.
  - all ideas should get a respectful treatment
  - Grading should be based on argument, not conclusion.
- BUT, how do we prepare students to make informed decisions in a world in which there is all kinds of information—and misinformation—on the Internet?

Headlines about West Antarctic Ice Sheet

- Marine Ice Sheet Collapse Potentially Underway for the Thwaites Glacier Basin, West Antarctica (*Science*)
- Scientists Warn of Rising Oceans as Antarctic Ice Melts (*New York Times*)
- West Antarctic Ice Sheet's Collapse Triggers Sea Level Warning (*NBC*)
- This Is What a Holy Shit Moment for Global Warming Looks Like (*Mother Jones*)
- Fox News: No coverage

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Help Save The ENDANGERED

PACIFIC NORTHWEST TREE OCTOPUS

From EXTINCTION!

THE PACIFIC NORTHWEST TREE OCTOPUS

The Pacific Northwest tree octopus (*Octopus paxarbolis*) can be found in the **temperate rainforests** of the Olympic Peninsula on the west coast of North America. Their habitat lies on the Eastern side of the Olympic mountain range, adjacent to Hood Canal. These solitary cephalopods reach an average size (measured from arm-tip to mantle-tip,) of 30-33 cm. Unlike most other cephalopods, tree octopuses are amphibious, spending only their early life and the period of their mating season in their ancestral aquatic environment. Because of the moistness of the rainforests and specialized skin adaptations, they are able to keep from becoming desiccated for prolonged periods of time, but given the chance they would prefer resting in pooled water.

Rare photo of the elusive tree octopus

An intelligent and inquisitive being (it has the largest brain-to-body ratio for any mollusk), the tree octopus explores its arboreal world by both touch and sight. Adaptations its ancestors originally evolved in the three dimensional environment of the sea have been put to good use in the spatially complex maze of the **coniferous Olympic rainforests**. The challenges and richness of this environment (and the intimate way in which it interacts with it,) may account for the tree octopus's advanced behavioral development. (Some evolutionary theorists suppose that "arboreal adaptation" is what laid the groundwork in primates for the evolution of the human mind.)

Reaching out with one of her eight arms, each covered in sensitive suckers, a tree octopus might grab a branch to pull herself along in a form of locomotion called tentaculation; or she might be preparing to strike at an insect or small vertebrate, such as a frog or rodent, or steal an egg from a bird's nest; or she might even be examining some object that caught her fancy, instinctively desiring to manipulate it with her dexterous limbs (really deserving the title "sensory organs" more than mere "limbs",) in order to better know it.

CEPHALONEWS

2014-05-15 **Scientists Discover How Octopuses Avoid Tying Themselves In Knots** (io9)

There are many things that make the octopus a strange creature, but one of them is that each of its eight arms has an essentially infinite number of positions, and yet each arm operates independently. How does an octopus keep from tying itself in knots?

2014-04-29 **Scientists Learn How to Put an Octopus to Sleep** (Scientific American)

While we are pretty adept at anesthetizing mice and monkeys, the mollusk body works so differently that human researchers are sill

Response

- Satire!
- Helpful resource
- Kids believe it easily
- 25 7th graders all fell for it!
- Authoritative
- Scientific language
- Lots of content
- Has characteristics of scientific websites

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Pair Brainstorming

1. How would you help your students "read" this website: how would they know it is a hoax?
2. How would you teach them to spot when someone is pulling the "system 1" wool over their eyes?
3. Generate a list of questions you would want them to ask.

Questions

- Is it credible?
- Look at citations for photos
- Look at citations for literature
- Look at web domain (.gov? .edu?)
- Is it peer reviewed?
- Is it a reputable source?
- Does it conform to your previous knowledge?
  - And is my prior knowledge informed?? Should I rethink it?
- Are they trying to get me to give money?

FIGURE 7 **How do scientists evaluate arguments?**

Some criteria (factors) scientists use to evaluate scientific arguments are as follows:

- Is there scientific evidence to support the claim?
- Is the sample size for collecting data sufficient? (In other words, is the sample big enough?)
- Were appropriate measures used in collecting data? (In other words, did scientists measure the right variables to answer the scientific question?)
- Was the data-collection procedure for gathering evidence rigorous and careful?
- Have the results been replicated? (In other words, has similar evidence been found in multiple separate instances)?
- Have multiple scientists found similar results? Have some scientists found different results?
- Is there an underlying scientific concept that links the evidence to the claim?
- Is there consensus (agreement) among scientists about the argument?
- Have the results been published in a peer-reviewed, reputable publication?
- Did someone who might have a bias fund or carry out this work? For example, was the work paid for by a company that has an interest in getting certain results?

v to consider the scientific argument that is made. Then discuss your
s with the class.

Discuss with your group and write down your ideas about the following questions:

1. Why do you think the criteria on the list above are important to scientists?
2. Are there some factors on the list we developed as a class that are the same as or similar to criteria on the scientists' list? If yes, which factors from the class list are similar to those on the scientists' list?
3. Considering the scientists' list, are there any changes you would make to your evaluation of the strengths and weaknesses of the arguments provided by the stakeholders in the articles? Using different-color ink, make any additions or changes to your original list of strengths and weaknesses for the arguments.

Name: _____ Website URL or name: _____

Is This a Hoax?

1. Scan the perimeter of the page and look for answers to these questions, using the 5 W's of Cyberspace	
Who created the page? • Is there an "about us" section? • Do they list credentials? • Is there contact information? • Who is the intended audience?	
What information are you getting? • Are there multiple points of view represented? • Does the author use OPINION words, such as a*lways, never, least, greatest, best, worst, all, none, should,* or *most*? • What is the tone? Is it serious? Does it contain elements of parody, satire, or irony? • Can the information be verified through other sources?	
When was this article posted? • Is it current? • Has it been updated recently?	

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3 types of challenges

- “Hoax” websites (like the tree octopus)
- Websites that are designed primarily to persuade or entertain
- Websites that present incomplete perspectives on socio-scientific topics

Fracking Discussion:

Group 1: Gasland, the movie

- http://www.youtube.com/watch?v=dZe1AeH0Qz8
- http://www.gaslandthemovie.com/

Group 2: New York Times Article

- http://nyti.ms/1kuImPW

Group 3: EPA Website on Hydraulic Fracturing

- http://www2.epa.gov/hydraulicfracturing

Group 4: BBC Article

- http://www.bbc.com/news/business-24489986

Group 5: Energy From Shale website

- http://www.energyfromshale.org/fracking-benefits

Share out

- Tell us a briefly about your website/article.
- What would your students need to ask to understand the information on this website?

How do these websites compare with each other?

Conclusions

- What challenges do you predict when trying to teach about these issues in your classroom?

Resources for Helping Your Students Make Decisions

- Helping students be aware of our System 1 ways of thinking and how to compensate for them (see Covitt, et al. chapter and article)

  http://envlit.educ.msu.edu/publicsite/files/General/ProjectPaper/2013/Covitt_Harris_Anderson.pdf
- National Geographic Decision-making: http://education.nationalgeographic.com/education/topics/decision-making/?ar_a=1
- Zeidler, D. L., and Kahn, S. (2014). *It's debatable! Using socioscientific issues to develop scientific literacy.* http://www.nsta.org/store/product_detail.aspx?id=10.2505/9781938946004

Thank you!

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http://edr1.educ.msu.edu/environmentallit/publicsite/html/CarbonTIME1314_unit_zip_files.html