Developing Science Literacy by Involving Youth in Journalism

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School of Education

CSEN Meeting, January 2014

University of Colorado Boulder
Overview of workshop

• Introduction to approach toward science literacy
• Readaloud-thinkaloud
• Guidelines for science literacy
• Identification of uses of science literacy
• Key research findings
• Infographics and visual literacy
• Build an infographic
What is science/scientific literacy?

• Some would say: knowing how to read, write, and communicate as a scientist does
  – Lab reports, journal articles, professional presentations

• We emphasize: knowing how to critically read, write and communicate about scientific information in everyday life
  – Develop skills now
  – Use in future, “15 years after high school”
How can students make use of science 15 years after high school?

- Research on the internet, discuss with community
- Understand what is relevant, important, up to date and accurate
- Ask good questions in order to be informed
  
  ...
# Science for “Competent Outsiders”

<table>
<thead>
<tr>
<th>Personal Lives</th>
<th>Public Lives</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Health decisions</td>
<td>• Climate change policy</td>
</tr>
<tr>
<td>• Nutrition</td>
<td>• Public health policy</td>
</tr>
<tr>
<td>• Home environment</td>
<td>• Evolution and “Intelligent Design”</td>
</tr>
<tr>
<td>• Personal tech purchases</td>
<td></td>
</tr>
</tbody>
</table>
How?

• Science news journalism
• Data journalism
SciJourn & C-Isl

• NSF Grants
  – Science Literacy through Science Journalism
  – Collaborative Infographics for Science Literacy
• Youth as citizen science journalists and data journalists

www.scijourner.org

This material is based upon work supported by the National Science Foundation under Grant Nos. DRL-0822354 & CISE-1217052
A growing network ...

- 2008-2012
  - St. Louis, Missouri region
  - 45 teachers at 25 schools, & St. Louis Science Center
- Since ...
  - Kentucky, Indiana, New Jersey, Connecticut ...
  - Colorado
    - Nora Matell at Denver School of Science and Technology
    - Steve Smith at Animas HS in Durango
Readaloud-Thinkaloud

• Technique adapted from elementary literacy instruction
• Learn about in Saul, Kohnen, Newman, & Pearce’s book:
Questions and Comments on Readaloud-Thinkaloud?

What would you bring up?
What would you be interested in sharing?
Guidelines for Science News and Science Literacy

1. Personal relevance
2. Search
3. Multiple, credible, attributed sources
4. Contextualization
   – In science – What do scientists think? How sure are they?
   – In societal concerns – Who should care? Why?
5. Sense-making/accuracy
Relevance

A science news article is a tangible display of scientific literacy. A student reporter is expected to ...

- Present the personal or local impact of a timely, narrow, focused topic of interest to the audience from a unique angle. **

- Establish the relevance of science/technology information to their own and others' lives. 


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Relevance

A scientifically literate person can ...

- Establish the relevance of science/technology information to their own and others' lives.

Building mold
A science news article is a tangible display of scientific literacy. A student reporter is expected to …

- Search effectively for and recognize relevant, credible information sources. Successful authors …
  a. use Internet search terms and search engines effectively,
  b. privilege data from credible government and non profit sites and can justify the use of “other” sites, and
  c. locate and query experts and relevant stakeholders.

A scientifically literate person can …

- Search effectively for and recognize useful STEM information from credible sources, especially on the Internet.
Search

A scientifically literate person can ...

- Search effectively for and recognize useful STEM information from credible sources, especially on the Internet.

“Healthbolt” - blogger

WIKIPEDIA
Sources

A science news article is a tangible display of scientific literacy. A student reporter is expected to …

- Write articles based on multiple, credible, attributed sources
  a. sources are relevant and reliable,
  b. stakeholders with varying expertise and experiences are consulted,
  c. sources are identified and basis of expertise is explained, and
  d. all assertions, numbers, details and opinions are attributed.

A scientifically literate person can …

- Utilize multiple, credible sources, and be able to attribute the expertise and/or perspectives provided by those sources.
SLA: Sources Named by Experts

n=18. Topics: diabetes, high blood pressure, the Deepwater Horizon oil spill, and a volcano ash plume.
Sources Named by Novice Teens

n=100. Topics: diabetes, high blood pressure, the Deepwater Horizon oil spill, and a volcano ash plume.
Sources

A scientifically literate person can …

• Utilize multiple, credible sources, and be able to attribute the expertise and/or perspectives provided by those sources.
Contextualization

A science news article is a tangible display of scientific literacy. A student reporter is expected to …

- **Contextualize** scientific information, discoveries and technologies; note broader implications and reflect on past and future understandings.

- **Contextualize** new STEM information in terms of societal impact or import and in terms of what is already scientifically established or tentative.

A scientifically literate person can …
A scientifically literate person can …

- Contextualize new STEM information in terms of societal impact or import and in terms of what is already scientifically established or tentative.
Sense-making/Accuracy

A science news article is a tangible display of scientific literacy. A student reporter is expected to …

- Communicate information that accurately represents up to date science and forefront the most important elements.

A scientifically literate person can …

- Make sense of and accurately relate the important scientific concepts, methods, and explanations in STEM news.
Sense-making/Factual Accuracy

“A scientifically literate person can ...

- Make sense of and accurately relate the important scientific concepts, methods, and explanations in STEM news.

“Mold is a fungus that grows in multicellular filaments. According to the EPA, mold grows on various kinds of damp or decaying organic matter. People are at risk anytime, because mold is floating in the air and so small you cannot see them until they build up like a colony. Mold needs certain things in order to form: water, food, suitable air quality and temperature. Mold forms in places such as food, walls, or any place where it’s moist, hot, and humid.”
Science literacy in action

• Personal relevance – Why did they care?
• Contextualization
  – In related science – What do scientists think? How sure are they?
  – In societal concerns – Who should care? Why?
• Sources
  – Multiple
  – Credible – for different purposes (e.g., stakeholder, researcher, non-profit organization, for-profit company)
  – Attributed
• Sense-making/accuracy – Is the science explained?
Key Research Findings
Beyond the school walls ...

- Science news articles as “boundary spanning”
- Interaction with science news editor key
- Meaningful publication
  - Local and school community recognition
  - Communities on the internet (e.g., “orphan diseases”)
- Development of new interests and identities
Scientific Literacy Assessment

- Open-ended and forced choice critical questions
- Four sections evaluating different modes (2 versions)
  - News story – relevance, sources
    - Lead pipe
    - Volcano ash plume
  - Photo series with caption - contextualization
    - Deepwater Horizon
    - Hurricane Katrina
  - Simulated health brochure – relevance, search, sense-making
    - High blood pressure
    - H1N1 Influenza
  - PowerPoint presentation slide – sense-making, search
    - Climate change
    - Obesity and diabetes
SLA Pre-Post-Results

Scaled scores 0-3 points, ** p > 0.001, n=673.
ANOVA and a Generalized Linear Mixed Model (GLMM)
Implementation Level

![Graph showing the SLA Scaled Score (0-3) for Reading, Reading and Writing, and Reading, Writing, and Revision for Publication. The graph includes Pre-Mean and Post-Mean data points, with linear trends for both. The number of participants, n=673, is also indicated. The p-value is 0.001.](#)
Infographics

Tornadoes in Missouri

2000
- January: 1
- February: 1
- March: 1
- April: 1
- May: 1
- June: 1
- July: 1
- August: 1
- September: 1
- October: 1
- November: 1
- December: 1
Total: 11

2001
- January: 1
- February: 1
- March: 1
- April: 1
- May: 1
- June: 1
- July: 1
- August: 1
- September: 1
- October: 1
- November: 1
- December: 1
Total: 11

2002
- January: 1
- February: 1
- March: 1
- April: 1
- May: 1
- June: 1
- July: 1
- August: 1
- September: 1
- October: 1
- November: 1
- December: 1
Total: 11

2003
- January: 1
- February: 1
- March: 1
- April: 1
- May: 1
- June: 1
- July: 1
- August: 1
- September: 1
- October: 1
- November: 1
- December: 1
Total: 11

2004
- January: 1
- February: 1
- March: 1
- April: 1
- May: 1
- June: 1
- July: 1
- August: 1
- September: 1
- October: 1
- November: 1
- December: 1
Total: 11

2005
- January: 1
- February: 1
- March: 1
- April: 1
- May: 1
- June: 1
- July: 1
- August: 1
- September: 1
- October: 1
- November: 1
- December: 1
Total: 11

2006
- January: 1
- February: 1
- March: 1
- April: 1
- May: 1
- June: 1
- July: 1
- August: 1
- September: 1
- October: 1
- November: 1
- December: 1
Total: 11

2007
- January: 1
- February: 1
- March: 1
- April: 1
- May: 1
- June: 1
- July: 1
- August: 1
- September: 1
- October: 1
- November: 1
- December: 1
Total: 11

2008
- January: 1
- February: 1
- March: 1
- April: 1
- May: 1
- June: 1
- July: 1
- August: 1
- September: 1
- October: 1
- November: 1
- December: 1
Total: 11

2009
- January: 1
- February: 1
- March: 1
- April: 1
- May: 1
- June: 1
- July: 1
- August: 1
- September: 1
- October: 1
- November: 1
- December: 1
Total: 11

Totals by Month
- January: 40
- February: 15
- March: 74
- April: 66
- May: 188
- June: 56
- July: 16
- August: 14
- September: 44
- October: 22
- November: 23
- December: 16

**Data source is creditable from www.tornadohistoryproject.com made by Joseph Lietz who got his information from the Storm Prediction Center and the National Climatic Data Center.
Visual literacy – new guideline

A scientifically literate person ... knows how representational devices and visualizations are used to convey scientific meaning. When making infographics, uses representational forms to fulfill various functions to assist readers in making sense of data and concepts.

- Forms
- Functions
- Conventions
Shark Attacks In The US

Narrowing it down, The Atlantic Coast of Florida is the most dangerous for shark attacks because of its beautiful coastal location, and subtropical weather that attracts many people year round. Since there are high human density in the waters, there's an increased chance for someone to be attacked.

U.S. Shark Attacks from 2006-2010

- Florida: 42 attacks
- California: 14 attacks
- North Carolina: 15 attacks
- Oregon: 18 attacks
- Hawaii: 12 attacks
- South Carolina: 10 attacks
- Texas: 6 attacks
- Georgia: 5 attacks

Great White Shark
- Vulnerable (Exposed to the possibility of being harmed or attacked)
- Least concerned (Has been evaluated but do not qualify for any other category)
- Endangered (Seriously at risk for extinction)

Megamouth Shark
- Data Deficient (When the available information is not sufficient for a proper assessment of conversation status to be made)

Goblin Shark

Hammerhead Shark
- Dying from a hornet, wasp or bee sting: 1 in 218
- Chance of getting struck by lightning: 1 in 2.3 million
- Getting killed by a shark: 1 to 11.5 million

Sources: Wikipedia, Oceana, Venomous, Poisonous, Dangerous and other Wonders, National
Examples from Rob Lamb’s class, Spring 2013

**Chemicals that Make up the Colors of Fireworks**

- **Strontium (Sr)**: Carbonates and sulfates show the strontium reaction, and become alkaline after they are ignited. Silicates and phosphates do not give a strontium flame. Wavelength 652 nm.
- **Calcium (Ca)**: Only a few minerals give this calcium color definitively when heated. Often, however, the color shows distinctly after moistening it with hydrochloric acid. Wavelength 653 nm.
- **Sodium (Na)**: Sodium is so intense, you must block out this emission to observe the less intense colors. Wavelength 589-621 nm.
- **Barium (Ba)**: Carbonates and sulfates show the reaction, and become alkaline after they are ignited. Silicates and phosphates do not give a barium flame. Wavelength 455 nm.
- **Aluminum (Al)**: Aluminium gives off a bright “Silver” or “White” color. Wavelength 396 nm.
- **Barium (Ba)**: The copper flame color needs Cl to produce blue. Wavelength 505-535 nm.

In making fireworks, the metal salts are put into shells. The colors are produced by heating metal salts that emit characteristic colors. The atoms of each element absorb energy and release it as light of specific colors.

**Sources:**
- Spectra of Gas Discharges
- Flame Tests
- Chemical of the Week – Fireworks!
- How Fireworks Work: PyroUniverse.com

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**Deadliest Snakes & Reactions**

- **Eastern Brown Snake**
- **Blue Krait**
- **Black Mamba**
- **Common Rattlesnake**

**Facts**
- Eastern Brown: Eats Frogs, Lizards, Rodents. Found in Rain Forest & Wetlands. Range from 3.5 - 6 ft.
- Blue Krait: 5 Feet 9 inches is the typical length of a blue krait. Mostly from India.
- Black Mamba: This snake is fast-moving, land-dwelling. Black Mamba is known to chase and attack humans.
- Common Rattlesnake: 32 Types. Wide range of habitats from Canada to Western U.S., To Argentina, Small Rodents, Heat Visions.

**To test the mortality rate of a snake, scientists use 10 mice to see how many mice die from the snake’s venom without treatment.**
- Mice killed due to bite of a snake
- Mice not killed due to bite

Snakes are shown to size of how dangerous they are to humans.

**Sources:**
- http://animals.nationalgeographic.com/animals/reptiles/eastern-diamondback-rattlesnake/
- http://animals.nationalgeographic.com/animals/reptiles/eastern-diamondback-rattlesnake/
SPORTS DRINKS

Examples

Source: calories in sport's drinks / daily intake guide

<table>
<thead>
<tr>
<th>Drink</th>
<th>Calories</th>
<th>Sodium</th>
<th>Carbohydrates</th>
<th>Sugar</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gatorade</td>
<td>82.5</td>
<td>55</td>
<td>82.5</td>
<td>110</td>
<td>2.50</td>
</tr>
<tr>
<td>Powerade</td>
<td>82.5</td>
<td>55</td>
<td>82.5</td>
<td>110</td>
<td>1.25</td>
</tr>
<tr>
<td>Propel</td>
<td>27.5</td>
<td>55</td>
<td>55</td>
<td>110</td>
<td>1.00</td>
</tr>
<tr>
<td>Sobe</td>
<td>1.50</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1.18</td>
</tr>
<tr>
<td>Water</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1.50</td>
</tr>
</tbody>
</table>

Example from Rob Lamb’s class, Spring 2013
Color Blindness

Monochromacy:
No types of functioning color receptors

Dichromacy:
2 types of functioning color receptors

Trichromacy:
3 types of functioning color receptors

% of people affected:

Male
- Dichromacy: 28%
- Trichromacy: 72%

Female
- Dichromacy: 7%
- Trichromacy: 93%

Monochromacy is less than 0.01% for both male and female

Sources: Wikipedia Webexhibits.org Webmd.com Kidshealth.org Webaim.org

Example from Rob Lamb’s class, Spring 2013
Example from Rob Lamb's class, Spring 2013
When do you REALLY pay for tobacco use?
The ages that people are diagnosed and die from the three most common tobacco-related cancers.

Tobacco increases the risks of cancers in the mouth, throat, nose, lips, lungs, stomach, ovary, pancreas and kidney. Tobacco use accounts for at least 30% of all cancer deaths and 87% of lung cancer deaths. —American Cancer Society, Cancer Facts and Figures 2013

The following information is an age distribution of diagnosis and mortality for three types of cancer between 2006–2010. This data was collected based on the total population of the U.S.
Build an Infographic
<table>
<thead>
<tr>
<th></th>
<th>Amphibians</th>
<th>Mammals</th>
<th>Reptiles</th>
<th>Birds</th>
<th>Total Specimens</th>
<th>Visitors '05</th>
<th>Acreage</th>
</tr>
</thead>
<tbody>
<tr>
<td>San Diego Zoo</td>
<td>280</td>
<td>1,693</td>
<td>1,043</td>
<td>1,992</td>
<td>5,008</td>
<td>3,200,000</td>
<td>240</td>
</tr>
<tr>
<td>Omaha</td>
<td>528</td>
<td>3,314</td>
<td>624</td>
<td>1,710</td>
<td>6,176</td>
<td>1,347,853</td>
<td>220</td>
</tr>
<tr>
<td>Bronx Zoo</td>
<td>322</td>
<td>2,164</td>
<td>422</td>
<td>859</td>
<td>3,767</td>
<td>1,932,638</td>
<td>540</td>
</tr>
<tr>
<td>San Diego Wild Animal Park</td>
<td>0</td>
<td>1,701</td>
<td>28</td>
<td>1,527</td>
<td>3,256</td>
<td>1,476,762</td>
<td>1,700</td>
</tr>
<tr>
<td>San Antonio Zoo &amp; Aquarium</td>
<td>225</td>
<td>783</td>
<td>452</td>
<td>1,271</td>
<td>2,731</td>
<td>834,328</td>
<td>100</td>
</tr>
<tr>
<td>Saint Louis Zoo</td>
<td>441</td>
<td>491</td>
<td>699</td>
<td>901</td>
<td>2,532</td>
<td>2,932,252</td>
<td>180</td>
</tr>
<tr>
<td>Houston Zoo</td>
<td>143</td>
<td>700</td>
<td>543</td>
<td>882</td>
<td>2,268</td>
<td>2,500,000</td>
<td>110</td>
</tr>
<tr>
<td>Fort Worth Zoo</td>
<td>251</td>
<td>222</td>
<td>545</td>
<td>1,125</td>
<td>2,143</td>
<td>910,247</td>
<td>140</td>
</tr>
<tr>
<td>Denver Zoo</td>
<td>132</td>
<td>802</td>
<td>432</td>
<td>596</td>
<td>1,962</td>
<td>1,711,593</td>
<td>160</td>
</tr>
<tr>
<td>Louisville Zoo</td>
<td>878</td>
<td>239</td>
<td>372</td>
<td>388</td>
<td>1,877</td>
<td>757,517</td>
<td>260</td>
</tr>
</tbody>
</table>
## Elements to Consider

<table>
<thead>
<tr>
<th>Icons or Images (can be different sizes, or repeated to represent a number)</th>
<th>Tree Map</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bar Graph</td>
<td>Map</td>
</tr>
<tr>
<td>Scatter plot/X-Y graph</td>
<td>Diagrams – hierarchy tree, Venn, network, process, concept or mind map</td>
</tr>
<tr>
<td>Pie Chart</td>
<td>Timeline</td>
</tr>
<tr>
<td>Line Chart</td>
<td>Tag cloud</td>
</tr>
<tr>
<td>Radar Chart</td>
<td>Gauge</td>
</tr>
<tr>
<td>Bubble Chart</td>
<td></td>
</tr>
</tbody>
</table>
Animals in the House

Omaha's Henry Doorly Zoo
2,774 specimens, 1,487,633 visitors

San Diego Zoo
4,736 specimens, 1,208,666 visitors

Bronx Zoo
2,747 specimens, 1,332,613 visitors

San Diego Wild Animal Park
2,105 specimens, 1,474,761 visitors

San Antonio Zoo and Aquarium
2,713 specimens, 834,328 visitors

Saint Louis Zoo
3,333 specimens, 2,982,165 visitors

Housten Zoo
2,267 specimens, 1,066,009 visitors

Fort Worth Zoo
2,141 specimens, 932,247 visitors

Denver Zoo
2,944 specimens, 1,721,999 visitors

Louisville Zoo
2,971 specimens, 707,537 visitors

Source: http://www.good.is/posts/animals-in-the-house - Author Barbara Glauber, Heavy Meta
To learn more, or get involved

- Email me: joseph.polman@colorado.edu
- http://bit.ly/1bP0lIb = http://sites.google.com/a/colorado.edu/joepolman/presentations
  - SciJourner (student publication) www.scijourner.org
  - Teaching resource: teach4scijourn.org
  - Infographics resource: science-infographics.org
  - Articles in The Science Teacher