Writing to Learn:
Reading and Writing in STEM

Chris Thaiiss
University Writing Program
UC Davis

Oregon State University
May 13, 2016
Objectives

• Define a “rhetorical approach” to STEM reading and writing

• Describe and practice techniques for assignment design that enact this approach

• Describe techniques for effective response to student writers—including peer review.

• Describe a long-standing science writing program that uses this approach in an inclusive environment
A Rhetorical Approach to STEM Reading/Writing

- Relies on tradition in science communication studies of analyzing (1) the argumentative structure of scientific articles and (2) differences in scientific writing for specialist and non-specialist readers (e.g., Bazerman, LaTour/Woolgar, Myers, Perrault)

- Focuses on analyzing purposes, audiences, genres, style, and graphics in science documents

- In teaching writers and readers of science, actively rejects the myth that the “data speak for themselves”
Goals for the Approach

• Help science majors become more savvy readers of any kind of science-related document: print, online, multimedia
• Help science majors become more organized and impactful writers of science documents to diverse readers
• Help science majors become more savvy consumers and producers of science
Usefulness of this approach…

• By teaching students to see the rhetorical features of STEM writing, the approach helps all students see what science communication shares with all other types of communication, and how it differs.

• Recent attention in writing-in-disciplines research (e.g., Leki, Zawacki and Cox, Kruse, Wu, Hirsch) to the needs of English language learners shows importance of rhetorically-aware teaching.

• “Rhetorically-aware” STEM teaching includes meaningful reading/writing assignments and feedback on content and argument, not just on perceived language errors.
## Heuristic for Critical Reading in Science

<table>
<thead>
<tr>
<th>Purposes</th>
<th>Journal articles</th>
<th>Blogs, Reports, etc.</th>
<th>Popular science news</th>
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<td>Audiences</td>
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<td>Types of Evidence</td>
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<td>Graphic Elements</td>
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Sample Assignment Based on the Heuristic: Comparative Document Analysis

• “Compare three articles (on the same specific topic of your choice). One should be from a peer-reviewed journal, another from a popular news publication, a third from a science blog or government report”
• “Using the heuristic, identify the purposes and audiences for each article.”
• “How do the writers of these articles use
  (1) types of evidence
  (2) order of information
  (3) tone and style, and
  (4) graphic elements
to achieve their purposes for their target audiences?”
Designing Rhetorically-Aware Assignments

• **Purposes**
  
  What should the writer achieve or demonstrate or argue?

• **Audiences**
  
  Who are the readers? How can they use the writing?

• **Genre and Format**
  
  What expectations do the readers have for format and style? (E.g., standard science journal format? Research review? Poster?)

• **Process**
  
  Will there be a proposal? A first draft? Peer review?
Giving Feedback to Student Writers

• Prioritize feedback according to main objectives for (purposes of) the assignment (see handout).

• Consider using a simple rubric (see handout) to ensure useful feedback.

• Consider using rubric-driven peer review (see handout).

• Use feedback to promote real improvement through revision (as in the professional peer-review process).
UC Davis UWP 104E: Writing in the Professions--Science

- One of 20+ upper-level (jr-sr) courses in the University Writing Program taken to fulfill the upper-level writing requirement for all students
- One of 7 such courses popular with STEM majors (writing in biosciences, writing in health professions, writing in engineering, technical writing are among the other courses) [http://writing.ucdavis.edu/course-information/writing-in-the-disciplines](http://writing.ucdavis.edu/course-information/writing-in-the-disciplines) (Taken by 2000 students per year.)
UWP 104E: Writing in the Professions--Science

• From course objectives: To introduce students to the rhetorical principles underlying...the major genres of scientific writing

• To teach students the rhetorical principles underlying effective scientific style

http://writing.ucdavis.edu/course-information/course-descriptions-1/uwp
“Scaffolded” Science Writing Assignments

1. Writing and Science: Your History
2. Team Research Review (developed in stages throughout course)
3. Comparative Document Analysis
4. Popular Science Project (multimodal)
5. Oral/Visual Presentation of Team Research Review

• Assignments 2, 3, and 4 are all developed in stages based on the heuristic: proposal, first draft, peer review, revised draft (with “change memo”).
Continuous Assessment by Peers and Instructor

Rhetorical heuristic informs each stage of process:
1. Assignment description
2. In-class exercises
3. Request for proposals (RFPs)
4. Peer review forms
5. Change memos

Proposals, Drafts, and Revised Drafts of successive assignments provide ongoing data for measuring growth by each student in metacognitive understanding and application of rhetorical approach.
Comparative Document Analysis: Sample Topics (Spring 2014)

- Retrotransposons as a source of genetic variations among cells
- Conservation of gorillas in the wild and in captivity
- Curing osteoarthritis through regeneration of chondrocytes
- Epigenetic stress in offspring based on the stress of the parents
- Use of epigenetics in cancer therapy
- Effects of rodent maternal behavior on the glucocorticoid receptors of offspring
- Effects of ecotourism on wildlife
- Relationship between telomere length and cellular aging
Assignment: Popular Science Project

• Individual projects mostly based on topics chosen for Team Research Reviews (TRR)
• Among TRR topics in latest iteration (Summer 13):
  – How, why, and where black holes are created
  – Honeybee colony collapse disorder
  – Radioembolization in treatment of liver cancer
  – Pre- and probiotics and fecal transplants for gut health
  – HIV as transport in gene therapy
  – Exercise regimen for mitochondrial growth
  – Stem cells for *in vitro* meat production
### Popular Science Project

- **Task**: Each student chooses a focus/subject, a major purpose, a primary audience, appropriate language and graphics, and an appropriate genre/medium/venue.

- **Success** depends on understanding and using classical and contemporary rhetorical theory (e.g., Aristotle, Burke, Miller, Turkle, Perrault)
Popular Science Project: Rhetorical Schema

• Earlier assignments and exercises teach students to analyze research journals and journalistic science texts for writers’…
  – purposes
  – audiences
  – types of evidence
  – order of information
  – tone/style
  – and graphic presentation.

• Students use this learned rhetorical schema to create and explain their essays, websites, phone apps, posters, brochures, videos, powerpoints, etc.
A Few Sample Projects...

• T.F. (neurobiology/physiology/behavior major) creates a pamphlet and slide show to help parents of children in UCD autism study understand the goals and methods—and long-term value—of the multi-year research.

• T.C. (microbiology major) creates website, including video narrative clips, to help sufferers from GI infections accept the idea of fecal transplants as a treatment option.

• J.L. and H.D. (aerospace engineering majors) create posters to teach museum goers, from teenagers to adults, basic principles of dark matter and black hole formation.---------->
Sample Projects...

**MYSTERIES OF BLACK HOLES REVEALED**

**HOW BLACK HOLES ARE MADE**
It all begins with a huge cloud of superhot gases and dust called a nebula. This nebula starts to clump together and turns into a star, much bigger than our sun. As this star gets older its gets bigger and bigger and becomes a Red Supergiant star. The Red Supergiant gets so big that it actually explodes! This turns it into a Supernova. If this Supernova is big enough its gravity will be so strong that it will form a black hole. But if it’s a small supernova, the explosion will turn into a neutron star. [Ref. A]

**WHAT THEY DO**
From the minute they are born black holes begin to eat everything in sight. They suck up small stars and asteroids. The more they pull in the bigger they get, and the bigger they get the stronger they get. When black holes get stronger they are able to pull in larger things like solar systems much faster than before. These things are so powerful that they can even suck in light. But it doesn’t stop, they keep going and getting bigger, and are able to eat entire nebulae and even other black holes! [Ref. B]

**WHAT’S INSIDE**
When matter goes inside of a black hole many things happen. Molecules are ripped apart atom by atom. And then they are pulled down the throat of the black hole, which just keeps getting smaller and smaller. The atoms begin to get crammed in together as tight that even the distance from the nucleus and electrons shrunk! Everything is pushed together into a very small ball that is called a singularity. But then what? Can it suck in too much matter? Or could this singularity be a portal to another universe? [Ref. C]

**Reference Materials**
A.R. (biochemistry major, pre-med) writes a personal essay about his care of his immigrant grandfather dying of cancer, and what he learns about diagnosis and doctor-patient relations. He bases his style on that of Atul Gawandi and wants to publish in our annual magazine of undergrad scientific essays.

B.L. (environmental toxicology major), whose team is studying colony collapse disorder, writes an essay for a journal of alternative medicine to promote the varying therapeutic benefits of honeys from diverse plants.
K.H. (animal biology major) rekindles her love of art and blends it with her love of science to create a children’s book on the prognosis for cultured stem-cell meat and its environmental advantages.
Popular Science Project: Impacts on Transfer/Transformation of Learning

• Changes students’ attitudes to the relationship of writing and science—expands appreciation, definitions, and possibilities

• Rhetorical focus pushes students to think of effects of science beyond school, into the future

• Links learning and scholarly expression with multimedia tools of social networking and community building
For further investigation…


More sources...


UC Davis University Writing Program [http://writing.ucdavis.edu](http://writing.ucdavis.edu)

*The Wheel: UC Davis Teaching with Technology Blog*

