Interview with the Golem:
Science as a Language

Jason Goldberg

Opinions about whether cloning and robotics are good or bad can only be informed by asking ourselves what science is. Scientists and educators try to tell us what it is. We learn about it in layers, always latching onto the concept of science being right or wrong. The truth is, with enough study, scientific facts suddenly gain meaning. Speaking and writing as a scientist is a valuable commodity in our society. It sells books, ratings, products, and magazines. Why teach science as a language to bilingual 6^{th} graders is a good question. My hope is that it will interest them and that they will come to like, if not love, the subject. The best way we can do this together is to begin to own some of the language that science speaks. When we start to talk about science, we see that it affects us in many more ways than we originally thought.

Communicating scientific knowledge requires use of special language. Understanding scientific knowledge requires something akin to skill in a second language. This paper considers the role of the scientists, those who own the language, in creating and communicating language. It also addresses the role of the media, those who manipulate the language. And finally, it looks at the role of the public, those who struggle with the language. HIV/AIDS and related issues is an example of science as a second language. The acquisition of this second language of science contains one level of scientific knowledge, the language of facts in science, and one of the nature of science, the language about science. By examining each of these roles and their relation to each other, the reader gains proficiency in a foreign language .

What makes science powerful as a language is its growing impact on daily life. Like the public, some scientists welcome scientific journalism and some are skeptics. Scientists write for the following reasons as listed in Dunwoody: 1. To be inspired by others, 2. To share excitement, experience and ideas, 3. To reach out as academics, 4. To educate the public, thus feeding the scientific enterprise, 6. To gain personal reward, and 7. To face the challenges of telling a good story, clarity and understanding. This list certainly takes some of the mystique out of the language by identifying one or more reasons why scientists want to be understood.

Scientists must question themselves and their supporters when they write. Shortland lists the following questions. Why should anyone be interested in what I've got to say? Why is my subject important? Why am I doing this now? Why should anyone trust me? To sum it up, Allan Bromley states on NPR's "Science Friday" that, "if you can't explain what you're doing and why you're doing it to any intelligent layman, that really means you don't understand it yourself." The same obstacles in communication that face all writers make the scientist seem more human. A special skepticism seems to creep in when dealing with journalists.

In learning science as a second language, both the learned and the learner depend on the media. The following, from La Follette, pp. 189-193, illustrates the importance of the scientist's relationship with the media. The scientist's skepticism arises from a distrust that the story is being represented accurately or fairly. A symbiotic dependence between the scientist and the writer results when the researcher must interpret and explain the technical details to the journalist. By this argument, it would appear that the scientist sets the agenda and that the journalist must stay on the scientist's good side. With the rise of journalists who specialize in science news, this is changing. There is also a difference between the real and the perceived audience for science. With the Internet, anything from the most simple to the most complicated science story is available at the press of a button. A science magazine for affluent college-graduates will not have the same audience as commercial TV that reaches all people.

This has had enriching as well as complicating effects. The entrance of science in common usage has come through linguistic avenues. Scientists use metaphor to make their words more understandable and useful to the public. There are theories about the communication of science and handbooks about how to do so in writing and speaking. They are based in the fact that the public is not versed in the language of science. One linguistic technique that has brought science out of the labs and into our hearts is metaphor. Holten says "metaphor has a creative function in the nascent phase of the scientific imagination." He means that putting science into words is not always easy. Many metaphors are visual, anthropomorphic or come from folklore, like "strange" particles, families of radioactive isotopes, birth and death on the atomic, molecular and cosmic scales.

Scientific vocabulary and imagery are never stabilized, so metaphor is our way of giving them meaning. Unlike the foreign language, science is constantly presenting the world with new technical terms. Metaphor is a way of stabilizing the language. More recent metaphors ring with disintegration, violence and derangement, such as radioactive decay, fission, and negative states (Holten, pp. 234-40). Students enter the classroom for the first time with many metaphors already built in which construct their view of the universe. When they learn new ones, it is like learning a new language. They agree on how to talk about science but not about what science is. When Bucchi talks about metaphor and paradox, two literary terms, he says, they "attempt to link an unknown concept to a more familiar one by comparing them." In learning a second language, there is much dependence on metaphors which relate what is familiar with what is new or unknown. Boundary objects, continues Bucchi, like Big Bang, DNA/Gene are used at different levels providing a common language although they have one meaning in a lab ad and another in a car ad. One can imagine encountering the exact same terms in a scientific journal and in an auto mobile magazine.

The media talk of the "blueprint" for a gene. Though this image can appeal to the lay and professional person alike, it’s accuracy is arguable. A blueprint is a familiar concept for most of the public means a model, skeleton or copy. A blueprint really functions as the plan from which a builder builds. Not so with genes, and the metaphor falls apart rapidly when we apply to the Human Genome Project. That genes code for proteins which fold and interact to form complex systems is the fact. Moreover, genes may interact in such a way as having one missing can turn a healthy human into one suffering a deadly disease. A blueprint does not go far in explaining this knowledge.

The pages of a recent HIV/AIDS magazine, *hivplus*, April/May 2001, illustrate the ramifications of scientific writing in politics, society and public health. AIDS remains controversial with captions such as "In President Bush’s first few months in the White House, his administration sends out conflicting messages about HIV care and also raises the ire of activists." We all have at least a minimal knowledge of the science of HIV/AIDS. According to Di Clemente, this knowledge in adolescents is fairly good, but attitudes and beliefs vary according to geography. The author says, "we need to address and allay the anxiety accompanying ill-founded health beliefs which are based on misconceptions." (p. 229). It is the teachers’ responsibility to make the language of this health science more understandable to the public. If people are not going to be told by their educational institutions and care-givers what is needed, they must find out for themselves. Activists educate themselves based on this fact. One avenue is instruction about communicable diseases in the school curriculum. This is an example of how the press, teachers and students are involved in a language-learning process, a second-language learning, to improve knowledge, attitudes and beliefs.

In the first years of the AIDS crisis, the situation was different. In *The Golem at Large*, "ACTing UP: AIDS cures and lay expertise" (pp. 126-150), uncertainties abound. Historically, when the AIDS virus was first identified, health educators found a great deal of public uncertainty about what caused it and who contracted it. The level of public knowledge and uncertainty had to be identified since ignorance about AIDS would have been deadly. Since the early 1980's , media coverage of AIDS has mirrored the progression of AIDS from minor to major health threat, but it was not always easy to understand. The 11^{th} International AIDS Conference in Vancouver, July 1996 explained reasons why:

- Lack of information about definitions, side effects and cost issues forced assumptions. Lack of context made too many points about two very different aspects, one medical and the other social, about AIDS.
- The relative importance and implications were omitted.
- Visuals of happy, apparently side-effect-free individuals contradicted the narrative.
- Most reports made AIDS sound like a disease that was definitely understood, while real conflict in the community raged on.

AIDS activism changed the face of the practice of science and of the doctor-patient relationship. It did so by taking control of the language and demanding to be heard in the upper realms of politics and public health policy. Activists found their voices on clinical trials and equal partnership with researchers through learning the language of biomedicine. In the case of AIDS, that resolution came through learning the second language. *HIVplus* articles and advertisements abound with terms like "antiretroviral," "protease inhibitors," and "T-cell" demanding a continuing fluency on the part of the reader.

Jonathan Silin, a teacher whose life was touched by HIV/AIDS, writes of language and education (pp. 24-27). Presenting HIV/AIDS as a disease of others fosters a dangerous ignorance. The educator can make students aware that all of use are others in some sense. Categories only confounded educational efforts by creating neat groups like gays, Haitians, women and drug users. The solution: to emphasize specific human practices rather than social labels. Clarifying the errors takes time. Silin experienced the New York City public schools' curriculum on HIV/AIDS (pp. 57-70). He criticizes the objectivity and assumptions made. Students question the sources of their knowledge and seek alternatives. Children's mind are not ordered and HIV/AIDS is not confined to health class. Instead, children find challenges in all subject areas. Likewise, HIV/AIDS blurs teachers' personal as well as professional lives. Children have different competencies now than they did in the past. This issues challenges authority, changes constantly and holds no absolutes. Science literacy is a defense against ignorance.

Scientists and writers made efforts to dismantle the boundaries between science and society (Cooter, p. 241). However, these efforts seemed to have the opposite effect of reinforcing the idea of a division between scientists and the public. In the mid-70's, sociology of science maintained the autonomy and *a*social aspects of science, the very characteristics it was trying to dispel. The public is aware today of many more scientific issues than it used to be through the media. Media science, however, is not the answer to the uncertainty in this second language. Collins, one of the authors of the *Golem*, in an article about certainty in science asks whether the uncertainty is about scientific content or about the nature of the scientific enterprise. Merely raising the amount of knowledge about scientific facts a person has does not necessarily make them more adept at dealing with uncertainty, risk or disagreements, as in the case of well-educated scientists who themselves are unfamiliar with the interactions between science and society. Controversial science is not made any more tenable through knowledge of ordinary science. As educators, we are faced with the task of getting certain key points about basic science across. But this is only part of the picture which fails to address what science is. We need to gain a reflective understanding of science, something a language based model might call fluency. The extent to which science is seen as a producer of certainty and distance from the research front both are forces shaping the public view of science (Collins, pp. 690-693). Learning to imitate scientific language is not the same as incorporating a view of science which can be applied more generally.

There is general agreement on entitlement to information, not on what kind of information, how much and for whom. It is each individual's responsibility to become fluent in another language because of it empowers one to make decisions about science which need to be made by the public, not *for* the public. What scientists said about uncertainties in the AIDS crisis and what the public reads, sees and hears may differ. An effort from both sides to communicate more clearly, and to see science as more a part of society instead apart from society, saves lives.

Implementation

Essential Question: Is scientific language hard to understand because of the science or because of the language?

By learning to express their views about who scientists are and what they do, students will be able to form a basis for all learning of science which is personal, critical and analytical. They will find out what their and their classmates views of science are in a session which incorporates science in the media and they will list which kinds of science news are most important to them. They will also include how they found out about the news and what, if any, misconceptions they have. These misconceptions can be dispelled by other students or by the teacher if we feel it necessary to comment on them at all. Then, by comparing primary sources of science media, on different levels and in different languages, students can learn to discern between writing styles, writers and audiences. They may also see which publications have certain tones to them and what to expect when they see a particular medium or title. Lastly, they will take these preparatory exercises and use them to write their own scientific story, which will differ from a report or lab in its literary focus on appealing to the reader.

The unit will take three weeks to complete, one week for each of the three main parts: 1. Pre-conceptions about science, 2. What is science literacy? And 3. Writing their own account of a science story, in the language of their choice.

New Mexico Standards and Benchmarks

5A. Knowledge of the scientific method will help them identify it in the stories.
5B. Interpretation of data will help them recognize whether scientific work is valid.
6A and 6B. See how other scientists answer scientific questions and try to answer some themselves.
6C and 6D. Verify the truth of the results, choose appropriate methods
6E and 6F. Realize the extent to which technology and scientific methods are used, and find ways to present their new knowledge.
6G and 6H. Science can result in new ways of thinking and living and it can result in disagreements.
11H, I and J. Know the synergy among organisms and the environment.
11K. Impact of nutrition and exercise on personal health.
14A and 14B. Distinguish between natural and artificial and consider technological solutions.
14C and 14D. See how problems are addressed using science and technology.

15A, B and C. See how work settings, social and economic issues impact science.
15D, E, F and G. Consider the role of science in society and the role of society in science.
16A. Analyze environmental risks for personal and social costs.
16D. Substance abuse.

Activities—2 days each

Preconceptions about science

Make a collage about what science is and what scientists do (standard 5). On one side, using words and pictures, make a collage of what science is. On the other, make a collage of what scientists do. Get together with the class and try to determine which side is which. *Making it happen—using prior knowledge, visuals and hands-on*. Brainstorm ideas about what science is and what scientists do (standard 5). The class discusses what scientists are like. Then, groups defend their definitions and post them on the wall

Making it happen—Listening, relaxing, allowing each other not to know, relating to what you already know about science, questioning, looking for overall meaning and taking notes. Speaking, making mistakes, using techniques to be better understood, like repetition, gestures, synonyms, examples, acting, staying on track and repairing errors. Study the life and work of a famous scientist (standard 6). Write 10 facts about a famous scientist. Play 20 questions to guess which scientist they are. *Making it happen—Finding out what the scientist did and what you might learn from their work, what the scientist says, how it relates to what you already know and what might follow, being confident, sharing information, taking notes finding out as much as you can about the topic*.

Science literacy

Write an autobiography in the tone of popular science news (standard 6). Read several accounts of popular science news stories and pick out the styles. Use these stylistic elements to write an autobiography. *Making it happen—Using the reader's interactive process, imitating how scientists write.* Tell an actual science news story from a made-up one (standard 14). Read actual science news from a variety of sources. Decide if a piece of news is scientific or not and explain why. *Making it happen—talking about, discussing and writing about what you've read.* Keep a journal (standard 15). Write down new vocabulary in a journal with practice. Write down new ideas in the journal where they came from. *Making it happen—making your own word bank of scientific terms, using word maps, using various kinds of dictionaries* *(bilingual or scientific), using the new terms in your own context*.

Write a science news story (standards 14 and 15)

Write an Ad or Commercial for science, the practice of science or an innovative product. Given what we've learned in the unit, write a science news story. Write a play, song or poem telling a science news story. *Making it happen—relating lessons to students' lives, avoiding forcing them to speak, read or write if they are uncomfortable, reassuring, making corrections, trying to answer, reinforcing key concepts in a variety of situations and activities, honoring culture, preparing and increasing opportunities for success*.

Applying concepts to HIV/AIDS

Learn about HIV/AIDS. Open up to he students' knowledge, questions and misconceptions about HIV/AIDS followed by questions, answers and group discussion.

Learn how HIV/AIDS work regarding transmission and our immune system. Using a jeopardy format, the class will form a set of questions regarding the nature of HIV/AIDS, transmission, prevention, symptoms, treatments, and stereotypes and play a game in teams in class for correct answers. Determine the effect of HIV/AIDS on students' lives (standard 16). When A friend or family member has HIV/AIDS. (PWA's) People living with HIV/AIDS are people, too. Discover that science is not just about "the facts." Using primary sources and first-hand accounts, students will make a poster about HIV/AIDS.

Assessment and Evaluation

Use a values survey before and after the unit to determine knowledge gained

1. What kind of scientist would you rather be?
2. If you had $2000, what science project could you do?
3. What is your scientific question?
4. What qualities must a scientist have?
5. How do you prefer to learn about science?
6. If you could spend an afternoon with a scientist, who would it be and why?
7. What's your least favorite thing about science?
8. What can you do to change the environment?
9. What kind of technology would you buy if you could?
10. What is your most important personal value? A scientist's? Are

they the same?

Values Voting—order the following from most to least important

1. Knowing scientific facts
2. Getting several different opinions from different sources on an issue
3. money
4. making a technological advance
5. learning about controversies in science
6. doing science following the scientific method
7. a scientist’s own story
8. what TV and the media say about science
9. A crisis in your life
10. A crisis in the environment

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