# Scientific Literacy in the Classroom

**Carol Brewer**
An ActionBioscience.org original interview

**interviewhighlights**

*Fostering scientific literacy empowers students to:*

- *understand the basic concepts in the media and civic policy*
- *improve inquiry and critical thinking skills*
- *make connections about our interaction with the natural world*

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***Literacy encompasses skepticism.***

### What is your definition of scientific literacy?

**Brewer:** For me the definition of scientific literacy is being able to look at an article in a newspaper or in a magazine or listen to commentary on a newscast or on TV and be able to understand what is being talked about and also being able to be skeptical. It's knowing enough about science to be able to judge if the story that you are being told is being told in a fair and accurate way.

***Asking questions is basic to scientific literacy.***

### Does that definition also apply to fostering scientific literacy in the classroom?

**Brewer:** I think it does. One of the most important skills that we can teach our students is how to ask a question, which is really at the root of scientific literacy. They don't have to ask some high fallutin question. Questions such as: why are there more earthworms in this part of the schoolyard than another? Why does this plant grow here and not there? Those are the kinds of questions that you want to get students asking at the very earliest age, and in fact, there is no dumb question. Asking questions is basic to scientific literacy.

## What school projects would you suggest to promote scientific literacy?

***Observation exercises promote inquiry.***

**Brewer:** I get asked to go out to elementary and middle schools all the time to talk with students about science and also about the kind of science I do, which is ecology. And, the first thing I always do is what I call “dink around outside.” Just go outside, sit on the grass, and look around. When you actually get down on your hands and knees and you peer at the ground, you start to see little things going on, like tiny insects and little plants. From that , the questions just follow… I have never not seen that happen. Dink around first, make observations, and then your curiosity is peaked. That is the start of science—at least that is the start of the type of scientific research that I do.

## Are there assessment strategies to evaluate student scientific literacy?

**Brewer:** Assessment is one of those final frontiers in a way, and I get asked that question a lot. Assessment is an interesting process and I like to think of assessment in two ways: there is the kind of assessment that schoolchildren and teachers are most familiar with, where you give a test at the end of a unit and you see how much material somebody remembers.

***Assessment is a map of the process.***

But as a scientist, if you really want to model science, I think assessment is a map of the process. Where did you start? What got you interested in the question? What tools did you bring to bear on figuring out how to do a fair test to answer that question? At the University we might call that an experiment, but what were those tools? How did you use the tools? What kind of evidence did you collect? How did you make sense of the evidence?. Those are all things that somebody can look at through the process of scientific inquiry, and the key here is that you don’t always arrive at the right answer or the best answer the first time you do this. I mean we are here at this meeting of the AIBS, and there are hundreds of biologists here, and I think if you asked every one of them, “What did it take for you to get that fact cited in a textbook?,” they would say that it took thousands of hours and

thousands of dead ends, and a bunch of dinking around to figure out how to best ask the question and collect the evidence.

***It evaluates habits of mind.***

So much of what we can do with in assessment can be in evaluating those habits of mind that people develop to be able to ask questions and figure out on their own how to answer them. I would urge people to look at those habits of mind, and see how people are posing and answering questions. It takes a little longer to do this, but when we assess we are fundamentally connecting all of teaching with student learning, and frankly, that is what it is all about!

I think you have to use lots of different assessment choices. I teach large classes at the University of Montana, where you have to use multiple choice exams, but I also think that it is important to talk to my students and to quiz them verbally to see how they respond and how they are thinking. I think having students create portfolios of their thinking and what they're doing is helpful. Having students write and reflect on what they think they are learning is also an important part of the assessment process. Just as we wouldn't teach in any one way only—I don't think we should assess in one way only.

### Is there a teaching model you recommend that promotes inquiry?

***The 5E model is good methodology.***

**Brewer:** I am firmly rooted in the school of having people learn by doing and that is what the 5E model is all about and it works well. I am sort of embarrassed to say that I made it nearly all of the way through my PhD without knowing much about this model. When I got to Montana, and I started working with teachers to show them how to use their school yards to teach ecology, a second grade teacher asked, "What do you think about inquiry?" And I said, well, what do you mean? I think we learn best by doing, and that is why I think it is so important, at least in my field, to get people outdoors and just stimulate their curiosity about what they see. My "dinking around outdoors" suggestion corresponds to the explorer part of that 5E model.

Sometimes when you set up learning that way, students may

*fosters life-long learning.*

come away with misconceptions. But even as researchers, we sometimes have misconceptions when we don't have all of the data that we need. I think that really models what we need to be doing for developing life-long learning. We need to go out, we need to practice with our hands; we need to see with our eyes and hear with our ears; we really need to use all of our senses to gather information so our intellect is engaged in figuring out what all of that information means. It doesn't stop there because you may have seen things in a different way from someone else. That's when sharing information and coming to a consensus comes in. Everyone can do that.

### Does the biology curriculum as practiced today do enough to improve science literacy?

*Textbooks may not cover relevant current issues.*

**Brewer:** I will go out on a limb on this! I am a professional biologist who does biologic research and teaching for a living. When I started college in the 1970s, I had a textbook that was about three quarters of an inch thick and it weighed about 3 pounds. When I started teaching intro biology in 1993, I had a textbook that must have been 3.5 inches thick and it weighed seven pounds. That book was just a distillation, just a cross cut, through the fact-based knowledge that some publisher thought was important to include. If you look at all of the journals that report on biology, how on earth could we pick a particular subset to say this is what you should know about biology? My biggest concern today, especially with the accountability movement as it is, is that we are picking certain kinds of facts that have a historical tradition and that certainly provide some important foundation for biology understanding, but frequently they may not point to the future. That is really troubling to me as a scientist. As an educator, I am concerned we are implying that if you can do well at a certain level of these fact-based multiple-choice assessments, then you have some sort of mastery of biology. I would argue that it gives the wrong impression about knowledge and about life-long learning.

*Some teachers*

I am troubled by how we are teaching biology today and I am worried about this because of what teachers are telling me on a very regular basis. They say that they are having trouble teaching

***with teaching inquiry.***

about inquiry. They are having trouble giving students the time to ask and answer their own questions because they are studying for a test. That is the opposite of what a life in science is. Many years ago, I read this great anecdote, and I wish I could remember who said it, that we are starting to teach biology almost like teaching a crazy way to play baseball. For the first few years you let children touch the bat and the mitt. Maybe by the time they get to middle school you let them throw the ball back and forth to each other, but you still don't let them play the game. It isn't until graduate school that you let them ask and answer their own questions. That would be like having your first pickup baseball game when you are already in your late 20s! That is a crazy way to teach people baseball, and it is a crazy way to teach people biology.

**The biology that we teach is the same for all students, regardless if they go on to major in the subject. Do you see that as a problem?**

**Brewer:** My colleagues and I at the University of Montana have talked about this a lot. Some students, especially at the freshman level—whether they are adult reentry or students fresh out of high school—come into my intro biology course with a biology major in mind. Others come to the class as non majors. But everybody in that class needs to be excited about the study of life, whether they are eventually going to be apprenticed into the fields of biology, or whether they are going to be captains of industry. In fact, maybe the captains of industry are our most important biology students.

***Non-traditional reading material appeals to all kinds of students.***

Many years ago, I decided that instead of using a very traditional biology textbook—you know the 7 lb variety—I decided I was going to use a totally different approach to teach intro biology, and so I selected a book written by Pulitzer Prize author Edward Wilson titled *Diversity of Life* and that was our textbook. I made it clear to the students that there were going to be concepts in that book that needed to be explored using a traditional textbook or the Web or some other resource to fully understand them. I thought it was important for students to explore Wilson's lovely story line through the history of life and what that means for the biodiversity of our planet. Two weeks into the course, students would ask, "I have read the book, what do we read next?" In ten years of teaching

intro biology, students have never asked after the first two weeks, “I finished the big intro biology textbook, what do we read next?”. My students, whether they were going to become biologists or not, were fascinated by a magical story that is full of discovery and questions yet to be answered vs. something that lives in a textbook like readymade slants, where is your role is a less clear.



**Carol Brewer, Ph.D.**, is Associate Dean of the College of Arts and Sciences and biology professor at University of Montana, Missoula. The core philosophy of my research program is that acquisition of knowledge alone will not be sufficient for improving scientific literacy unless such knowledge is disseminated and applied effectively. This is an important part of the researcher’s role in promoting scientific literacy. Her awards include the 2007 Odum Award from the Ecological Society of America and the 2007 Education Award from the American Institute of Biological Sciences (AIBS). Brewer was interviewed at the 2007 AIBS annual meeting. <http://www.bioed.org/

## learnmore links

**The 5E Model**

Learn more about this approach to teaching science:

- » http://cte.jhu.edu/techacademy/fellows/Ullrich/webquest/mkuindex.html
- » http://www.bscs.org/pdf/bscs5eexecsummary.pdf
- » http://mdk12.org/instruction/curriculum/science/design_sci_model.html

**21st Century Skills: Literacy in the Digital Age**

Help prepare your students for the 21st century by checking out this online guide. It addresses scientific literacy and also other types of literacy such as basic, economic, and multicultural literacy.
http://www.ncrel.org/engauge/skills/skills.htm

**An overview of the National Academy of Science Education Standards**

This informative website offers an overview and a detailed account of the National Science Education Standards (NSES). See also the NSES Correlation Charts on ActionBioscience.org for a quick overview.

» http://www.nap.edu/readingroom/books/nses/overview.html#teaching
» http://www.actionbioscience.org/educators/correlationcharts.html

**Scientific literacy test**

Read Richard Carrier's point-of-view of why we should be literate in science. There are some interesting concepts, including science and faith, and he even provides a "Test of Scientific Literacy" to see where you stand.
http://www.infidels.org/library/modern/richard_carrier/SciLit.html

**Why should you be scientifically literate?**

Find out by reading the article on our website by Robert M. Hazen.
http://www.actionbioscience.org/newfrontiers/hazen.html

**Case studies to teach science**

Check out the article on our website by Clyde Freeman Herreid, who promotes the use of case studies to teach science, maintaining that this method creates interest and promotes thinking.
http://www.actionbioscience.org/education/herreid.html

**Read a Book**

» Berkowitz, A., M. Ford, and C.A. Brewer. 2005. A framework for integrating ecological literacy, civics literacy and environmental citizenship in environmental education. In, Johnson, E.A. and M.J. Mappin (eds.), *Environmental Education or Advocacy: Perspectives of Ecology and Education in Environmental Education.* Cambridge University Press. New York. Pp 227-266.
» Brewer, C.A. 2004. Near Real-Time Assessment of Student Learning and Understanding in Biology Couses . *Bioscience* 54:1034-1039
» *Rethinking Scientific Literacy* by Wolff-Michael Roth and Angela Calabrese Barton, "presents a new perspective on science learning as a tool for improving communities." (Routledge, 2004).

## getinvolved links

**The Foundation for Scientific Literacy**

This website has similar goals as ActionBioscience.org—to spread the word about science. They have informative links and have Stephen Hawking on their advisory

board. They are looking for volunteers, help with projects, sponsors, and more.
http://www.scientificliteracy.org/index.htm

**Parents, help your children**
Check out this website that provides ideas for both parents and students to learn about science.
http://school.discoveryeducation.com/sciencefaircentral/scifairstudio/parents.html

**Parents & Children: online science field trips and more**
TryScience.org provides a database of over 400 science centers worldwide so that kids can "investigate, discover, and try science" themselves. Included are interactive field trips and live webcams of exhibits.
http://www.tryscience.org/fieldtrips/fieldtrip_home.html

**For educators and students: The Science Club**
The club offers science projects and activities for children, as well as a science fair ideas exchange. Includes links to many other science resources.
http://www.scienceclub.org/

**For educators/researchers: science events database**

» **The COPUS Coalition** is a grassroots effort linking universities, scientific societies, science centers and museums, government agencies, advocacy groups, media, educators, businesses, and industry in a peer network having as its goal a greater public understanding of the nature of science and its value to society. The site includes a calendar of events and a resource directory.
http://www.copusproject.org/

» "A free, fully searchable, multi-disciplinary scientific events database" including conferences on zoology conferences, biotechnology, pharmacology, and biotechnology. "Browse events, order brochures, register and purchase proceedings papers online."
http://www.nature.com/nature-events/

**Student Chapters**

» AIBS maintains student chapters to serve the intellectual and professional interests of students in the biological sciences. There's also a student chapter Facebook group. http://www.aibs.org/student-chapters/

» Join the Science National (US) Honors Society or start a society chapter at your high school. http://www.scienceNHS.org