

**National Congress on  
Science Education**

of the

**National Science Teachers  
Association**

**Focus Group  
Resource Guide**

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Minneapolis, MN**



# The National Congress on Science Education 2005 Focus Group Resource Guide

Enclosed is a series of resource materials identified by the NCSE Planning Committee. Please read these papers prior to the meeting and **bring your copy with you to the meeting.**

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# The Challenge of the **Evolution** Debate

Prepared by Steve Rich, Congress Committee and District V Director  
Co-facilitators: Ken Heydrick, Science Teachers Association of Texas and  
Joyce Tugel, NSTA Director, Professional Development

## Overview

How can we stay true to science without offending the belief structures of those on the other side of the evolution debate? Examine varying beliefs and the resources available to design an intelligent response.

## Discussion Questions

1. How can we stay true to science without offending the belief structures of those on the other side of the evolution debate?
2. What are the belief systems of those who oppose the teaching of Evolution?
3. How should science teachers respond to those who believe in "intelligent design"?
4. What further steps should NSTA take to assist teachers & school systems in their response to the same?

## Bibliography

### **Teachers, Scientists Vow to Fight Challenge to Evolution Creationists Seek Curriculum Change; Kan. Education Hearings Open Today**

Washington Post, Thursday, May 5, 2005

By Peter Slevin

<http://www.washingtonpost.com/wp-dyn/content/article/2005/05/04/AR2005050402022.html>

TOPEKA, Kan., May 4 -- Alarmed by proposals to change how evolution is taught, scientists and teachers are mobilizing to fight back, asserting that educational standards are being threatened by what they consider a stealth campaign to return creationism to public schools. This week's battle is focused on Kansas, where State Board of Education hearings begin Thursday on evolution and intelligent design, a carefully marketed theory that challenges accepted understandings of Earth's origins in favor of the idea that a creator played a guiding role....

At the national level, Sen. Rick Santorum (R-Pa.) demonstrated political savvy envied by scientists when he proposed an addition to the No Child Left Behind education bill in 2001: "Where biological evolution is taught, the curriculum should help students to understand why this subject generates so much continuing controversy, and should prepare the students to be informed participants in public discussions." "When it was first introduced, we didn't really understand it. He did it at the eleventh hour, and we didn't know it was coming," said Jodi L. Peterson, legislative director of the National Science Teachers Association. Her group and others mobilized to quash it, but the language remained in the bill's nonbinding conference report.

**Now evolving in biology classes: a testier climate. Some science teachers say they're encountering fresh resistance to the topic of evolution - and it's coming from their students.**

The Christian Science Monitor, May 3, 2005

By G. Jeffrey MacDonald

<http://www.csmonitor.com/2005/0503/p01s04-legn.html?s=hns>

Nearly 30 years of teaching evolution in Kansas has taught Brad Williamson to expect resistance, but even this veteran of the trenches now has his work cut out for him when students raise their hands. That's because critics of Charles Darwin's theory of natural selection are equipping families with books, DVDs, and a list of "10 questions to ask your biology teacher."

The intent is to plant seeds of doubt in the minds of students as to the veracity of Darwin's theory of evolution. The result is a climate that makes biology class tougher to teach. Some teachers say class time is now wasted on questions that are not science-based. Others say the increasingly charged atmosphere has simply forced them to work harder to find ways to skirt controversy...

...an informal survey released in April from the National Science Teachers Association found that 31 percent of the 1,050 respondents said they feel pressure to include "creationism, intelligent design, or other nonscientific alternatives to evolution in their science classroom."

These findings confirm the experience of Gerry Wheeler, the group's executive director, who says that about half the teachers he talks to tell him they feel ideological pressure when they teach evolution. And according to the survey, while 20 percent of the teachers say the pressure comes from parents, 22 percent say it comes primarily from students.

**'Call to arms' on evolution**

By Dan Vergano and Greg Toppo, USA TODAY

March 24, 2005

[http://www.usatoday.com/news/education/2005-03-23-evolution\\_x.htm](http://www.usatoday.com/news/education/2005-03-23-evolution_x.htm)

Nearly one-third of science teachers who participated in a national survey say they feel pressured to include creationism-related ideas in the classroom.

And an alarmed science establishment is striking back in defense of teaching evolution.

"I write to you now because of a growing threat to the teaching of science," National Academy of Sciences chief Bruce Alberts says in a letter to colleagues March 4. He calls on academy members "to confront the increasing challenges to the teaching of evolution in public schools." The nation's top scientists belong to the congressionally chartered academy.

Albert's plea comes as the National Science Teachers Association prepares to release the survey at the group's meeting March 31. "Teachers are under attack all the time and need more support from scientists," he says.

## **Design for Living**

The New York Times, February 7, 2005

Op-Ed Contributor: By Michael J. Behe

<http://query.nytimes.com/gst/abstract.html?res=F70713FD355F0C748CDDAB0894DD404482>

(only abstract...I can provide full article)

Bethlehem, Pa. — IN the wake of the recent lawsuits over the teaching of Darwinian evolution, there has been a rush to debate the merits of the rival theory of intelligent design. As one of the scientists who have proposed design as an explanation for biological systems, I have found widespread confusion about what intelligent design is and what it is not.

First, what it isn't: the theory of intelligent design is not a religiously based idea, even though devout people opposed to the teaching of evolution cite it in their arguments. For example, a critic recently caricatured intelligent design as the belief that if evolution occurred at all it could never be explained by Darwinian natural selection and could only have been directed at every stage by an omniscient creator. That's misleading. Intelligent design proponents do question whether random mutation and natural selection completely explain the deep structure of life. But they do not doubt that evolution occurred. And intelligent design itself says nothing about the religious concept of a creator.

## **'Intelligent Design'**

The New York Times, February 12, 2005

Letter to the Editor: By Bruce Alberts

<http://www.nytimes.com/2005/02/12/opinion/12science.html>

In "Design for Living" (Op-Ed, Feb. 7), Michael J. Behe quoted me, recalling how I discovered that "the chemistry that makes life possible is much more elaborate and sophisticated than anything we students had ever considered" some 40 years ago. Dr. Behe then paraphrases my 1998 remarks that "the entire cell can be viewed as a factory with an elaborate network of interlocking assembly lines, each of which is composed of a set of large protein machines."

That I was unaware of the complexity of living things as a student should not be surprising. In fact, the majestic chemistry of life should be astounding to everyone. But these facts should not be misrepresented as support for the idea that life's molecular complexity is a result of "intelligent design." To the contrary, modern scientific views of the molecular organization of life are entirely consistent with spontaneous variation and natural selection driving a powerful evolutionary process.

## **Evolution Takes A Back Seat In U.S. Classes**

The New York Times, February 1, 2005

By CORNELIA DEAN 1716 words

Late Edition - Final , Section F , Page 1 , Column 1

<http://query.nytimes.com/gst/abstract.html?res=F40A14FE395F0C728CDDAB0894DD404482>

(abstract only, I can provide full article)

Dr. John Frandsen, a retired zoologist, was at a dinner for teachers in Birmingham, Ala., recently when he met a young woman who had just begun work as a biology teacher in a small school district in the state. Their conversation turned to ... "She confided that she simply ignored...

**Doubling Rationalist: 'Intelligent Design' Proponent Phillip Johnson, and How He Came to Be**

Washington Post, Sunday, May 15, 2005

[http://www.washingtonpost.com/wp-dyn/content/article/2005/05/14/AR2005051401222\\_pf.html](http://www.washingtonpost.com/wp-dyn/content/article/2005/05/14/AR2005051401222_pf.html)

"I suppose you think creation is all about unguided material processes, don't you? Well, I don't have the slightest trouble accepting microevolution as the cause behind the adaptation of the peppered moth and the growth of finches' beaks. But I don't see that evolutionists have any cause for jubilation there.



## **NSTA Position Statement**

# **The Teaching of Evolution**

### **Introduction**

The National Science Teachers Association (NSTA) strongly supports the position that evolution is a major unifying concept in science and should be included in the K–12 science education frameworks and curricula. Furthermore, if evolution is not taught, students will not achieve the level of scientific literacy they need. This position is consistent with that of the National Academies, the American Association for the Advancement of Science (AAAS), and many other scientific and educational organizations.

NSTA also recognizes that evolution has not been emphasized in science curricula in a manner commensurate to its importance because of official policies, intimidation of science teachers, the general public's misunderstanding of evolutionary theory, and a century of controversy. In addition, teachers are being pressured to introduce creationism, “creation science,” and other nonscientific views, which are intended to weaken or eliminate the teaching of evolution.

### **Declarations**

#### **Within this context, NSTA recommends that**

- Science curricula, state science standards, and teachers should emphasize evolution in a manner commensurate with its importance as a unifying concept in science and its overall explanatory power.
- Science teachers should not advocate any religious interpretations of nature and should be nonjudgmental about the personal beliefs of students.
- Policy makers and administrators should not mandate policies requiring the teaching of “creation science” or related concepts, such as so-called “intelligent design,” “abrupt appearance,” and “arguments against evolution.” Administrators also should support teachers against pressure to promote nonscientific views or to diminish or eliminate the study of evolution.
- Administrators and school boards should provide support to teachers as they review, adopt, and implement curricula that emphasize evolution. This should include professional development to assist teachers in teaching evolution in a comprehensive and professional manner.

- Parental and community involvement in establishing the goals of science education and the curriculum development process should be encouraged and nurtured in our democratic society. However, the professional responsibility of science teachers and curriculum specialists to provide students with quality science education should not be compromised by censorship, pseudoscience, inconsistencies, faulty scholarship, or unconstitutional mandates.
- Science textbooks shall emphasize evolution as a unifying concept. Publishers should not be required or volunteer to include disclaimers in textbooks that distort or misrepresent the methodology of science and the current body of knowledge concerning the nature and study of evolution.

*--Adopted by the  
NSTA Board of Directors  
July 2003*

**NSTA offers the following background information:**

**The Nature of Science and Scientific Theories**

Science is a method of explaining the natural world. It assumes that anything that can be observed or measured is amenable to scientific investigation. Science also assumes that the universe operates according to regularities that can be discovered and understood through scientific investigations. The testing of various explanations of natural phenomena for their consistency with empirical data is an essential part of the methodology of science. Explanations that are not consistent with empirical evidence or cannot be tested empirically are not a part of science. As a result, explanations of natural phenomena that are not based on evidence but on myths, personal beliefs, religious values, and superstitions are not scientific. Furthermore, because science is limited to explaining natural phenomena through the use of empirical evidence, it cannot provide religious or ultimate explanations.

The most important scientific explanations are called “theories.” In ordinary speech, “theory” is often used to mean “guess” or “hunch,” whereas in scientific terminology, a theory is a set of universal statements that explain some aspect of the natural world. Theories are powerful tools. Scientists seek to develop theories that

- are firmly grounded in and based upon evidence;
- are logically consistent with other well-established principles;
- explain more than rival theories; and
- have the potential to lead to new knowledge.

The body of scientific knowledge changes as new observations and discoveries are made. Theories and other explanations change. New theories emerge, and other theories are modified or discarded. Throughout this process, theories are formulated and tested on the basis of evidence, internal consistency, and their explanatory power.



## Evolution as a Unifying Concept

Evolution in the broadest sense can be defined as the idea that the universe has a history: that change through time has taken place. If we look today at the galaxies, stars, the planet Earth, and the life on planet Earth, we see that things today are different from what they were in the past: galaxies, stars, planets, and life forms have evolved. Biological evolution refers to the scientific theory that living things share ancestors from which they have diverged; it is called “descent with modification.” There is abundant and consistent evidence from astronomy, physics, biochemistry, geochronology, geology, biology, anthropology, and other sciences that evolution has taken place.

As such, evolution is a unifying concept for science. The *National Science Education Standards* recognizes that conceptual schemes such as evolution “unify science disciplines and provide students with powerful ideas to help them understand the natural world” (p. 104) and recommends evolution as one such scheme. In addition, *Benchmarks for Science Literacy* from AAAS’s Project 2061, as well as other national calls for science reform, all name evolution as a unifying concept because of its importance across the disciplines of science. Scientific disciplines with a historical component, such as astronomy, geology, biology, and anthropology, cannot be taught with integrity if evolution is not emphasized.

There is no longer a debate among scientists about whether evolution has taken place. There is considerable debate about how evolution has taken place: What are the processes and mechanisms producing change, and what has happened specifically during the history of the universe? Scientists often disagree about their explanations. In any science, disagreements are subject to rules of evaluation. Scientific conclusions are tested by experiment and observation, and evolution, as with any aspect of theoretical science, is continually open to and subject to experimental and observational testing.

The importance of evolution is summarized as follows in the National Academy of Sciences publication *Teaching about Evolution and the Nature of Science*: “Few other ideas in science have had such a far-reaching impact on our thinking about ourselves and how we relate to the world” (p. 21).

## Creationism and Other Non-Scientific Views

The *National Science Education Standards* note that, “[e]xplanations of how the natural world changes based on myths, personal beliefs, religious values, mystical inspiration, superstition, or authority may be personally useful and socially relevant, but they are not scientific” (p. 201). Because science limits itself to natural explanations and not religious or ultimate ones, science teachers should neither advocate any religious interpretation of nature nor assert that religious interpretations of nature are not possible.

The word “creationism” has many meanings. In its broadest meaning, creationism is the idea that the universe is the consequence of something transcendent. Thus to Christians, Jews, and Muslims, God created; to the Navajo, the Hero Twins created; for Hindu Shaivites, the universe comes to exist as Shiva dances. In a narrower sense, “creationism” has come to mean “special creation”: the doctrine that the universe and all that is in it was created by God in essentially its present form, at one time. The most common variety of special creationism asserts that

- the Earth is very young;
- life was created by God;
- life appeared suddenly;
- kinds of organisms have not changed since the creation; and
- different life forms were designed to function in particular settings.

This version of special creation is derived from a literal interpretation of Biblical Genesis. It is a specific, sectarian religious belief that is not held by all religious people. Many Christians and Jews believe that God created through the process of evolution. Pope John Paul II, for example, issued a statement in 1996 that reiterated the Catholic position that God created and affirmed that the evidence for evolution from many scientific fields is very strong.

“Creation science” is a religious effort to support special creationism through methods of science. Teachers are often pressured to include it or other related nonscientific views such as “abrupt appearance theory,” “initial complexity theory,” “arguments against evolution,” or “intelligent design theory” when they teach evolution. Scientific creationist claims have been discredited by the available scientific evidence. They have no empirical power to explain the natural world and its diverse phenomena. Instead, creationists seek out supposed anomalies among many existing theories and accepted facts. Furthermore, “creation science” claims do not lead to new discoveries of scientific knowledge.

## Legal Issues

Several judicial decisions have ruled on issues associated with the teaching of evolution and the imposition of mandates that “creation science” be taught when evolution is taught. The First Amendment of the Constitution requires that public institutions such as schools be religiously neutral; because “creation science” asserts a specific, sectarian religious view, it cannot be advocated in the public schools.

When Arkansas passed a law requiring “equal time” for “creation science” and evolution, the law was challenged in Federal District Court. Opponents of the bill included the religious leaders of the United Methodist, Episcopalian, Roman Catholic, African Methodist Episcopal, Presbyterian, and Southern Baptist churches, along with several educational organizations. After a full trial, the judge ruled that “creation science” did not qualify as a scientific theory (*McLean v. Arkansas Board of Education*, 529 F. Supp. 1255 [ED Ark. 1982]).

Louisiana's equal time law was challenged in court, and eventually reached the Supreme Court. In *Edwards v. Aguillard* [482 U.S. 578 (1987)], the court determined that “creation science” was inherently a religious idea and to mandate or advocate it in the public schools would be unconstitutional. Other court decisions have upheld the right of a district to require that a teacher teach evolution and not teach “creation science” (*Webster v. New Lennox School District #122*, 917 F.2d 1003 [7th Cir. 1990]; *Pelozo v. Capistrano Unified School District*, 37 F.3d 517 [9th Cir. 1994]).

Some legislators and policy makers continue attempts to distort the teaching of evolution through mandates that would require teachers to teach evolution as “only a theory” or that require a textbook or lesson on evolution to be preceded by a disclaimer. Regardless of the legal status of these mandates, they are bad educational policy. Such policies have the effect of intimidating teachers, which may

result in the de-emphasis or omission of evolution. As a consequence, the public will only be further confused about the nature of scientific theories. Furthermore, if students learn less about evolution, science literacy itself will suffer.

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# EVOLUTION: IS THERE A MISSING LINK?



By Anne  
Tweed, NSTA  
President  
2004–2005

“Almost 80 years after the Scopes trial, the debate over the

teaching of evolution continues to rage. There is no easy resolution—it is a complex topic with profound scientific, religious, educational, and legal implications. How can a student or parent understand this issue, which is such a vital part of (science) education?”

These are the introductory words on the back cover of Eugenie C. Scott’s latest book, *Evolution vs. Creationism* (2004). If you have been reading major newspapers, magazines, and other media, this issue has been featured prominently during recent months. New strategies by anti-evolution groups have complicated the issue. Initially centered around the openly religious ideas of “creationism,” groups are now using more covertly religious-based tactics by advocating for so-called “intelligent design” and “weaknesses of evolution” to be taught alongside evolution in science classrooms.

Did you know that it is illegal for science teachers to teach creation science? Eight major court decisions relate to this issue. Because by law, science teachers cannot advocate religion, schools must not teach as scientific fact or theory any religious doctrine, including “creationism.”

As for intelligent design and other nonscientific based ideas, quite frankly, they just don’t cut it. As science educators, we look to the scientific community to investigate, research, test, validate, and debate science. In a nutshell, “no attempt to discredit the concept of evolution has proved successful.” (Moore 2004)

So was Darwin wrong, as a recent *National Geographic* article (Quammen

2004) asked? Emphatically, the answer is no! So does the theory of evolution contain a missing link? Also emphatically, no! What is missing is the education of students, parents, and policy makers about the theory of evolution and why it is considered a central unifying theme of science.

What are the implications for science teachers? All science teachers—not just biology teachers—need to understand both evolutionary theory and the social issues related to its teaching. To assist teachers, the National Academy of Sciences (NAS) has published three reports that provide needed background information. Descriptions of these reports and a summary of the academy’s efforts to deal with the challenges to teaching evolution are summarized in a recent article in *Cell Biology Education*. (Alberts and Labov 2004)

Teachers need to educate themselves about not only the scientific evidence for the theory of evolution, but also strategies to address the issues that have arisen in our society. In his recent “‘Call to Arms’ on Evolution” article in *USA Today*, NAS President Bruce Alberts notes that members of the academy stand ready to help teachers deal with these issues in their state and school district.

Science teachers need to be prepared to respond clearly to parent and community questions about this issue and help to educate them. Strategically, teachers must take an offensive position and serve as advocates for evolutionary theory. What is “missing” is an adult population that understands the scientific concepts that form the basis for evolution. Most adults were never taught about evolution in school. Clearly, this lack of understanding has resulted in misconceptions about the theory and the scientific evidence that supports it.

In addition to the NAS resources, NSTA offers resources that teachers can provide to parents and policy mak-

ers to clarify the theory and the legal issues related to the teaching of evolution. These can be found at [www.nsta.org/evresources](http://www.nsta.org/evresources), which includes links to the NSTA Press book *Evolution in Perspective* and the association’s position statement on the teaching of evolution. The National Center for Science Education ([www.ncseweb.org](http://www.ncseweb.org)) is also a good source for this information.

One of the most common misconceptions related to this controversy is confusion about the definition of a scientific theory. In common usage, “theory” may be a prediction, hunch, guess, or explanation based on opinion. These “theories” are not, however, the same as scientific theories. A theory in science is not just a hunch!

What is also “missing” is a clear understanding of the terms *fact*, *hypothesis*, *theory*, and *belief*. As a high school biology teacher for almost 30 years, I found it important to provide students with a clear understanding of these terms. I presented students with 25 different statements and then asked them to determine which statements were facts, theories, and hypotheses and which were beliefs. The speed of light, for example, is a scientific fact that can be measured again and again with the same result. A hypothesis is a prediction statement that is based on prior observations that can be tested experimentally. And a scientific theory is a well-substantiated explanation of some aspect of the natural world that can incorporate facts, laws, inferences, and tested hypotheses.

Beliefs, on the other hand, are opinions and do not require any evidence or scientific data. They are based on societal norms, religious teachings, and ethics. Beliefs and actions define a person’s character.

As a teacher, I believe that all students can learn. This belief, while not based entirely on scientific fact, is foundational to my philosophy of education. Students’ religious beliefs similarly do not require evidence to

support them. As a science teacher, I will not challenge a student’s belief system, nor will I allow other students to promote or advocate for their religious beliefs in a science class. It is essential, however, that I teach the science behind the theory of evolution because evolution is the central organizing principle that biologists use to understand the world.

We not only need students to be scientifically astute, we also need the greater population, including parents, school board members, policy makers, and so many others, to understand the nature of science and what it tells us about our world. And whose job is it to educate our society about scientific theories and evolution specifically? Science teachers, of course! So as professional science educators, we must be advocates for science literacy and the teaching of evolution.

And what is my recommendation to administrators, legislators, and reporters? If you want to know about scientific theories, ask a science teacher!

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# *The Challenge of Reviving Elementary Science*

Prepared by Vanessa Westbrook, Congress Committee  
Co-facilitators: Vanessa Westbrook, Past President, Science Teachers Association of Texas and Paul Drummond, President-Elect, Michigan Science Teachers Association

## **Overview**

How should we focus on rebuilding elementary science in schools? Reading and mathematic assessment has strongly influenced what is currently taught in elementary schools. What should be done to insure science is actually being taught at the elementary level?

## **Discussion Questions**

1. How should we focus on rebuilding elementary science in schools? Reading and mathematic assessment has strongly influenced what is currently taught in elementary schools. What should be done to insure science is actually being taught at the elementary level?
2. The following questions are designed to lead the discussion and work of the focus group:
3. What are some consequences for the K-12 science program if elementary science is not in place?
4. What are some ways to support more acquisition of content knowledge for elementary educators?
5. What steps can be taken to encourage more experience-based science instruction in elementary classrooms?
6. What roles should chapters and affiliated groups play in designing and providing professional development for elementary educators?

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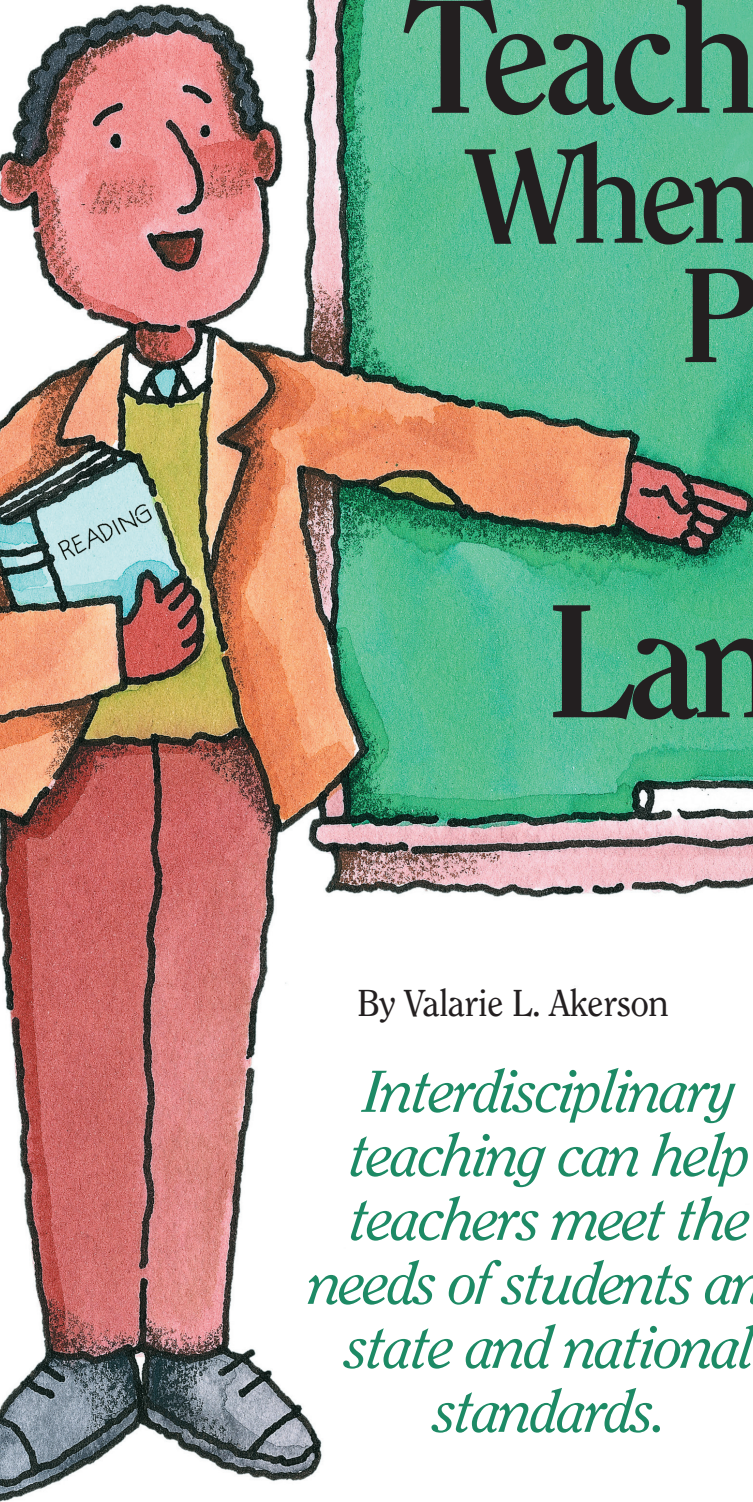
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Highlighting practical teaching methods for preservice and inservice teachers.



# Teaching Science When Your Principal Says “Teach Language Arts”

SHIRLEY V. BECKES

By Valarie L. Akerson

*Interdisciplinary teaching can help teachers meet the needs of students and state and national standards.*

**A**S AN ASSISTANT PROFESSOR OF ELEMENTARY science education, I teach many practicing teachers in graduate courses and teacher institutes. While some elementary teachers may avoid teaching science (Borko 1992; Enochs and Riggs 1990; Smith and Neale 1989), the elementary teachers who take my courses are generally very enthusiastic about teaching science and want to learn strategies to help them become better science teachers. These teachers believe that language arts are important and that science and other important disciplines can be supported by language arts, even with a reciprocal relationship (Akerson and Flanigan 2000; Dickinson, Burns, Hagen, and Locker 1997; Dickinson and Young 1998). Recently, however, several teachers

have commented that principals tell them to focus on language arts and mathematics because those subject areas are being tested. While some teachers may be specifically told *not* to teach science, most are being asked only to *emphasize* language arts. This can make it difficult to satisfactorily meet state and national recommendations that indicate science content should be learned in kindergarten through high school. To help address this problem, teachers are seeking strategies that can help them focus on language arts while continuing to do a good job teaching science.

## Why Use Interdisciplinary Instruction?

How do teachers respond when principals tell them to emphasize language arts? Teachers who are committed to meeting state and national standards of all curricular areas are bound to state the importance of teaching science just to help students meet those science standards. However, there are other important reasons.

First, learning science and language is reciprocal (Casteel and Isom 1994). Proponents claim that learning science can be described as a process similar to learning language, from questioning and setting a purpose to analyzing and drawing conclusions, and reporting/communicating results. Thus, processes of science and literacy learning are similar and may help the development of each discipline if the teacher is explicit in helping students note the similarities. Second, elementary students need to read, write, and communicate about something; science can provide that purpose. Finally, the most pragmatic response may be that science will soon be tested as well (in some locales it already *is* tested), using

the same high-stakes examinations that language arts and mathematics enjoy at this time. Do we really want to start at a disadvantage with science? Using an interdisciplinary strategy can help us meet those state and national science objectives in a way that supports language arts.

Connecting language arts to science makes sense because many elementary teachers' strengths are in language arts (Akerson et al. 2000; Dickinson et al. 1997). Additionally, there are similarities in national reform goals for both science and language arts. Use of language arts to promote literacy and support learning in other content areas is recommended and encouraged by the International Reading Association (IRA) and the National Council of Teachers of English (NCTE). The *Standards for the English Language Arts* recommend that language arts serve the goals of purposeful communication through reading, writing, speaking, and listening (IRA/NCTE 1996). In addition, recent reforms in science education recommend that students communicate ideas through written and oral interactions, which are applications of language arts (National Research Council 1996).

It is possible to use language arts to support science learning and to use science as a purpose for learning language arts. Interdisciplinary teaching can help teachers meet objectives for both language arts and science and still prepare our elementary students for the tests they must take.

## Successful Interdisciplinary Instruction

The following suggestions offer various teacher-tested ways to include science in a language arts curricu-

lum. The subsections range from ideas to consider to specific strategies particularly suited for interdisciplinary science and language arts instruction.

**Choose a Meaningful Theme.** Elementary curricula often follows themes that do not meet both science and language arts objectives. For example, thematic instruction based on topics such as teddy bears or apples may lend itself to language arts instruction using reading and writing, but offer little to focus on with science instruction. A meaningful theme, however, promotes for discussion of big ideas and offers a greater likelihood that science objectives can also be met. For example, common themes from the *National Benchmarks for Science Literacy* (AAAS 1993)—such as systems, models, constancy and change, or scale—enable teachers and students to explore a wide variety of science concepts. Language arts skills can be incorporated in the same way as in the study of other, less scientific themes. Adams and Hamm (1998) recommend that selection of thematic big ideas meet the following criteria:

- the big idea is constant over space and time,
- the big idea broadens students' understanding of the world or what it means to be human,
- the big idea is interdisciplinary,
- the theme relates to the genuine interests of the students,
- and the interdisciplinary work lends itself to student science inquiry.

Using a *Benchmarks*-recommended theme meets those criteria.

For example, teachers in my advanced science methods course used the theme "systems" to explore such topics as electricity, seasons, chemi-



cal and physical reactions, and plant growth. Within this theme teachers learned science content as it related to interactions of components of the system, such as components of plant growth, electrical circuitry, and causes of seasonal changes.

By continually focusing teachers' attention to the theme, they were able to recognize that "systems" is a component of all science content, as recommended in the *Benchmarks*. Additionally, they were able to hone language arts skills through their oral and written discussions of the theme in class discussion and reflection paper writings.

## Developing Science Skills Through Language

**Explore Students' Ideas and Misconceptions.** The language arts are well suited to helping teachers identify student science misconceptions. It has been long recommended that teachers of science seek to know children's ideas about a science concept prior to teaching it, so they can build on those understandings rather than teaching past the student (Driver, Guesne, and Tiberghien 1985). By using language arts skills of speaking, listening, and writing, teachers can identify students' scientific understandings.

Teachers can use class discussions to help identify children's ideas about a science topic. One useful language arts technique that lends itself to this purpose is K-W-L. Because it is more effective to identify student ideas by asking what they "think" about science content than what they "know," I've used a modified model with both elementary and adult students, such as a "T-W-L," where students tell what they *think* about the content,

*By having students write about their understandings, a teacher can track the development of student ideas from misconceptions to better understandings.*

what else they *want* to know, and what they *learned*.

For example, in response to the question, "How do you think electricity works?" both children and adults shared their ideas in a large-group setting, debating their ideas while I observed their thinking on that topic. Both adults and children answered with similar incomplete conceptions prior to instruction, such as "electricity is lightning" or "electricity is power."

I used the same T-W-L technique after students (both adults and children) were asked to light a bulb using a battery and a wire. The T-W-L enabled students to express their views regarding explanations for phenomena. For the most part, both practicing teachers and elementary students tended to believe prior to experimentation that connecting a wire from one end of a battery to the bottom of a bulb would make the bulb light, but after exploring configurations, they recognized the necessity of a complete circuit. Some ideas shared after exploration included, "you need everything in a circle—that makes a circuit so the electricity can flow." Students developed oral-language skills around a shared experience, as well as developed content knowledge, something many language arts methods texts recommend (Rubin 1995; Templeton 1995; Tomkins and Hoskisson 1995; Tway 1991).

Written language can also help

teachers identify students' ideas about a topic and develop profiles of individual student's thinking, particularly through science journals. For example, during a unit on sinking and floating, one elementary student's journal included the following entry, "An anchor keeps a boat floating in the river." When questioned, I found he believed the anchor did not merely hold the boat in place, but held it afloat. Following an activity involving sinkers and toy boats in a tub of water; however, the student's revised entry was, "An anchor holds a boat in place. But why does it keep floating?"

By having students write about their understandings, a teacher can track the development of student ideas from misconceptions to better understandings. The questions that students raise in their journals can also help teachers recognize areas of focus for future instruction (i.e., explore the forces that "keep boats floating").

Another benefit of using writing to elicit student thinking about science concepts is to help students develop their ideas and understand their own thinking. The *National Science Education Standards* (NRC 1996) recommends meaningful written communication of scientific understandings, which could take place in early stages of the writing process, later developing into meaningful reports of scientific investigations.

One way to develop ideas would be

to have students write down observations and inferences during an investigation, such as an investigation exploring magnets. Students could record observations of magnetic items and then make written inferences for why they think certain items are magnetic and others are not. From this simple listing, students could write a formal report based on their scientific investigations of and explanations for magnetism. Students could present the reports orally or make them into books to share with classmates.

## Getting the Most Out of Nonfiction Books

**Share Nonfiction Literature.** Nonfiction children's science literature can be used in various ways in the science classroom. First, teachers can share these books with their students during a read-aloud time (Dickinson, et al. 1997). The teacher can lead discussions during and after the reading related to the scientific accuracy of what is included in the book.

For example, in *The Emperor's Egg* (1999) the reader is left with the idea that penguins "think" as humans do. Similarly, in *Bright Beetle* (2000) the reader is left with the idea that the ladybug purposefully seeks out adventures, rather than responding to its environment as it does in nature. After reading these books, the teacher could discuss these issues with students to address the inaccurate impressions the books present.

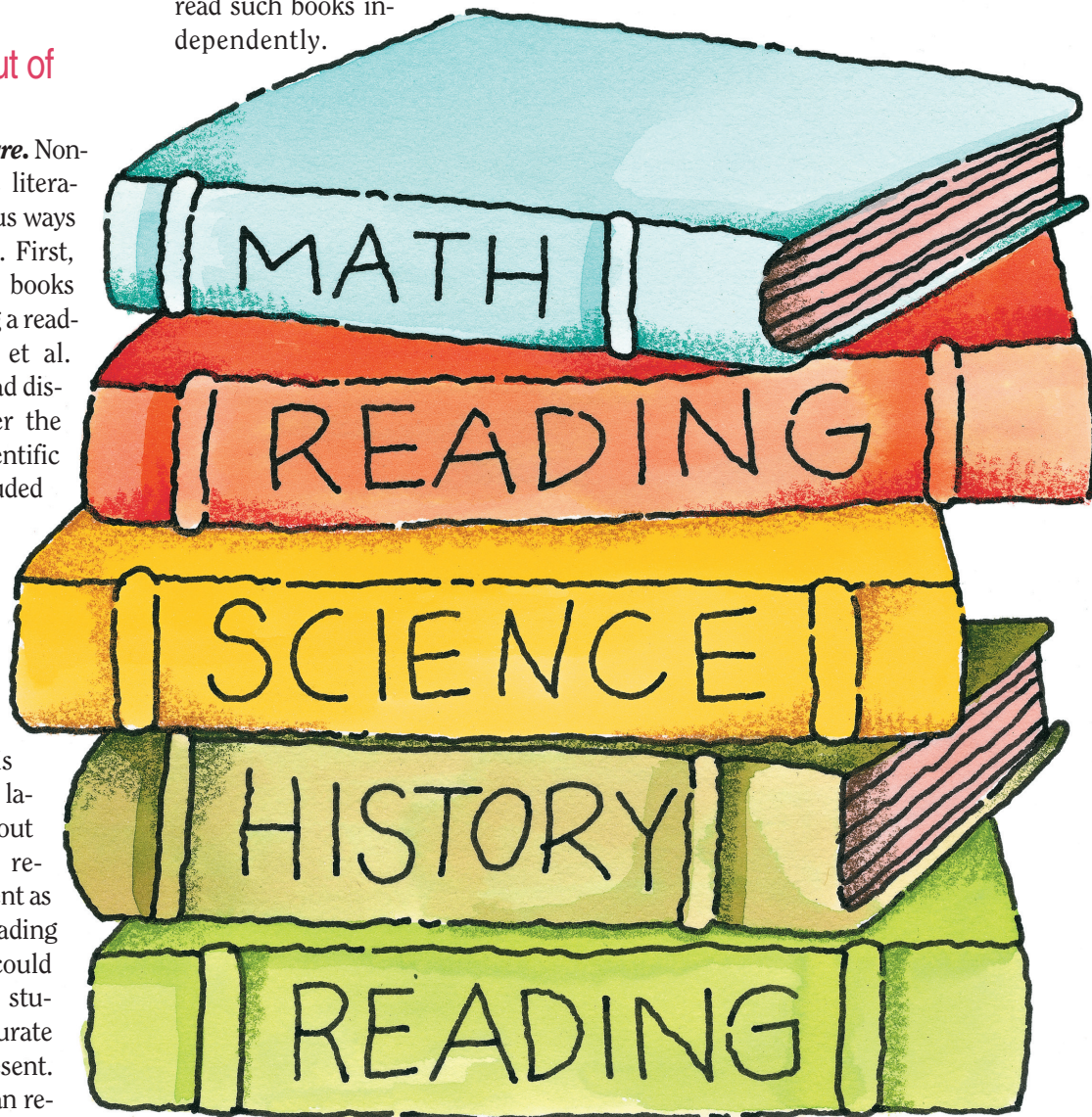
In addition, students can re-

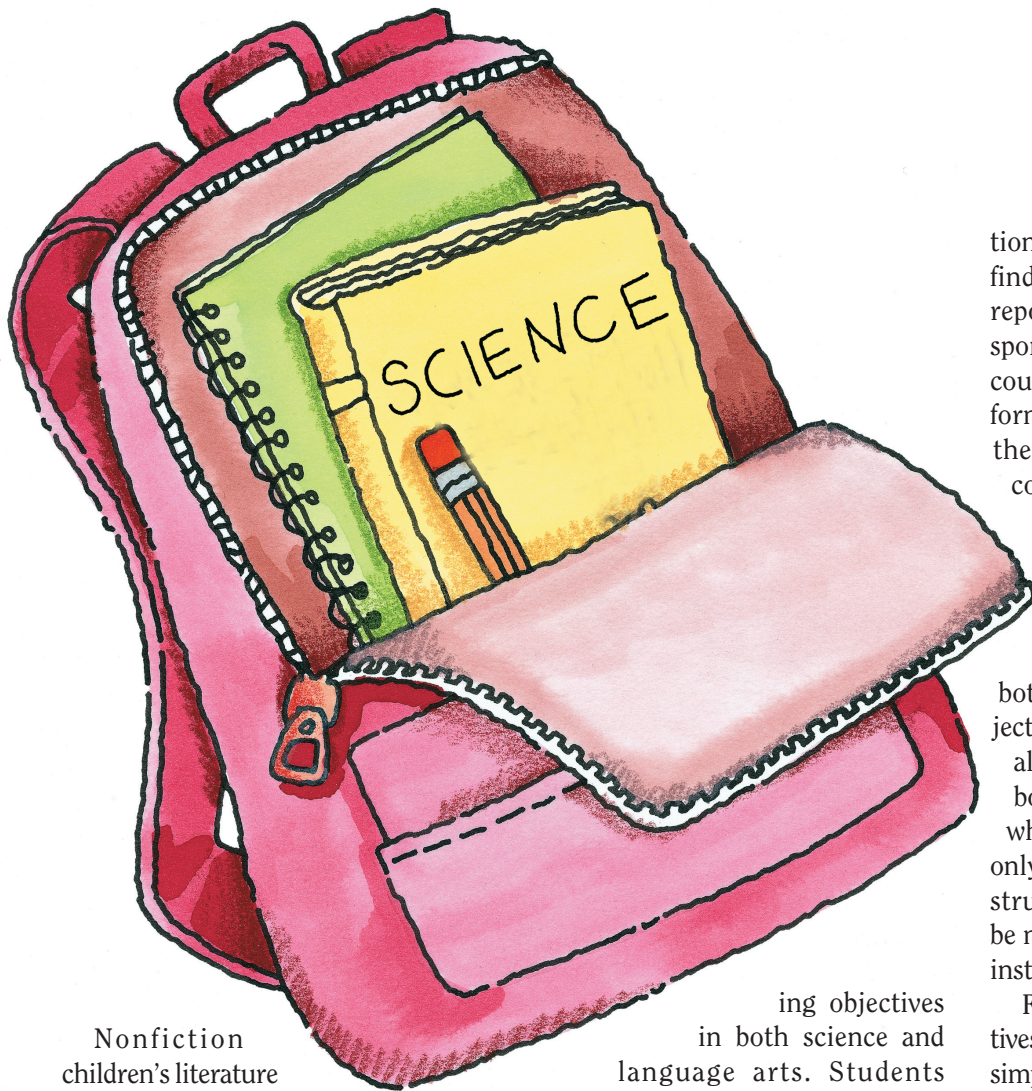
view various nonfiction books from different years, opening the discussion that different "facts" will be in books on the same subject. Students can consider why they think that is the case. Were the writers of earlier books necessarily wrong? Teachers and students can discuss the tentative nature of science, helping students understand that scientific knowledge changes with new investigations and evidence.

Another way to use nonfiction children's literature in the science classroom is to encourage students to read such books independently.

Nonfiction science books can give students background knowledge for future hands-on science investigations. Students can prepare written or oral reports to share the scientific background knowledge they have gathered from nonfiction books.

Students can also read nonfiction biographies about scientists to learn more about what scientists actually do. Reading these biographies can help students understand scientists and perhaps help them recognize that they can become scientists, too.





Nonfiction children's literature can also help teachers develop further understandings of science content (Akerson et al. 2000). As stated earlier, elementary science teachers in particular can be less confident regarding their content knowledge. It would be virtually impossible for any teacher to have thorough understandings of all the many different science concepts. Using children's literature as a means of improving science content knowledge can be a nonintimidating way to explore scientific knowledge.

### Using Available Resources

**Meet Language Arts and Science Objectives.** Educators recommend students experience various information sources including books, magazines, the Internet, field trips, and resource people—to meet learn-

ing objectives in both science and language arts. Students could conduct a scientific inquiry exploration—thus meeting science objectives—after researching background information in resources, which meets language arts objectives. They could meet both disciplines' objectives for meaningful communication through oral discourse regarding science content, as well as written records of their inquiry investigation.

For instance, a teacher in my class who was also taking an advanced language arts methods course conducted an investigation on factors that influence plant growth in my science methods course. From this investigation she learned under which conditions her houseplants grew best (i.e., amount of sunlight, water, and soil pH). She prepared a poster of her investiga-

tion to communicate her ideas and findings. She also wrote a formal report of her investigation in response to a language arts methods course requirement to write an informational report based on an authentic inquiry. Similar projects could be conducted with elementary students.

**Include Disciplinary Instruction.** While it is apparent that interdisciplinary instruction can help meet both language arts and science objectives, interdisciplinary instruction alone is not sufficient for meeting both objectives. There are times when literacy objectives can be met only through explicit literacy instruction, and science objectives can be met only through explicit science instruction.

For example, to meet science objectives, teachers cannot have students simply read, write, and share ideas about concepts. Students must also be actively engaged in inquiry investigations and experimentation. Conversely, a language arts teacher would not want to have students reading, writing, and communicating solely about science concepts. Thus, separate disciplinary instruction in both language arts and science is necessary to meet each disciplines' objectives. The goals and objectives of both science and language arts must be considered and assessed if both disciplines are appropriately addressed in elementary schools and teachers hope to help students meet both the *Standards for the English Language Arts* (IRA/NCTE 1996) and the *National Science Education Standards* (NRC 1996). Interdisciplinary instruction can help meet those objectives, but without explicit disciplinary instruction it is possible—and maybe

even probable—that some disciplinary goals and objectives are lost. Teachers must balance interdisciplinary instruction with disciplinary instruction.

## The Benefits

Science concepts can be explored through literacy in a fashion supported by science and literacy reforms. Although one must balance interdisciplinary with disciplinary instruction, a teacher can often concurrently help students meet both literacy and science objectives with single activities, such as *Benchmarks* (AAAS 1993) and *Standards* (IRA/NCTE 1993) communications objectives with written and oral descriptions of science inquiries. With thoughtful interdisciplinary instruction, teachers will be able to continue to successfully teach science without compromising literacy instruction.

*Valarie L. Akerson is an assistant professor of science education at Washington State University in Richland.*

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*If you have an idea that you think could benefit your fellow teachers in their understanding of science and/or teaching, send your manuscripts to column editor Michael Kotar, Department of Education, California State University, Chico, CA 95929; mkotar@csu.edu.*

# *The Challenge of Supporting First and Second Career New Teachers*

Prepared by John Olson, Congress Committee  
Co-facilitators: John Olson, President, Minnesota Science Teachers Association and  
Bambi Bailey, Faculty Advisor, Midwestern State University Student Chapter

## **Overview**

People become science teachers through many pathways including college graduation, master's programs, and alternative licensure. How do we help them become effective teachers during their early years?

## **Discussion Questions**

1. How are the needs of new teachers different for persons who enter teaching from: traditional college programs, adult learning programs and alternative licensure programs?
2. What preparation should new and second career teachers have to be effective teachers of science? What current programs are effective? What aspects of preparation are lacking?
3. What support should be provided by the science education community to teachers in their early years?

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- First Year 101
- Sink or Swim

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# Everyone Needs a Mentor

*Guiding first-year teachers toward success*

Michael Lach and  
Douglas Goodwin

Mentoring is a complex role that encompasses criticism and praise, pressure and nurturing, logistics, organization, and persistence. While many school districts have specific procedures and objectives for mentoring, the common focus is to provide the best possible experience for first-year teachers. This article offers ways in which mentors can ensure the success of new teachers for years to come.

As mentors, we need to acknowledge the perspectives and mindset of new teachers. In all likelihood, they just completed their education credentials, have tremendous enthusiasm for kids, and are in tune with the latest science content and education pedagogy. New teachers probably haven't written many lesson plans, given many tests, or led many discussions. They aren't familiar with lab equipment and how to use it safely with a group of teenagers. More importantly, they don't have the repertoire of tricks or confidence that comes with years of experience.



However, new science educators offer a fresh perspective on teaching and learning and an enthusiasm untarnished by bureaucracies, difficult students, and parents. Strong science departments and schools provide new teachers with enough support to stand comfortably on their own without zapping the energy that can revitalize a school system. The more we veteran teachers capitalize on the innovations of our new peers, the better we all will perform.

### Before school starts

Mentors should get in touch with new science teachers before the first day of school to fill them in on district and school policies, first-day strategies, classroom structures, and any shared school laboratories or facilities. Mentors can assist new teachers with creating a syllabus, writing a welcome letter to parents, and developing a grading policy that meshes with the district and science department.



Classroom management is often a challenge for new teachers. Before the first day, new teachers must familiarize themselves with the school's discipline practices—procedures for tardiness, detentions and suspensions, and protocols for including parents when resolving classroom issues. Mentors should emphasize that many classroom discipline problems are avoided by having organized classroom operating systems, such as managing laboratory materials, distributing and collecting papers, recording tardy students, and conducting group work. If new teachers thoroughly review discipline policies before school starts, they can concentrate more on science content and process when students arrive.

Setting goals at the beginning of the school year allows new teachers to reflect on their progress as they revisit and revise their strategies throughout the course. Having a clear set of goals on paper is particularly useful because it helps focus energy on important objectives for science students and classrooms.

### An open classroom

Once school begins, new teachers need to observe classrooms taught by veteran teachers. Mentors should invite new teachers into their classrooms and provide objectives for the class and how they will be accomplished. Mentors also can highlight verbal cues used by teachers to keep students focused, or small comments and glances used to build rapport and community within a group. The observing teacher can write down questions that arise. The rationale behind observed actions can be discussed after class. In subsequent observations, new teachers should focus on particular aspects of teaching: how to manage material resources, target activities to multiple ability levels among students, and instruct students to take notes during a class discussion.

Mentors also should observe new teacher classrooms. Peer advice and assistance are valuable development tools for new teachers learning the ropes. New teachers may also benefit from team-taught or team-planned lessons and units.

In schools where materials aren't plentiful, veterans should be generous with lab equipment and office supplies. The department should share resources acquired over the years and include new educators on special orders or deals.

### School and district

Processes and procedures can be overwhelming to someone inexperienced and just out of school. Mentors help ease some of the burden by showing new teachers how to complete progress reports, order materials, reserve space in computer labs, set up field trips, and obtain resources from the library or media center. Mentors also should



Keyword: Mentoring  
at [www.scilinks.org](http://www.scilinks.org)  
Enter code: TST90203

explain how to record attendance and tardies and ways to track phone calls to parents. New teachers should be introduced to the district's science coordinator and made aware of special events, such as districtwide professional development opportunities. Local e-mail lists are crucial for contacts and the chance to converse about science education with other professionals. Opening the school and district to new teachers provides much-needed resources and the comfort of knowing additional help and information is nearby. Introducing new teachers to the benefits of professional education organizations may help them identify potential contact sources when they need help with lesson plans or new trends.

### Community connection

Even if new teachers grew up in the same neighborhood where they teach, they probably haven't looked at it from a scientific perspective. By encouraging new teachers to attend local museums, geological and environmental exhibits, and scientific group meetings in the region, mentors show them that every community has some sort of scientific presence. New teachers also should be encouraged to attend local school government or parent meetings.

### A vision

New teachers need concrete examples of excellent practices. If there is a renowned teacher in the school, for instance, a teacher-of-the-year or one certified by the National Board for Professional Teaching Standards, new science teachers should observe the master in action. The school administration can support such observations by providing release time and class coverage. The aspects of quality teaching unique to science include laboratory activities with diverse groups of students and scientific inquiry. The more observations made of good teaching, the more background new teachers will have in their arsenal and the sharper their focus will be on their future growth.

### Social importance

Given how isolating the teaching profession can be, mentors should reach out to new teachers on a social and personal level. Sitting by them in department and staff meetings, inviting them to the teachers' lounge for lunch or a break, and joining them at conventions or conferences can make a difference. Mentors should inform new teachers of opportunities to get involved with the school, such as chaperoning dances, attending athletic events, and organizing field trips with other classes.

### Easing in

In many schools, classes are apportioned so new teachers receive the most difficult assignments—classes with large numbers of students, younger students, lower-ability students, or more special education students. Because the

first year is so challenging, the most inexperienced faculty members should be assigned to the least difficult classes. This allows the new teacher to ease into the career of teaching by minimizing frustration to ensure a positive attitude about science, students, and the teaching and learning process. Mentors need to advocate the needs of new teachers to department heads and administration—their success will bring success to everyone.

### Focus on implementation

For new teachers, classroom management and lesson planning are activities of immediate concern. Many new teachers have difficulty seeing the connection between a well-behaved class and well-planned instructional activities. Standards-based curricula, such as those produced with support from the National Science Foundation, provide well-written lessons with student materials and equipment kits, allowing new teachers to focus more on implementation and less on curriculum design. They provide the research base and have documented effectiveness that offers a safety net to a novice teacher's first year. New teachers can focus attention on classroom management, interactions with students, and relationships with parents. For those who want to flex their creative muscles, there are plenty of additional resources, ideas, and activities that can be implemented to supplement what's already been developed.

Most teacher preparation programs will instruct new teachers in the appropriate use of state and national science standards (NRC, 1996), yet connecting these to practice is difficult. In conversations with new teachers, it is helpful to concentrate on standards that describe student knowledge and capabilities, particularly when goal setting. This ensures that the focus remains on the academic achievement of students.

The science teacher's first year doesn't have to be a difficult and trying experience. While many factors can influence the effectiveness of a first-year teacher, strong and meaningful support from colleagues can make the difference between a young amateur and a savvy practitioner. By working together, we can make new science educators in our schools more effective and that helps all of us. ~

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# *The Challenge of Bridging the Achievement Gap*

Prepared by Joe Moore, Congress Committee and Past President, AMSE  
Co-facilitators: Bobby Jeanpierre, NSTA Director, Multicultural/Equity in Science  
Education and Deborah O’Gorman, President, Nevada State Science Teachers Association

## **Overview**

In science education an achievement gap exists between various subgroups based upon factors such as gender, race, ethnicity, ESL, and social economic status. What strategies can be used to help reduce these gaps?

## **Discussion Questions**

1. What factors contribute to today’s achievement gap?
2. How do you predict recent immigration trends might affect the achievement gap?
3. How can we shape our curriculum and instruction practices in science to address the achievement gap?
4. What is the role of professional organizations in closing the achievement gap?

# *The Challenge of Assessment in 2007/08*

Prepared by Nancy Bennett, Congress Committee  
Co-facilitators: Nancy Bennett, Past President, New Jersey Science Teachers  
Association and Mary Lightbody, Past President, Science Education Council of Ohio

## **Overview**

For the first time NCLB calls for states to test students in science once a year in each of three grade spans—3–5, 6–9, and 10–12 in 2007/08. How should science teacher organizations shape the response to the challenge?

## **Discussion Questions**

1. How should science teacher organizations shape the response to the challenge of the 2007/08 NCLB science assessment?
2. How should teachers prepare students for state assessments without "throwing out" quality inquiry instruction?

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## Will States Be Ready to Implement Science Assessments by 2007?



By Anne Tweed,  
NSTA President

The gauntlet has been thrown down, and the challenge is on: Will states be ready to implement science assessments in 2007–2008 as required by the No Child Left Behind (NCLB) Act? At this stage, it is a race too close to call.

The Education Commission of the States reports that every state is making progress in writing grade-level standards in science. But when it comes to developing science assessments, five states and the District of Columbia are not even close to meeting the goal, and another seven states are only partially on track to have their assessments ready. The bottom line is that most state departments of education have a long way to go to develop high-quality assessments that are aligned with challenging state standards.

What does this mean for elementary teachers who teach mathematics, reading and writing, *and* science? Before we consider assessments, we must look at this issue: First and foremost, students need to be given the opportunity to learn science at all grade levels. This sounds simple, but it hasn't been happening: Elementary teachers have largely focused instruction on math and reading in the effort to meet current assessment targets. A recent report prepared by Horizon Research, Inc., states that students are averaging only about 25 minutes of science a day in a self-contained elementary classroom. A logical response by school districts preparing for the science assessments is to first make certain that science is being taught.

To ensure that science is being taught, many districts are employing science specialists. A specialist with a science background can plan and present inquiry lessons that align with the grade-level expectations, as well as plan and work with the classroom teacher to provide more science in the regular classroom.

Another way of ensuring that science is being taught is to use science as the integrating context for learning math and language arts. This strategy has proven successful in El Centro, California, and is being adopted by other districts as well.

It takes time for students to understand science concepts and learn problem-solving skills. Teachers also need time: time for planning high-quality science lessons, as well as time for students to make sense of their learning. Ultimately, these goals can best be accomplished by teachers who are as prepared and qualified to teach science as they are to teach reading.

Taking this a step further, what is really needed in many districts is an integrated approach to literacy and science. After all, science standards and assessments require students to be good readers and writers: How many times are students asked to describe, compare, explain, analyze, and evaluate what they have studied? Students need to be sufficiently literate to demonstrate their understanding of science concepts.

Furthermore, *all* science teachers should know how to integrate literacy and science, not just elementary teachers. Large-scale state assessments frequently contain nonfiction readings in science, and students are asked to state the main ideas of these readings and to infer from what they have read. Helping students strengthen these skills can result in improved performance on science *and* reading assessments.

Developing large-scale state assessments that measure both science knowledge and science understanding can be challenging even for assessment specialists. And teachers are not trained to design and develop valid and reliable assessment instruments that can give students practice for the 2007 tests. What teachers *can* do is provide students with opportunities to design and conduct their own experiments, which will help them become better problem solvers. They also will gain

experience with analyzing data in charts and graphs and making inferences from the results.

The jury is still out on the question of what makes a good science assessment. What is certain is that teachers can provide students with learning experiences that focus on rigorous, meaningful content. They can challenge students to learn science concepts in depth and help them do it in ways that enable students to understand what they are learning. And they can ensure that the classroom environment is one in which all students can learn.

In preparation for the upcoming NCLB-mandated science assessments, the NSTA area and national conventions have included strands on assessment. These professional development opportunities will support teachers as they prepare for science assessments.

Teachers are already doing a terrific job teaching accurate science content. Now they must prepare students to demonstrate both science knowledge and conceptual understanding on state-level assessments. Clearly, planning plus preparation will yield a positive outcome, which is what we all want!

To find out more about the connections between science and literacy, check out the new NSTA Press® title *Crossing Borders in Literacy and Science Instruction* (see <http://store.nsta.org>). ●

# *The Challenge of Using **Research** to Inform Instruction*

Prepared by Becky Litherland, Congress Committee and District XI Director  
Co-facilitators: Melody Orban, Association Contact, Wisconsin Elementary and Middle Level and Science Teachers Association

## **Overview**

NSTA has a strategic goal to enhance science education through research-based policy and practice. How can teachers of science access and use education research to inform instructional practices?

## **Discussion Questions**

1. In what ways are teachers currently accessing/participating in educational research to inform instructional practices?
2. What are barriers for teachers getting access to and implementing research – based instructional practices?
3. What are some ways the information could be made available to teachers that would promote a better connection between the research and classroom practices?
4. What are some ways the state and national professional organizations could assist in connecting research-based practices with policy makers and classroom teachers?

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3. "How People Learn Brain, Mind, Experience, and School", NRC, John D. Bransford, Ann L. Brown, and Rodney R. Cocking, editors, National Academy Press, 2000.
4. "Scientific Research in Education", NRC, Richard Shavelson and Lisa Towne, (Ed's), National Academy Press, 2002.
5. "A Policymaker's Primer on Education Research How to Understand, Evaluate and Use It" from McCrel. There are 4 "chapters".
  - "How Do I Know What the Research Says?"
  - "How Do I Know if the Research is Trustworthy?"
  - "Appendix A: A Research Typology"
  - "Appendix B: NRC's Principals of Scientific Research in Education"

It also includes a Research Utility Assessment Guide that can be printed off or used online to evaluate research. All of these documents are found at  
[www.ecs.org/html/educationissues/research/primer/researchsays.asp](http://www.ecs.org/html/educationissues/research/primer/researchsays.asp)