WORKSHOP ON TEACHING EVOLUTION IN NEW MEXICO

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New Mexicans for Science & Reason (NMSR) and the Coalition for Excellence in Science and Math Education (CESE) co-hosted a workshop with representatives from the Public Education Department (PED), former state education officials, teachers and professors on "**How Will New Mexico's New Science Standards Affect the Teaching of Evolution?**" This workshop was held on Wednesday, April 14th, 2004, from 7 to 9 PM in the UNM Law Building (1117 Stanford NE, Room 2402). Here follows summaries of workshop presentations.

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Dr. Steve Sanchez, former SDE Staff, on "Goals of the standards: Producing scientifically literate students"

April 14, 2004

In August 2003, the former President of the State Board of Education, Dell Archuleta, requested that staff from Curriculum, Instruction, and Learning Technologies (CILT) prepare a briefing on the development of the Science Standards for State Board of Education (SBE) to consider adoption of the revised Science Standards. A copy of this briefing is provided to the participants of the August 14, 2004, Coalition for Excellence in Science and Math Education (CESE) and New Mexicans for Science and Reason (NMSR) seminar.

I hope that this information assists you in developing a better understanding of the development of the current New Mexico Science Content Standards, Benchmarks, and Performance Standards.

Steven A. Sánchez, Ph.D.

Former Assistant Superintendent for Learning Services and

Director of Curriculum, Instruction, and Learning Technologies

New Mexico Department of Public Education

I. Process

In June 2002, the SBE directed CILT staff to begin the revision of the existing science content standards, to better define the expectations for learning in science. The Department implemented the SBE approved Standards Revision Process (Attachment A) that emerged from the development of the Language Arts, Social Studies, and Mathematics content standards. The writing and review process engaged educators, scientists, university faculty members, business partners, representatives from public and private organizations, and community members from throughout the state.

The Department researched state and national standards and convened a small group of five experts, composed of educators and scientists, who suggested a three-strand framework that included: Scientific Thinking and Practice; Content of Science; and Science and Society. Following the development of this framework, writing teams composed of primary and secondary science teachers, academics, and science professionals developed the first draft of the science content standards, benchmarks, and performance standards. The writing team took six months to complete their task.

The resulting draft was reviewed through a community "Mega Review," conducted by 35 representatives from organizations throughout the state. Based on feedback from this review, a field draft was prepared by CILT staff members and distributed statewide to all educators and the public at large. During the formal comment period, approximately 200 responses via letters, e-mails, web survey responses, and telephone calls from 24 New Mexico communities were reviewed. Thirty-three percent of the responses were from teachers, 24% from community members, 20% from parents, 4% from administrators, and 18% from other respondents. The responses were categorized in three areas: those in general agreement with the standards, those providing suggestions for changes, and those stating distinct positions or opinions. In addition, the Education Standards Commission was briefed on three occasions during the standards development process.

II. Additional comments and reviews

CILT staff received reviews of the draft standards from New Mexico organizations, including the New Mexico Intelligent Design Network, the Coalition for Excellence in Science Education, and the New Mexico Academy of Science. Dr. Lawrence Lerner, who has reviewed state science standards over the past six years for the Fordham Foundation, stated, "This draft is one of the finest I have read in the course of six years of reviewing science standards . . . . They compare well with, and in some ways surpass, the very best standards adapted to date . . . . They should be adopted pretty much as they stand, so the people of New Mexico can be proud of their science standards." The Fordham Foundation initially gave New Mexico's science standards an "F" grade in 1998, and after some improvements were made in 1999, they received a "C". Dr. Lerner noted that he would give the current draft New Mexico science standards an "A".

CILT staff and the writing teams considered carefully all public comments when refining the working draft.

III. Issues

Several issues and concerns emerged during the development of the standards. These issues are summarized below with explanations of their resolution in the final draft.

Language:

Several comments were received relating to the use of specific language.

The language of the standards differs from the language of curricula, as well as from common usage. For example, it is understood that in the standards the terms 'know' and 'understand' are intended to be developmentally appropriate at specific grade levels. In addition, like many other technical terms, the word 'theory' in science is reserved for an accepted collection of ideas, explanations, and testable hypotheses as opposed to the usage in common English, which implies significant doubt. Scientific members of the writing team assisted staff in understanding and thoroughly researching the distinction in the use of words in scientific discourse. All language is intentional and was carefully examined by professional scientists to ensure that the concepts and skills are accurately presented and appropriate for building sound instructional programs.

Coherence and articulation:

Several comments were received related to the omission of certain concepts from specific grades or from specific strands, when these concepts were present elsewhere in the standards.

The standards represent essential K-12 concepts and skills that, as a coherent body of knowledge of scientific understanding, all students are expected to know to become scientifically literate. Schools and districts use the standards to develop local curricula. For example, the high schools strands are not courses; rather, they provide guidance for the development of an array of courses to meet the learning needs of students.

The standards form a spiraling network of concepts, principles, and skills. It is implicit that once an important concept is introduced, it continues to be developed and need not be repeated in the standards at each grade level. Essential ideas are developed over time from simpler, coherent ideas that build upon one another. Instructional design weaves the standards together both horizontally and vertically. For example, Strand I: Scientific Thinking and Practice should be interwoven with content standards in curricula to ensure that content is learned in the context of scientific thinking and practice.

Transitions from K-4 through 5-8 to 9-12:

Comments were received related to which topics should be taught at particular grades.

Some comments reflected a misunderstanding of the difference between standards and curriculum, and other comments related to the transitions from elementary through middle to high school. The K-4 and grade 5 standards form a solid general foundation. In grades 6 through 8, the standards begin to transition from a general to a more focused understanding in grades 9-12 of specific disciplines (i.e., life science, physical science, earth and space science). For example, in grade 6, curriculum can focus on the earth and space sciences, in grade 7 on the life sciences, and in grade 8 on the physical sciences. At the same time, the standards maintain an opportunity for a continued general approach in grades 6 through 8 for those schools that prefer that option.

Standards-based learning:

Several comments raised a concern regarding the number of performance standards and the degree to which students can accomplish the amount of material contained in the standards.

The performance standards are not intended to be taught as a checklist of disconnected facts or concepts. Rather, the benchmarks summarize what students need to understand and be able to do, and the performance standards elaborate those expectations by grade level. As criterion referenced tests (CRTs) are developed that accurately measure the proficiency level of the students against the standards, instructional strategies can be adjusted to meets the needs of the students.

In implementing standards, teachers are guided by the needs of the learner, and curriculum becomes a coherent system that connects teaching, learning, and assessment to the standards. The nature of this system (standards-based learning) uses standards that focus on the most essential things students need to know in-depth ('power standards') with an aligned system of teaching and learning activities to meet diverse student needs. When viewed as a system, the performance standards are not excessive.

Evolution and Scientific Inquiry:

Several comments raised concerns about the evolution of species, the age of the earth, and the nature of scientific inquiry in those contexts.

In preparing the draft document the writing team based its treatment of biological evolution on the following principles:

· Evolution is the accepted scientific theory of the history and development of life on Earth.

· Science is only one approach to knowledge, with limitations as well as strengths.

· The standards convey accepted scientific principles.

· Students should have opportunities to understand mainstream, peer-reviewed, scientific theories.

· No license can be given to allow teaching that imposes a religious belief in the classroom.

While many individuals praised the standards and offered constructive suggestions during the field review, some expressed strong criticisms that focused principally on the 9-12 life-science performance standards in the area of biological evolution and related performance standards in the 9-12 "Scientific Thinking" and "Science and Society" strands. The following statements characterize the general nature of the comments received in this area:

> *"Evolution is a proven fact; don't describe it with wishy-washy language, just say it's a fact."*
>
> *"Evolution is false. Darwin was wrong."*
>
> *"These standards will teach our children that they are just another species, without special dignity."*
>
> *"Evolution in the standards conflicts with our children's religious beliefs."*

"These standards open the door to creationism and Intelligent Design, which are religion, not science."

"Intelligent Design is the truth; please give it equal time."

"Allowing Intelligent Design or other forms of religiously motivated pseudoscience into the standards is unconstitutional."

In addition to these comments from individuals, staff received comments from representatives of organizations, including the New Mexico Council of Churches and a 1999 letter from Archbishop of Santa Fe Michael Sheehan. Archbishop Sheehan stated,

I don't believe there is any real contradiction between the theory of evolution and the creation of the world by God. The Church has no problem accepting the theory of evolution provided that it is understood that God infuses a human soul at a certain point in the evolutionary process and that in fact God is the force behind the evolution process.

CILT staff carefully considered all these perspectives and studied references when provided. Based on these careful considerations, CILT staff remained confident that the final draft represents the best approach for all children of New Mexico, for the following reasons:

Evolution: Evolution is the accepted scientific explanation for the diversity of life on Earth, and Life Science cannot be taught coherently without the accepted theory of evolution. Modern evolutionary theory has grown far beyond what was proposed by Darwin. To his "natural selection," science has now added mechanisms such as genetic drift, punctuated equilibrium, and sexual selection. These additions have strengthened the theory of evolution, not cast doubt on it. Science has no accepted explanation for how life first arose on Earth, or for how some of life's widespread molecular machinery arose, but this does not diminish the importance of evolution in describing how life has developed during the past 3.5 billion years and in unifying man's understanding of the living world today.

Intelligent Design: Members of the Intelligent Design Network participated in the writing teams, were present at the "Mega Review," were active in the public review, met with staff, and provided valued contributions in all steps of the process. In the final steps of the process, their concerns centered largely on the nature of scientific inquiry and biological evolution. Their issues and concerns were carefully considered to ensure that the NM standards are of the highest quality. However, in-depth analysis reveals that Intelligent Design is not science in that it has posed no testable hypotheses, have not tested their hypotheses, have not submitted such tests for mainstream scientific peer review, and have not gained acceptance in the mainstream scientific community.

Religion: People in New Mexico hold many religious beliefs about the origins of life and Earth, and the special dignity and responsibilities of man. Children of all religious beliefs can feel comfortable with their religious beliefs in public schools guided by these standards. The 9-12 Strand I and Strand III describe the limitations of scientific knowledge and scientific content as well as its strengths and accomplishments. Students of all backgrounds will thereby appreciate that people have different ways of knowing things, and that the scientific approach is only one of those ways-a way that has been very successful in bringing logic and observation to the discovery of how things work, but a way that is always subject to revision. For example, in Science and Society grades 9-12, the standards state,

"Understand that reasonable people may disagree about some issues that are of interest to both science and religion (e.g. the origin of life on Earth, the cause of the "Big Bang," the future of the Earth), and "Identify important questions that science cannot answer (e.g., questions that are beyond today's science, decisions that science can only help to make, questions that are inherently outside the realm of science).

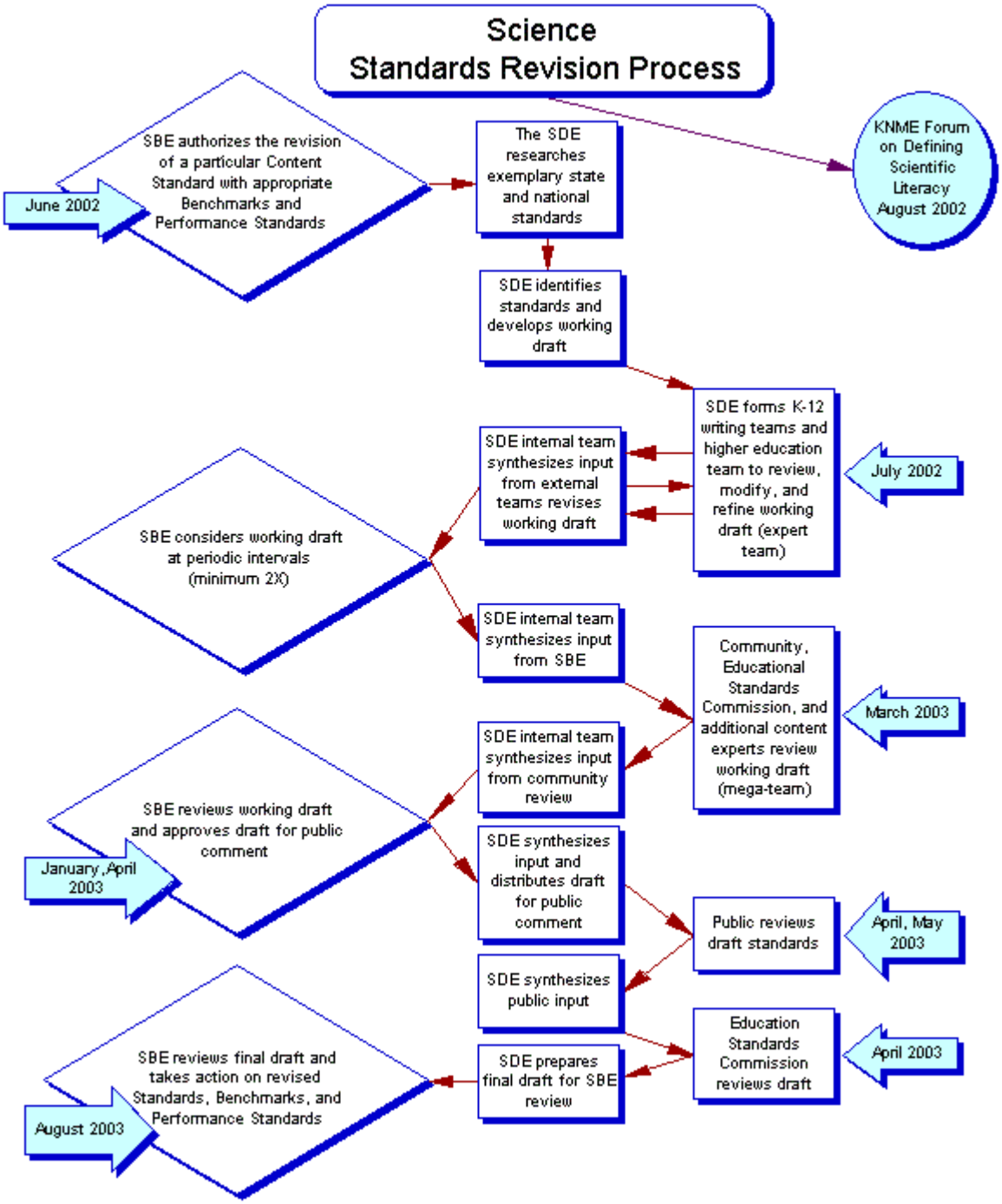
By learning about the strengths and limitations of science, students will be better educated and better prepared to integrate science appropriately into the complexities of their own adult lives as parents, citizens, and workers.

Dignity of man: CILT staff saw no merit whatsoever in the argument that these standards teach that man has no special dignity. The very existence of language, science, music, arts, social studies, mathematics, etc. demonstrates without a doubt that man has special dignity and a special role among the creatures living on Earth. In Science and Society grades 9-12, for example, the standards state, "Know that science plays a role in many different kinds of careers and activities (e.g., public service, volunteers, public office holders, researchers, teachers, doctors, nurses, technicians, farmers, ranchers)."

Legal considerations: The New Mexico Constitution is particularly clear about the separation of church and state:

> *"Article II, section 11: Every man shall be free to worship God according to the dictates of his own conscience . . . . No person shall be required to attend any place of worship or support any religious sect or denomination; nor shall any preference be given by law to any religious denomination or mode of worship." [Emphasis added]*

Courts throughout the country, including the U.S. Supreme Court, have repeatedly found "Creation Science" and "Intelligent Design" to be religion, not science. Hence, it cannot be taught in New Mexico public schools. Deceptive statements by creation-science advocates about an amendment introduced by Senator Santorum into the *No Child Left Behind Act* (NCLB), an amendment that was quickly removed from the Act by other Senators, do not change this fact.


Science
Standards Revision Process
SBE authorizes the revision of a particular Content Standard with appropriate Benchmarks and Performance Standards
June 2002
The SDE researches exemplary state and national standards
KNME Forum on Defining Scientific Literacy August 2002
SDE identifies standards and develops working draft
SDE forms K-12 writing teams and higher education team to review, modify, and refine working draft (expert team)
July 2002
SDE internal team synthesizes input from external teams revises working draft
SBE considers working draft at periodic intervals (minimum 2X)
SDE internal team synthesizes input from SBE
Community, Educational Standards Commission, and additional content experts review working draft (mega-team)
March 2003
SDE internal team synthesizes input from community review
SBE reviews working draft and approves draft for public comment
January ,April 2003
SDE synthesizes input and distributes draft for public comment
Public reviews draft standards
April, May 2003
SDE synthesizes public input
Education Standards Commission reviews draft
April 2003
SBE reviews final draft and takes action on revised Standards, Benchmarks, and Performance Standards
August 2003
SDE prepares final draft for SBE review

Prof. Tim Moy, UNM, on
"Evolution and the university curriculum"

Timothy Moy, history of science professor at UNM, spoke on "Evolution and the university curriculum." Actually, Prof. Moy said, the university does not have any set "curriculum." There's no agreement on, for example, what to teach in history. There is the expectation, however, that incoming students will have a framework of understanding that will help them come to new knowledge. An essential part of scientific literacy, Tim said, is our understanding of nature. The Copernican insight, Newton's work, atomic theory, electromagnetism and light, cells, germs, and DNA are all part of a basic framework of understanding of the natural sciences. And biological evolution, and the role of natural selection, are an important part of that framework. Beyond the purely scientific side of things, he said, the story of evolution is an amazing human drama loaded with sex, violence and death. It's important to recognize the nature of science, and not just the content of science. If a student coming to study science in college had no knowledge of the theory of evolution, that would be like a history major having no knowledge of the Nazis, or having the view that the Holocaust never happened. They don't get a large number of Holocaust deniers at UNM, Prof. Moy said, but it's hard to imagine how someone who holds that view could ever become a history professional. Tim concluded that university students who have no knowledge of evolution or who think it's a "controversy" will simply be unprepared to deal with the essence of science - consensus building, ongoing testing, and so forth.

Dr. Richard J. Reif, Public Education Department (PED), on "Teaching Evolution in New Mexico"

April 14, 2002

K-4 Benchmark II: Know that living things have similarities and differences and that living things change over time.

o Performance standards that follow this benchmark include:

o 3.2 Know that some kinds of organisms that once lived on Earth have become extinct (e.g., dinosaurs) and that others resemble those that are alive today (e.g., alligators, sharks).

o 4.2 Know that a change in physical structure or behavior can improve an organism's chance of survival.

o 4.3 Describe how some living organisms have developed characteristics from generation to generation to improve chances of survival.

5-8 Benchmark II: Understand how traits are passed from one generation to the next and how species evolve.

o Performance standards that follow this benchmark include:

o 6.1 Understand that the fossil record provides data for how living organisms have evolved.

o 7.7 Describe how typical traits may change from generation to generation due to environmental influences.

o 7.8 Explain that diversity within a species is developed by gradual changes over many generations.

o 7.9 Know that organisms can acquire unique characteristics through naturally occurring genetic variations.

o 7.10 Identify adaptations that favor the survival of organisms in their environments.

5-8 Benchmark II: Understand how traits are passed from one generation to the next and how species evolve.

o Performance standards that follow this benchmark include:

o 7.11 Understand the process of natural selection.

o 7.12 Explain how species adapt to changes in the environment or become extinct and that extinction of species is common in the history of living things.

o 7.13 Know that the fossil record documents the appearance, diversification, and extinction of many life forms.

9-12 Benchmark I: Understand how the survival of species depends on biodiversity and on complex interactions, including the cycling of matter and the flow of energy.

o 9-12.9 Understand variation within and among species, including:

- o mutations and genetic drift
- o factors affecting the survival of an organism
- o natural selection

9-12 Benchmark II: Understand the genetic basis for inheritance and the basic concepts of biological evolution.

o 9-12.8 Describe the evidence for the first appearance of life on Earth as one-celled organisms, over 3.5 billion years ago, and for the later appearance of a diversity of multicellular organisms over millions of years.

o 9.12.9 Critically analyze the data and observations supporting the conclusion that the species living on Earth today are related by descent from the ancestral one-celled organisms.

o 9-12.10 Understand the data, observations, and logic supporting the conclusion that species today evolved from earlier, distinctly different species, originating from the ancestral one-celled organisms.

9-12 Benchmark II: Understand the genetic basis for inheritance and the basic concepts of biological evolution.

o 9-12.11 Understand that evolution is a consequence of many factors, including the ability of organisms to reproduce, genetic variability, the effect of limited resources, and natural selection.

o 9-12.12 Explain how natural selection favors individuals who are better able to survive, reproduce, and leave offspring.

o 9-12.13 Analyze how evolution by natural selection and other mechanisms explains many phenomena including the fossil record of ancient life forms and similarities (both physical and molecular) among different species.

9-12 Benchmark I: Examine the scientific theories of the origin, structure, contents, and evolution of the solar system and the universe, and their interconnections.

o Performance standards that follow this benchmark include:

o 9-12.4 Describe the key observations that led to the acceptance of the Big Bang theory and that the age of the universe is over 10 billion years.

9-12 Benchmark II: Examine the scientific theories of the origin, structure, energy, and evolution of the Earth and its atmosphere, and their interconnections.

o Performance standards that follow this benchmark include:

o 9-12.4 Understand the changes in Earth's past and the investigative methods used to determine geologic time, including:

o rock sequences, relative dating, fossil correlation, and radiometric dating

o geologic time scales, historic changes in life forms, and the evidence for absolute ages.

9-12 Benchmark I: Examine and analyze how scientific discoveries and their applications affect the world, and explain how societies influence scientific investigations and applications.

o Performance standards that follow this benchmark state:

o 9-12.10 Describe major historical changes in scientific perspectives (e.g., atomic theory, germs, cosmology, relativity, plate tectonics, evolution) and the experimental observations that triggered them.

o 9-12.16 Understand that reasonable people may disagree about some issues that are of interest to both science and religion (e.g., the origin of life on Earth, the cause of the Big Bang, the future of Earth).

New Mexico Statutes

o Section 22.13.1 NMSA

o "The State Board shall require public schools to address state board-approved academic content and performance standards when instructing in specific state board-required subject areas as provided in this section."

o Section 22.10A.3 NMSA

D. Each licensed school employee shall:

(3) if teaching, teach the prescribed courses of instruction."

First Amendment

o Congress shall make no law respecting an establishment of religion, or prohibiting the free exercise thereof; or abridging the freedom of speech, or of the press; or the right of the people peacefully to assemble, and to petition the Government for a redress of grievances.

Related Court Decisions

McLean v. Arkansas BOE (1982)

o Balanced treatment of evolution and creation science violates the Establishment Clause.

o Creation science is not science.

Edwards v. Aguillard (1987)

o Requiring that creation science be taught if evolution is taught is not constitutional.

References

o Moore, R., and Miksch, K. (2003). "Evolution, Creationism, and the Courts: 20 Questions." The Science Education Review, 2(1).

o "Eight significant court decisions regarding evolution/creation issues." At National Center for Science Education web site, www.natcenscied.org

Letter from Richard Reif to Marshall Berman regarding attempts of local "Intelligent Design" advocates to persuade teachers that the new standards allow teaching of "alternate theories of origin." (PDF). "**In no way do the science standards support the teaching of notions of intelligent design or creation science or any of its variations.**"

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BILL RICHARDSON
Governor

July 20, 2004

Dr. Marshall Berman
5408 Vista Sandia NE
Albuquerque NM 87111

Dear Marshall,

Thank you for your letter regarding the New Mexico Science Content Standards, Benchmarks, and Performance Standards, and their interpretation by the Intelligent Design Network of New Mexico. While controversies over topics such as biological evolution persist, it is important to clarify what our standards and expectations are.

First, the inclusion of the principles and concepts of evolution in the New Mexico science standards is well established. Basic evolutionary principles form an important thread that runs throughout the standards. Our students should have a firm understanding of the processes and mechanisms of evolutionary change and the data and observations that support them.

Second, districts must design and implement curricula aligned to the standards. Full standards implementation requires that teachers be prepared to teach effectively and to consistently implement their aligned curricula. This means that scientifically sound content regarding evolution will be taught where appropriate.

Third, the state must remain neutral in matters pertaining to religion. In no way do the science standards support the teaching of notions of intelligent design or creation science or any of its variations.

Fourth, fundamental to science and the New Mexico science standards is the role of inquiry in learning about our world. There is no place in science instruction for the teaching of notions that are not or have not been investigated through rigorous scientific means or that are not considered by the mainstream scientific community to be consistent with sound scientific inquiry.

Finally, the standards call for students to critically analyze data and observations supporting conclusions. To be valid in both a scientific and educational context, such analyses must involve objective scientific arguments presented in a manner appropriate for the classroom and students.

I hope that questions regarding the teaching of evolution and the content of the science standards have been clarified. The standards convey accepted scientific knowledge and principles, provide a framework to support scientific thinking and practice, and open the door for dialog. The spirit of inquiry promoted by the science standards should be nurtured throughout a student's school experience.

Sincerely,

Richard J. Reif, Ph.D.

Science Consultant

Xc: V. Garcia
P. Parkinson
P. Concannon

Sharon Dogruel, former SDE Staff, on "Teaching About Evolution and the Nature of Science "

Teaching About Evolution and the Nature of Science

from the National Academy Press, 1998

Sharon Dogruel

The Education Center

April 14, 2004

Why teach evolution?

- o What process has created the extraordinary variety of life?
- o How can similarities of life be explained?
- o How are different kinds of organisms, who share so many characteristics of structure and function, related to one another?

Biological evolution:

Accounts for three of the most fundamental features of the world around us:

- o Similarities among living things
- o Diversity of life
- o Features of the physical world we inhabit

Explanations in terms of evolution draw on results from physics, chemistry, geology, biology and other sciences.

Evolution is a central organizing principle to understanding the world.

Evolution and the Nature of Science

- o Goal of science is to understand nature.

o "Understanding" in science means relating one natural phenomenon to another and recognizing the causes and effects of phenomena.

o The statements of science must involve natural things and processes.

o Statements of science emerge from the application of human intelligence to data obtained from observation and experiment.

Scientific explanations:

Evolution is a scientific explanation that has been thoroughly tested and confirmed and is thus held with great confidence.

At the same time, evolution remains an extremely active field of research, with new discoveries that are continually increasing our understanding of exactly how the evolution of living things actually occurred.

Activities

o Examples of investigations to begin developing students' understandings and abilities of evolution and the nature of science.

o Provide a guide to actively engage students in developing the thinking skills needed to be effective in a world where the pace of change is accelerating.

Activity I: Introducing Inquiry and the Nature of Science

o Introduces basic procedures involved in inquiry and concepts describing the nature of science

Activity II: Formulating Explanations

o An invitation to inquiry on natural selection.

o Uses the concept of natural selection to introduce the idea of formulating a testing a scientific hypothesis.

Activity III: Investigating Natural Selection

o Students investigate one mechanism for evolution through a simulation that models the principles of natural selection and helps answer the question: How might biological change have occurred and been reinforced over time?

Activity IV: Investigating Common Descent

o Students formulate explanations and models that simulate structural and biochemical data as they investigate the misconception that humans evolved from apes.

Activity V: Proposing Explanations

o Students observe and interpret "fossil footprint" evidence.

o From the evidence they construct defensible hypotheses or explanations for events that took place in the geologic past.

Activity VI: Understanding Earth's Changes Over Time

o Students simulate geologic time scales using a long paper strip and a reasonable scale to represent visually all of geologic time, including significant events in the development of life on earth as well as human events.

Activity VII: Proposing the Theory of Biological Evolution

o Uses historical perspectives and the theme of evolution to introduce students to the nature of science.

Activity VIII: Connecting Population Growth and Biological Evolution

o Students develop a model of the mathematical nature of population growth.

o The investigation provides an opportunity for considering the population growth of plant and animal species and the relationship of mechanisms promoting natural selection.

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Lisa Durkin, Los Lunas, on "Teaching evolution in the high school classroom"

Teaching Evolution in the High School Classroom

Employing the Tactics of Reason

It can be somewhat daunting to teach a controversial subject like evolution.

Evolution is a reasonable theory

o It explains the variety of life on our planet.

o It explains ordinary occurrences like dog breeds, and big corn cobs.

- o Darwin made observations on bird beaks and explained them with Natural Selection.
- o Most students don't know the theory or how reasonable it really is.

Some students are not very reasonable about evolution

- o Greet their objections with a smile.
- o Be the adult.
- o Avoid sarcasm and a condescending tone.
- o Allow the debate as long as it is productive.
- o Answer their objections with facts, logic and reason.

Defusing the unreasonable situation

- o You are teaching science curriculum
- o You hope not to offend anyone
- o Evolution is widely accepted and is supported by a preponderance of evidence.
- o You are not teaching anyone's belief system
- o Evolution is a required subject that will be tested by standardized assessments

There is a difference between Science and Theology:

Science	Theology
Logic	Intuition
Facts	Faith
Validity	Truth
Thought	Feelings
Scrutiny	Beliefs
Critical thinking	Moral Judgments
Problem solving	Formulating perspective

Both have important roles in peoples' lives

You do not teach theology here.

It has no place in science curriculum

Students who challenge you play an important role

- o Students who want to debate are listening.
- o Students who have made up their minds are listening as well.

- Many students have never heard the rebuttal to creationism or intelligent design.
- It is important that all students learn to apply their critical thinking skills.

Make a reasonable case

- Give reasonable feedback
- Know your stuff
- Avoid alienating anyone
- Agree to disagree
- Listen
- Help students to think the issue through
- You are not asking students to "believe" in evolution.

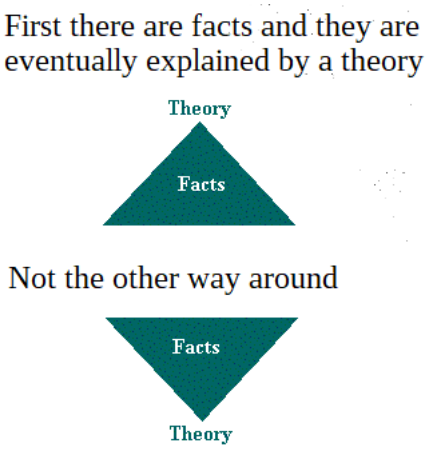
Some Common Unreasonable Arguments

- You believe your grandfather was a monkey? How Stupid…
- Evolution is ONLY a theory

Theories

- Formulated as a scientific explanation
- Based on facts
- Supported by a preponderance of evidence (including facts, laws, predictions, and tested hypotheses)
- Widely accepted by the scientific community

Reasonable Theories



One of the reasons that science has made so many advancements is that it does not rely on magic

- o Magic + Science = Superstition

Reasonable Feedback

- o Intelligent design is still a creator by another name
- o Shooting down evolution does not make creationism or ID more valid.

Reasonable Assignment Ideas

- o Value Analysis Assignment Ideas
  - - Presentation or paper
  - - Defend their opinion
  - - Must use only facts and logic
  - - Graded on use of facts and logic
- o Fun Creative Assignments

Example

- o Snapshot of Geologic Time
  - - Students select time period
  - - Assume time travel is possible
  - - Create a travel package to their time period according to specified criteria
  - - Develop a power point presentation
  - - When in the audience they must evaluate other presentations and make bids on which they prefer.

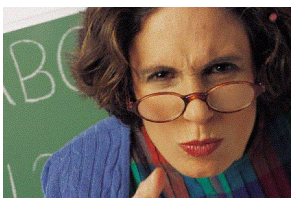
Help your students to be problem solvers instead of problem makers

You are their leader.

Set the example.

Reason is a science teacher's friend.

Be the voice of reason!



Dave Thomas, Peralta, on "Creationism's 'Scientific Evidence' Against Evolution: Not Scientific and Not Evidence."

Introduction

Years ago - in the 1980's - most creationists used to be forthright about their motives and agenda. They demanded equal time for Biblical creation, plain and simple. They wanted schools to teach a recent creation (6,000 years), Adam and Eve, Noah's flood, and all the rest. Anything else, they said, was the work of the Devil. While most mainstream religions found ways to accommodate modern science, and even embrace science (including the mountains of evidence for biological evolution), it was Biblical literalists who carried the creationist flag.

After years of losing court battles, however, creationists gradually adapted to the judicial landscape. In the 1990's, the new "Intelligent Design" (ID) breed of creationism emerged. It is led by Seattle's "Discovery Institute," which receives millions in funding from Christian fundamentalist leaders like Howard Ahmanson, Jr., who has stated "*My purpose is total integration of biblical law into our lives.*" ID spokesmen started saying it was no longer about the age of the earth, or Genesis, but simply about evolution being scientifically impossible. It wasn't about the Judeo-Christian God, they said, just some generic all-powerful Deity who happened to create the universe and all of its creatures. Structures like the bacterial flagellum are put forth as being just too darn complicated (or "irreducibly complex") to have evolved naturally. Experts that disagree with anything having to do with any aspect of evolution are often quoted out of context, and represented as critical of evolution itself. (By "evolution" I mean descent with modification, the interconnectedness of all species, the core of modern biology, and the guiding principle of fields from paleontology to genetics.)

Creationists employ a growing variety of "scientific arguments" against evolution: observations of light and dark moths, rates of evolution in the Cambrian period, drawings of embryos, and so on. They also try to pass modern biology off as a "Darwinist" religious cult, and say that "Darwinism" is compatible only with atheism, while only "Design" is properly respectful of religious beliefs. Numerous scientists have analyzed ID's claims, and

made many detailed responses, but the ID movement doesn't take criticism well, and moves ahead relentlessly, using the same discredited arguments.

Recently, however, creationists have started evolving yet again. The "ID" ruse is a hard sell for the general public, and school boards were beginning to use phrases like "These standards do *not* mandate the teaching of 'Intelligent Design'…" Biologist Ken Miller of Brown pointed out the obvious when he realized that to get any use from a "design," you must assemble the components, thus creating the designed object. "ID" is creationism - the only difference is that in ID, the Creator is not named in public.

The newest incarnation of creationism avoids mention of "design" altogether, and instead focuses completely on bashing evolution. The Neo-Creationists think that if evolution can be apparently toppled (or at least challenged) in class, then students will be forced to accept the "only alternative, creation" (and thus "religion").

The most alarming recent appearance of this new Creationism was in Ohio in March of 2004. When ID promoters recently managed to infuse an official Ohio science lesson plan with ID "evidence" against evolution, moths and all, they were careful not to reference the words "intelligent" and "design" together. When scientists rightfully pointed out the lesson plans used the same tired old ID arguments, Ohio state board vice president Richard Baker called them "a bunch of paranoid, egotistical scientists afraid of people finding out (they) don't know anything." And Jonathan Wells, Senior Fellow of the Discovery Institute, described a March 4, 2004 Cincinnati Enquirer editorial as "*…mistaken, however, in calling my Icons of Evolution a 'pro-Intelligent Design book.' Except for a few paragraphs describing how biology texts misuse scientific evidence to argue against design, and two brief references to the history of the controversy, the book doesn't even mention Intelligent Design, much less advocate it. …*" (Cincinnati Enquirer, March 7, 2004)

The new creationism is all about "teaching the controversy," or "just presenting both sides," or "presenting evidence for and against the theory," or "critically analyzing" evolution. What's so wrong about that? The problem is that creationism's "Scientific evidence against evolution" isn't scientific, and isn't evidence. This essay explains why.

Evolution is not a "theory in crisis"…

Anti-evolutionists like to portray evolution as a "theory on crisis," but the truth is that evolution is a thriving and robust part of modern science. In the words of the National Academy of Science, "*Progress in science consists of the development of better explanations for the causes of natural phenomena. Scientists can never be sure that a given explanation is complete and final. Yet many scientific explanations have been so thoroughly tested and confirmed that they are held with great confidence. The theory of evolution is one of these explanations. An enormous amount of scientific investigation has converted what was initially a hypothesis into a theory that is no longer questioned in science. At the same time, evolution remains an extremely active field of research, with an abundance of new discoveries that are continually increasing our understanding of exactly how the*

evolution of living organisms actually occurred." (National Academy Press, 1998, Teaching About Evolution and the Nature of Science, Chapter 3).

Like all sciences, good scraps exist…

Of course, thousands of eager scientists keen to make a name for themselves rarely agree on everything. Aspects of evolution are vigorously debated all the time, from rates of speciation, to details on ancestries, to mechanisms of change. Anti-evolutionists portray such debates as proof that the very idea of evolution is being challenged, when it is *not*. Misrepresenting the significance of such debates is poor instruction for our students.

"Alternate Scientific Views" in school must be about *accepted scientific* alternatives

Of course, science is all about critical thinking, inquiry, testing of presuppositions, and more. New Mexico's new science standards embrace this spirit of inquiry. But, when presenting "alternate views," are there limits? Is *every* "alternate view" worthy of consideration? Obviously, no! Science is not decided by popular vote, but by repeated and rigorous testing.

Just as evolution is opposed by a special interest group, Creationists, a similar phenomenon exists with a lobby of believers who claim that the moon landings were faked by NASA. Apollo-deniers have a collection of scientific-sounding "evidence against the Apollo landings" involving shadows on official photographs, claims of radiation dangers in space, and so on. Hoaxed-landing proponents can claim legions of scientist followers, books, television shows, and movies (Capricorn One). Should science teachers be required to spend hours and hours explaining their reams of supposed evidence against the moon landings? Clearly, *no*! Only accepted scientific alternatives deserve to be presented in science classes. If an "alternate view" is being discussed in mainstream journals like *Science* and *Nature*, it's probably fine to use in class. But, if the "alternate view" is culled from a non-mainstream, special-interest book or website (say, ID's Discovery Institute, or Apollo denier Bart Sibrel's www.moonmovie.com site), it may be unsuitable for use in class.

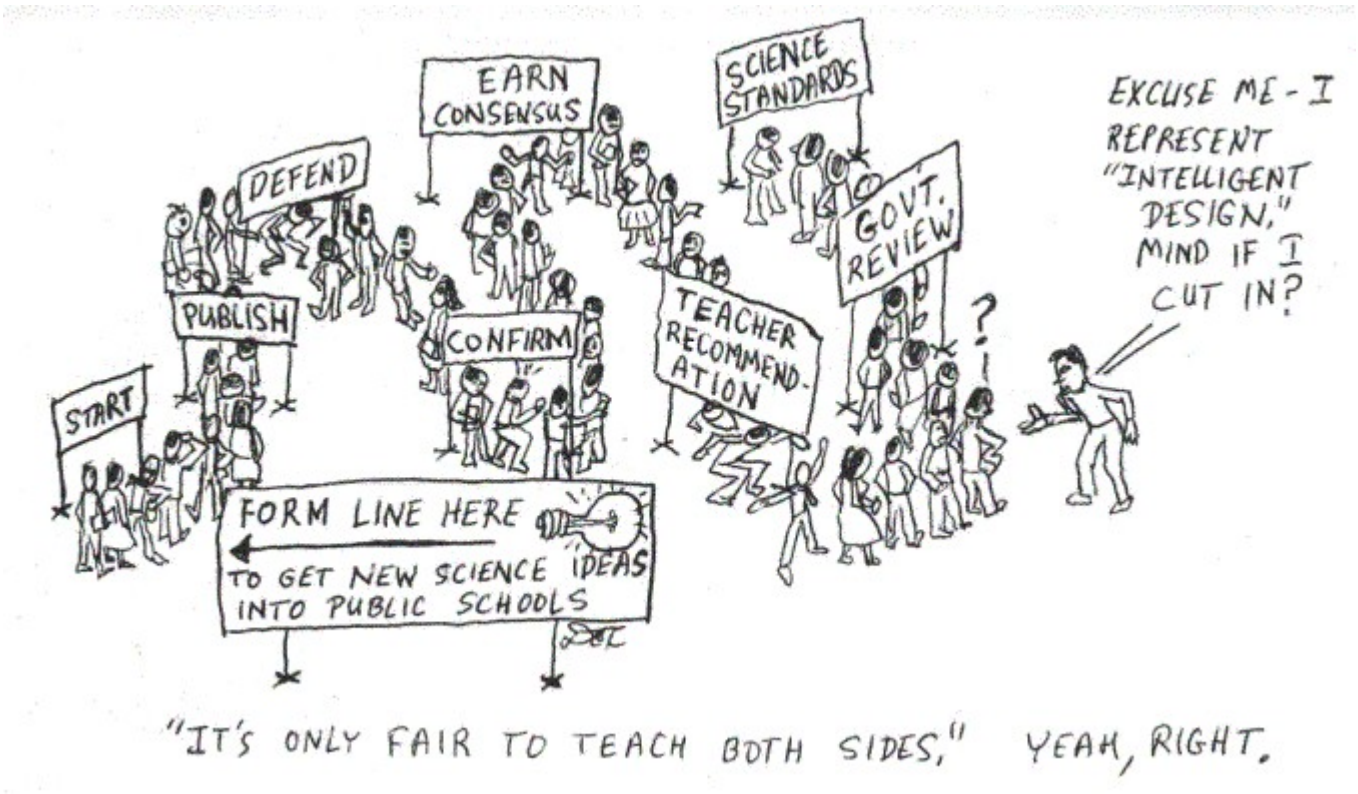
"Alternate Scientific Views" in school must be *appropriate* to students' *knowledge base*

Sometimes the arguments espoused by anti-evolutionists involve advanced concepts suitable for graduate students, not high school sophomores. The time to explain such subjects adequately far exceeds that available. And it would take as much or more time to present the detailed rebuttals scientists have made for almost all of the ID "evidences." There is only so much time for science teaching; it should not be wasted on grade-inappropriate material.

Isn't it "Fair" to teach "Both Sides"?

First off, the "two sides" in the creation-evolution debate are defined *politically*, not *scientifically*. In science, the debate is over *how* evolution works, not whether it even happens. It's only in politics that "sides" wanting to be heard form up on this question. As far as science is concerned, there are not "two sides" to be taught; evolution is the *only* scientific theory of the origin of species.

As far as being "fair" goes, it's not fair to teach concepts that have not passed the rigors of scientific testing. No one likes waiting a long time in line, only to have someone take cuts in front of them just as they're finally at the head of the line. It's just not *fair*. In our situation, the patient people waiting in line are mainstream scientists who have to publish their ideas, win consensus for them, see them verified by independent scientists, and eventually see them become accepted findings worthy of being taught. Just as these scientists are approaching the head of the line, where their work gets into school classes, we could imagine an ID creationist cutting into the line. The ID person's information isn't mainstream, has been rejected by scientists, and can be shown to be invalid; no matter, they take "cuts" and promptly put their "evidence" into lesson plans. Taking cuts is not fair. It's not funny, either. This has already happened in Ohio.



Why not "Teach the Controversy"?

If the "controversy" is *real* - say, debated in journals like *Science* and *Nature* - then it might be a part of an excellent class discussion. But if the controversy is *manufactured* by a political or special-interest group, it may well be unworthy of class time. Just because a

special interest group can create a "controversy" about the moon landing, or evolution, does not mean that it merits serious classroom consideration. Again, *mainstream* is the key.

Can't ID arguments be presented as "critically analyzing" theories, as the standards call for?

If "critical analyses" present genuine scientific arguments and debates in their actual scientific context, they are probably fine for classroom use. But, if "critical analyses" are based on *misrepresentation* of mainstream thought - for example, saying that science can't begin to explain the "Cambrian Explosion" - then they are *inappropriate* for the science classroom.

Misrepresenting evolution as "atheism" is subtle religious indoctrination

In the end, creationism, Intelligent Design, and their newest variant, "evidence against evolution" are all about religion and God. Anti-evolutionists of all stripes preach the same mantra against teaching evolution in schools: they try to convince the public that evolution is part of an atheistic, anti-religious agenda. The truth is, however, that students do NOT have to choose between science and faith. Numerous religions accept the findings of modern science, including evolution. Many believers, including theologians, find that knowledge of science expands and enriches their faith. As New Mexico Conference of Churches Executive Director Rev. Barbara Dua, one of the endorsers of New Mexico's new pro-evolution science standards, said during hearings on the standards: "*There should be no fear of conflict between religion and science.*" Anti-evolutionists are trying to force a "wedge" between students' appreciation of science and their personal religious beliefs, and nothing else so well reveals the sectarian and political nature of this manufactured "controversy."

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Dr. Marshall Berman, Workshop Organizer

NMSR/CESE Science Teachers Workshop

On August 28, 2003, the New Mexico State Board of Education approved a new set of science standards, acclaimed by many as among the best in the nation. But late in the writing and approval process, the NM Intelligent Design Network led a fight to make major changes in the standards, especially in the life sciences. Although the ID people were unable to make any substantive changes, they reinterpreted their defeat as a success. To further promote their anti-evolution ideas, they have proposed to conduct **workshops** to espouse their own Intelligent Design views.

To assist NM teachers in understanding and teaching the new science standards, the Coalition for Excellence in Science and Math Education and the New Mexicans for Science and Reason hosted a Science Teachers Workshop on April 14, 2004, with presentations by the people at the State Department of Education who guided this process, and teachers and professors who understand the science content and the issues. In addition, materials from the National Academy of Sciences, the National Science Teachers Association, NM organizations, and the presenters were distributed. Most of these materials and presentations are now available on this website.

Our organizations stand ready to assist New Mexico's science teachers in their extremely important tasks of educating our children in the wonders and workings of science.

Marshall Berman

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Useful Web Sites

Links Updated August 22, 2005

Quote from State Board of Education member Flora Sanchez , made during the hearing on the adoption of the standards (August 28, 2003). As reported by Diana Heil of the Santa Fe New Mexican on August 29, 2003,"**Board member Flora Sanchez put a stop to mixed messages, though. She clarified this point: The state is not asking teachers to present all the alternatives to evolution and 'put them on an equal footing.'...**"
(This is on-line here, here, and even on the ARN site.)

UNDERSTANDING EVOLUTION - a New Website for Teachers
http://evolution.berkeley.edu/

National Center for Science Education
http://www.ncseweb.org

The Pocket Darwin
http://www.nuuf.org/darwin.html

Index to Creationist Claims
http://www.talkorigins.org/indexcc/index.html

The National Academy of Science, "Teaching About Evolution and the Nature of Science"
http://books.nap.edu/html/evolution98/

The Talk.Origins Archive
http://www.talkorigins.org/

Evolution vs. Creationism (Syracuse University)
http://physics.syr.edu/courses/modules/ORIGINS/origins.html

Evolutionary Biology Resources
http://www.anselm.edu/homepage/jpitocch/resevol.html

Introduction to Evolutionary Biology
http://www.talkorigins.org/faqs/faq-intro-to-biology.html

The Descent Of Man by Charles Darwin
http://www.infidels.org/library/historical/charles_darwin/descent_of_man.html

The Truth about the "Santorum Amendment" Language on Evolution
http://www.millerandlevine.com/km/evol/santorum.html

Evidence Supporting Biological Evolution from the National Academy of Sciences
http://www.nap.edu/html/creationism/evidence.html

Darwiniana and Evolution
http://www.origins.tv/darwin/darwin.htm

Reptile-to-Mammal Transitionary Fossils
http://www.talkorigins.org/faqs/comdesc/section1.html#morphological_intermediates_ex2

EvoNet.org (University of Oregon)
http://evonet.sdsc.edu/

Useful sites related to evolution and/or creationism
http://www.stormloader.com/users/mesk/links.html

A molecular timescale of eukaryote evolution and the rise of complex multicellular life
http://www.biomedcentral.com/1471-2148/4/2

The Panda's Thumb (Evo Blog)
http://www.pandasthumb.org/

State Science Groups

Alabama Citizens for Science Education
http://www.alscience.org/

Colorado Citizens for Science
http://www.coloradocfs.org/

Georgia Citizens for Integrity in Science Education
http://www.georgiascience.org/

Kansas Citizens for Science
http://www.kcfs.org/

Michigan Citizens for Science
http://www.michigancitizensforscience.org/

Nebraska Religious Coalition for Science Education
http://puffin.creighton.edu/NRCSE/

(NM) Coalition for Excellence in Science and Math Education
http://www.cesame-nm.org/

New Mexicans for Science and Reason
http://www.nmsr.org

Ohio Citizens for Science
http://www.ohioscience.org/

Oklahomans for Excellence in Science Education (OESE)
http://www.biosurvey.ou.edu/oese/

Great Education Needs Evolutionary Science (G.E.N.E.S.), Tennessee
http://www.genestn.org/

Texas Citizens for Science
http://www.texscience.org/

The Burlington-Edison Committee for Science Education (Washington State)
http://www.scienceormyth.org/

Glossary of Scientific Terms

Glossary of Terms Used in Teaching About the Nature of Science

Ranked according to increasing confidence; there is no such thing as "certainty" in science.

Observations and Experiments: Anything you see, hear, smell, taste, or touch, with or without special instruments, is an observation. Observations can be wrong. Science begins with observations of nature. Thus Galileo began his study of falling bodies not by making general statements, but by performing experiments. Tycho Brahe began to make detailed nightly observations of the heavens in order to figure out how the universe was constructed.

Anything you see, hear, smell, taste, or touch is an observation. An observation may be quite casual - "You are wearing a blue shirt" - or it may be quite formal and planned. Formal, carefully planned and executed experiments are designed to make observations. (Actually, **experimental data** are observations. Scientists also draw conclusions from experiments.)

Fact: When an observation is confirmed repeatedly and by many independent and competent observers, it can become a fact.

Hypothesis: A testable statement about the natural world that can be used to build more complex inferences and explanations. If an hypothesis that describes how nature works survives many experimental tests or observations, it may become a law.

Law: A descriptive generalization about how some aspect of the natural world behaves under stated circumstances. A scientific law (sometimes called a principle) is a powerful summary of many previously unrelated facts. (E.g., Newton's Law of Gravitation, 1687)

Theory: An extremely well-substantiated explanation of some aspects of the natural world that incorporates facts, laws, predictions, and tested hypotheses. (E.g., Einstein's Theory of Gravitation, 1916)

Other Important Science Terms

Scientific Method: Principles and procedures for the systematic pursuit of knowledge about natural phenomena, involving the recognition and formulation of a problem, the collection of data through observation and experiment, and the formulation and testing of hypotheses.

The scientific method may be described as consisting of four steps:

1. Observation and description of a phenomenon or a group of related phenomena. When an investigator has little prior information, the first step is often description.

2. Formulation of a testable hypothesis to explain the phenomena. Investigators may speculate about which variables might be related to other variables and in what manner. The hypothesis is often a statement about the relationship between or among variables; it may merely ask whether a connection exists (correlational research), or whether there is a cause-and-effect relationship.

3. Prediction of the existence of other phenomena using the hypothesis, or of the results of future observations.

4. Conducting experiments and observations by several independent experimenters who use proper experimental methods and represent mainstream peer review.

Scientific Inquiry involves asking a question, completing an investigation, answering the question (if possible), and presenting the results to others.

Basic Skills of Scientific Inquiry include: Asking the right question; Observing Classifying and sequencing; Communicating; Measuring; Predicting; Hypothesizing; Inferring; Defining, controlling, and manipulating variables in experimentation; Designing, constructing and interpreting models; Interpreting, analyzing and evaluating data.

Uses of Scientific Inquiry: Making connections with world situations; Encouraging more active problem-solving approach to learning and thinking; Applying math skills; Reviewing what is already known in light of experimental evidence; Proposing answers, explanations and predictions; Using tools to gather, analyze and interpret data

Scientific Model:

A scientific model is an idea that allows us to create explanations of how we think some part of the world works.

An important model was that of the atom, in which there were subatomic particles (protons and neutrons) in a nucleus and electrons (organized into electron shells) that orbit the nucleus. This model of the atom allows scientists to explain why certain atoms (or molecules) combine in the ways that they do and to make predictions about which atoms (or molecules) will or won't combine when brought into contact.

Protons, neutrons, and electrons, in this sense, are not necessarily real in the way that basketballs are. Rather, they are ideas that humans have developed to help explain what we see and to make predictions about what may yet be seen. They are invented by scientists.

Have you ever put together a model airplane? Certainly you've played with toy cars. Both of these are "models" in the sense that they faithfully represent certain aspects of the real, full-size object (the overall shape, for instance) while ignoring others (the size, the way the engines function - or don't function - in the model).

When scientists create a model, they pick and choose what aspects contribute most to its behavior. They say what they are including in the model, and also what they are leaving out that may be significant, but may be too difficult to detect or measure.

With computers, we can create "virtual models," or *simulations*. Using mathematical formulas to mimic the behavior of as many phenomena as possible, we can run many scenarios of real-life phenomena rapidly, and often inexpensively.

Evolution: Evolution, simply put, is descent with modification. This definition encompasses small-scale evolution (changes in gene frequency in a population from one generation to the next) and large-scale evolution (the descent of different species from a common ancestor over many generations).