Science & Math CESE Education

The BEACON

News from

The Coalition for Excellence in Science and Math Education

Volume XIII, No. 3

PRESIDENT'S MESSAGE

How Might We Improve Science Education?

Just about everyone has an opinion on how to improve education. Consider any football enthusiast after a big game. "They need a new coach!" or "They went to the run instead of using the run-n-gun." are some typical comments from these unofficial experts. Many of these armchair quarterbacks can base their critiques on their own experience on the field, but probably most of the public realize they don't have enough expertise to criticize the coach.

On the other hand, almost ALL parents feel justified in criticizing their children's teachers. After all, parents were once students themselves, which qualifies them as experts in judging teachers. In addition, most parents have a vested interest in the outcome of their children's education, and thus a deeply felt interest in what happens in the classroom. Thus, teachers must deal not only with students, but with parents looking over their shoulders, as well as with administrators, and sometimes with school boards and lawyers.

All of this begs the question, has any of the meddling by politicians and lawyers improved the education of America's children? Certainly, legislation and litigation have a heavy hand in decisions made at the school level. Has anyone analyzed the effects? After countless bills and lawsuits, has the education of students in America improved? Have we fixed anything yet or have we created more problems? Are we making new laws based on evidence or on the roar of the crowd?

One year I worked at a school site that had nine science teachers and only 7 labs. Two teachers had to be rovers who taught in a different classroom every period on other teachers' prep periods. This is very difficult for any teacher but especially burdensome for science teachers who must cart around their assignments, books and lab equipment with them every period. New teachers rarely stuck around after roving for a year.

No Child Left Behind

The most recent piece of federal legislation passed to improve education is No Child Left Behind (NCLB). We have witnessed eight years of NCLB in our schools. Hundreds of schools have not met their Adequate Yearly Progress goals and the numbers continue to swell every year. Statistically, NCLB makes it more difficult for schools to meet their annual goals since it is easier for schools with low scores to improve than for schools with high scores to improve. The system used by NCLB sets itself up to fail and makes little statistical sense. Using almost any metric, NCLB has done little to improve student achievement in American education, including science achievement. Yet, it appears as though this legislation will be renewed. Over the past 20 years, politicians have repeatedly passed legislation to improve education—how effective have they been?

Twenty-one years ago I was doing research for my Science Methods class in order to obtain a degree in science education. One assignment was to find out

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WEBMASTER: Jesse Johnson

CESE annual dues are $25 for individual, $35 for family, and $10 for students. Please make check payable to CESE and mail to 11617 Snowheights Blvd. NE, Albuquerque NM 87112-3157. Email submissions to Editor, Nancy Shelton, nshelton10@comcast.net

Continued from page 1

how America compared with other countries in science education. To my astonishment I found out that in 1988, out of 15 developed countries, America ranked 13th in student achievement in science. It goes without saying that we have not improved by this measurement. According to President Obama, "America's fifteen-year-olds rank 25th in math and 21st in science among nations around the world."Currently we can't produce enough scientists to keep America competitive economically. It hardly helps that over 40% of Americans believe that ID/creationism has a place in the science classroom, taking up valuable time.

Our true "Education President"

On Monday April 27, 2009, President Obama spoke at the National Academy of Sciences where he declared that "science is more essential….than ever before" for the nation's security, health, and economy. This is a popular stand to make, supported by official and non-official experts all over the country. Prevailing public opinion recognizes the need to solve our nation's healthcare, energy and environmental issues with scientific endeavors. It is a given that our schools are the key to delivering tomorrow's scientists who will make the essential breakthroughs in science and technology. What to do about the situation is another story. Like the armchair quarterbacks, in living rooms across America, the emotionally charged opinions can be justified with many examples and much enthusiasm, but what is not part of the dialogue are tested and verified improvements that will truly impact science education in America.

How do we solve the problem of mediocrity in American science education? If we want progress and prosperity that stems from scientific breakthroughs, then this is the place to start. Obama proposed promising initiatives to reach the many lofty goals laid out in his recent speech. Among them are investments in the Recovery Act that will include $21.5 billion for research and development. Another encouraging initiative found in the President's FY10 budget makes the research and experimentation tax credit permanent. If scientists are paid well to do research, then more people will pursue a science education to secure these lucrative positions. Another hopeful initiative is the increase in funding for student grants, scholarships, tax credits and fellowships which make college education in science fields more affordable.

Other initiatives feel good but may or may not improve science interest and achievement. According to Obama, states making strong commitments and progress in math and science education will be eligible to compete later this fall for additional funds under the Secretary of Education's $5 billion Race to the Top Program. This fund will encourage states to improve the quality and supply of math and science teachers, including proposals to upgrade teacher training, alternative routes into math and science teaching, and promote and reward effective teachers. States can also use Recovery Act funds to modernize

and renovate new science labs. Math and science teacher scholarships will be made available through the Robert Noyce Scholarship Program. There is also a push for rigorous, internationally benchmarked standards, high-quality curricula aligned to the standards, and better assessments. A partnership with scientists at Department of Energy and National Science Foundation will be launched to inspire students to pursue careers in science, engineering and entrepreneurship related to clean energy. We can hope that these proposals will produce the desired results.

The question is whether raising standards, modernizing science labs, upgrading curriculum and forging partnerships with scientists to inspire future scientists will dramatically improve interest and achievement in math and science education. Will enhancing teacher preparation and training, and attracting new and qualified math and science teachers better engage students and reinvigorate these subjects in our schools?

International Standards

We have never aligned our curricula to international standards; in fact, we have never aligned school standards to a set of national standards. Without internationally aligned standards, how can we compete on international tests? Doing so might be effective and would certainly eliminate some of the ideological battles like what just occurred with the Texas state schoolboard.

When we improved classroom science and technology during the space race with the Russians was it effective? There are many claims that it was. Certainly, providing a first rate science facility for education couldn't hurt science education. Providing enough classroom space and science supplies would be a step in the right direction. The DOE was funded in the 1990's to work in partnership with science teachers in New Mexico. Has anyone analyzed the effectiveness of this program?

Obama made a statement in his speech about how the quality of math and science teachers "is one of the most influential single factors in determining whether or not a student will succeed or fail in these subjects." Billions of dollars and countless hours have been spent on teacher training over the past 20 years. Has there been any analysis as to its effectiveness? We certainly haven't seen improved test scores due to teacher training over the past 20 years. If we are indeed short 280,000 math and science teachers, a good idea might be to find out what we can do to improve workplace conditions so that we might retain the good science teachers we still have.

I quit teaching science two years ago after sixteen years. For almost all of those sixteen years I watched at least half of our school's science department leave every year. We didn't leave because we lacked training. It doesn't matter how many science teachers are recruited into the field. If they leave after less than five years, it was a waste of money.

Pennsylvania Governor Rendell is to lead an effort with the National Governors' Association to increase the number of states that are making STEM (science, technology, engineering and mathematics) a top priority. This sounds wonderful but again it is short on details and shows no proven and verified way to produce more interest and achievement in science teaching or education. Probably the biggest reason why these initiatives show limited promise is because there is little in the way of proven and verified ways to improve science interest and education. In short; we don't know what the solution is; in fact, I am not sure we understand the problem. Perhaps it would be a good time to examine what started the decline in the first place. We know that demographics play a pivotal role in education in general. What do sociologists have to say about the subject? Ironically, we are not addressing science and math education with a scientific approach. Where are the theories published in scientific journals? We can make an effort to improve science education by making it a top priority nationally, but if we don't ask the right questions and set out to solve it with analysis and data, then we are wasting our time and money. We are sitting around in our Lazy Boy recliners complaining about a bad referee call.

The President has called for an "all hands on deck" approach to this problem, which is refreshing since it puts the responsibility for solving the problem on everyone's shoulders rather than falling into the convenient "blame the schools" mentality of the last decade. Indeed it will take "all hands on deck" and not just a bunch of armchair quarterbacks to get down to the job of tackling this issue.

Lisa Durkin

CESE President

A message to President Lisa Durkin, The Coalition for Excellence in Science and Math Education

It gave me great pleasure to read your message, "Purpose and Intent," in the March, 2009 issue of the *Beacon*. In the course of reading it, and especially in the subsequent material concerning Jonathan Wells, I must admit the level of technical information was beyond my education level. However the basic thrust of the article was informative and well positioned.

Because I have written on related subjects of science and religion, I would take a moment to make a few observations of my own.

To begin with a bit of humor (?), there once was a discussion of the subject of human origins by a fundamentalist, a scientist and an ape. The fundamentalist, of course, cited Genesis and insisted that God created each plant and animal in its sole and final form, and that man was unique among those creations in being implanted with a soul—the likeness of God. The ape glared at the fundamentalist but did not speak. The scientist spoke of the advances in knowledge that had been made over the centuries since that legend was proposed, the validity of scientific method as an objective measure of reality, and of clear evidence that the humanoids that developed into modern races of man did indeed descend from the apes. Before the fundamentalist could sputter a reply, the ape spoke. At first, the ape rejected the fundamentalist concept that Man had some special relationship to his creator that made him superior. Then he rejected the scientist's belief that the ape in any way was connected with the one species that had shown purposeless violence, endless greed, vices of every description and unmitigated self-worship. But finally, the ape agreed that it is possible that some of the inferior subspecies of ape may have provided creatures from which man has descended. BUT, said the ape, let us be clear. Just as the scientist had insisted, Man descended from these apes—downward through the centuries and became the vile and despicable creature that no ape would ever wish to be!

As to the belief in "intelligent design": it is a misnomer at best. The term should have been "intelligible design." Intelligence is a quality of animals with a cortex, etc., not a non-anthropomorphic god. It is our intelligence that imposed a "grid" of analysis on the data of the universe and pronounces it as having order, consistency of performance, predictability, and therefore of being discerned as a design.

In general, science is concerned with the interrelationships of matter, energy, time and space as they define the reality of the universe in which we strive to thrive. It is not concerned with such questions as "why the universe is here," or "what non-natural force or will or whatever brought all matter, etc., into being, *ex nihilo*. The "problem" of conflict between science and religion occurs more and more, however, because (a) science has increasingly uncovered the history of the developing cosmos and thereby approaches the possibility of finding an "ultimate cause"; and (b) the act of canonizing a newly edited and redacted *Torah* by an act of the elders took place in the restored post-Exilic Judea in the last third of the 5th Century, BCE, (which, by the way, was done to "fix" authority in a struggle between priestly factions), therewith ruling out the future development of competing sources of information and becoming increasingly understood as "literal truth" despite the original intentions of different texts and traditions assembled in its composition.

If we were to permit the creation myths to be taught as alternative theories of the origin of the universe, then we should be open to teaching also the Babylonian stories of the primal egg and other stories from a host of other ancient religious societies. Should our fundamentalist friends then insist that only the "Bible" stories have credibility (because they are from God!), we would then have them self-impaled on a cross of their own admission.

In fact, our contemporary society has lost the meaning of a parable (or a mythic story), concentrating on a proof of facts. If Jesus were to answer today the question of "who is my neighbor" with the parable of the "Good Samaritan," the crowd today would insist he identify the rabbi, righteous man and Samaritan by name, the needful party by name, the street on which the incident occurred, and the name of the inn to which the needful party was taken, the date of the incident, etc. It would soon be clear that the story was "made up," and Jesus would be discredited with no comprehension of the purpose of the parable.

In this whole battle of our belief in what is real, a few observations need to be made:

• From the most primitive times, hominids have gazed upon the wonders and mysteries of the natural forces and fellow creatures with which they compete and upon which

they depend for their lives. Conditioned by environment and experience they formed communicative relationships with these forces and creatures, personalizing them in an effort to understand and to control the factors that are so vital to their own survival.

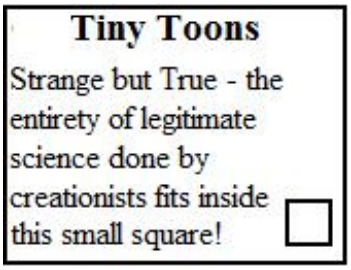
• This urge to personalize the impersonal is universal and coupled with a need to "organize" perceptual data into categories (for the same need to grasp understanding and to control) underlies the development of every society's spiritual and religious consciousness and its pursuit of knowledge in general.

• In the quest for understanding and control, any pathway that leads our journey away from a personal to an impersonal definition of reality will deprive us of the emotional fulfillment we seek and require. Hence, many would never abandon the comforting assurance and ever-dawning hope that cannot be addressed by our sciences—a faith that relies upon a very personal as well as an orderly "Power" in ultimate control of our destinies.

The battle is not actually irresolvable, but it will take a path that has scarcely been visualized, let alone traveled. Meanwhile, let us be mutually respectful of the provinces of teaching science and teaching religion, and, of course, refraining from asking our fundamentalist friends if we might teach "Darwinism" in their Sunday Schools!

Respectfully,

George Oppenheimer, Jr.
georgeoppenheimer@yahoo.com



Dave Thomas

Team Report for Noticias

The International Congress of Mathematics Education (ICME) is held every 4 years under the auspices of the International Commission on Mathematical Instruction (ICMI). The Congress is a *forum for mathematics educators from all over the world to exchange ideas, information and viewpoints and develop productive dialog with their peers. (ICME 11 website: www.icme11.org).* In Monterrey, Mexico, July 6-13th, 2008 more than 2000 educators from over 90 countries attended ICME.

The National Council of Teachers of Mathematics (NCTM) obtained a travel grant from the National Science Foundation to help fund travel to the Congress for United States mathematics educators. Teams of grantees were formed to focus on specific areas of interest, meet together during the conference, and report back to their peers on what they learned.

The "Educating Children of Diverse Cultures" team and individual areas for concentration consisted of: Rita Barger bargerr@umkc.edu (creativity and motivation*), Ed Dickey ed.dickey@sc.edu (technology and equity), Saul Duarte sxd9939@lausd.net (special education and research), Guillermo Mendieta pictorialmath@yahoo.com (student effort and access to quality mathematics education), Jill Newton janewton@purdue.edu (communication*), Hoa Nguyen hnguye4@tulane.edu (technology for teaching and learning calculus), Jennifer Weisbart jennifer.weisbart@cgu.edu (multilingual multicultural environment*), and Cindy Chapman harrisb609@aol.com (perspectives, team leader). Each of us looked through the lens of our focus to explore important aspects of the mathematical education of children whose backgrounds, cultures, and home languages differ from the mainstream. We found that most countries do, indeed, deal with the issue of diversity and its impact on teaching and learning mathematics.

ICME sessions consist of plenaries, regular lectures, Topic Study Groups, and Discussion Groups where the team was able to explore our theme. Common to our philosophies and found throughout the sessions we attended was the strongly held belief in the importance of respect and dignity for all students and the conviction that diversity may be challenging, but that the richness diversity offers more than makes up for its difficulties. One plenary and one regular lecture particularly held the interest of the group. Bill Atweh (Australia) moderated the plenary panel discussion on Equal Access to Quality Mathematics Instruction and Ubiratan D'Ambrosio (Brazil) spoke in a regular lecture on How Mathematics Education Can Help in Shaping a Better World. Atweh spoke about the difficulty of achieving both quality and equal access simultaneously. Quality mathematics without attention to equity leads to elitism whereas equitable education without high-quality mathematics leads to watered-down curriculum. So, 'equity in mediocrity' is easy to achieve, while 'equity with quality' is quite difficult.

D'Ambrosio spoke eloquently about the fact that quality doesn't simply mean doing better what we are doing now. To achieve quality we need to consider ideas of social justice in our teaching of mathematics. Respect, solidarity, and cooperation are essential and we must be sure that students' cultural roots are honored. D'Ambrosio also spoke of the importance of recalling the contributions of the common man toward the evolution of ideas.

D'Ambrosio spoke about Ethnomathematics and its ability to contribute to achieving social justice and peace with dignity for all through promoting dialogues that endure and allow communication between the educational institutions and local cultural communities. Examples of this came from the Topic Study Group on Mathematics Education in a Multilingual and Multicultural Environment. Participants learned of a textbook development project in China that focused on food, architecture, and farm work of a minority population in the Xinjiang region. A project involving two schools in Turkey and one school in Rhode Island used Turkish rugs to study fractions, patterns, and geometry concepts.

Respecting and understanding diversity includes recognizing and addressing the difficulties that language can bring to children of diverse cultures. The Topic Study Group on Language and Communication in Mathematics Education looked at issues of mathematics as its own language and problems that occur when words and symbols used in mathematics also have other meanings in the mainstream language. The significant role of gesture as complementary rather than merely supportive to speech in communication was considered. This can be an area of difficulty for students when they come from a different culture or language group from that of the teacher. In order to ensure quality mathematics instruction, teachers of students of diverse cultures need to be mindful not only of language differences but of gestures as well.

Issues of student attitudes toward learning mathematics intrigued our team. Michele Artigue (France), current President of ICME, discussed the differences between eastern and western cultures and these were emphasized in China's national presentation, a Japanese lesson study session, and Topic Study Group on Primary Education presentation on problem-solving in Japanese primary schools. Japanese educators talked about how students enjoy and expect to engage in challenging problems, even ones that might be beyond their skill level. Chinese educators talked about the work ethic of Chinese students and teachers and the Chinese saying that illustrates this: "Unpolished jade will never shine. To teach without severity is a dereliction of duty." For the Chinese, extensive and continued practice is a critical part of learning, although the country's educational leaders are very concerned about the narrow goal of exam-focused education.

In some western countries, educators lament the unwillingness of students to take risks or to work hard to learn math. Members of our team felt there was a definite difference in what they heard about student attitudes and effort in other countries from what they experience in their own classrooms in the United States.
Rosetta Zan (Italy) presented a longitudinal study which investigated a multi-dimensional way of looking at student attitudes. From 1st to 13th grades students themselves narrated their own 'stories' with mathematics. These stories tended to revolve around students' emotions (I like/don't like math), self-efficacy (I can/can't do math), and vision of math (math is skills/abilities vs math is problem solving/creative). One finding was that positive attitudes towards math (I like math and/or can do math) were more often included in stories where students' vision of math is that math is problem solving and creative.

Team members were enthusiastic about the opportunities afforded to them by their attendance at the Congress . They've made many exciting plans based on their experiences. Some will be exploring areas new to them such as psychology of mathematics education or the use of visualization software for calculus (GeoGebra, (www.geogebra.org). Feel free to contact team members for more information.

*These members have developed bibliographies in their focus areas and they're willing to share with you.

Cindy Chapman
CESE Board Member
and founding member of TODOS

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http://cesame-nm.org

Neil Shubin, *Your Inner Fish*, Pantheon, 2008.
Jerry A. Coyne, *Why Evolution is True*, Viking, 2009.

These two books belong together in every school library. They will be of value, not only to students and teachers of the biological sciences, but to everyone interested in who we are and where we came from. The authors, colleagues at the University of Chicago, have chosen complementary approaches to their material. Coyne's book is organized as a summary of the arguments for evolution; Shubin's as an exposition of our anatomical history at every level, from the skeletal to the molecular.

Shubin starts by describing the circumstances of one of the most spectacular series of discoveries of recent years, largely under his own direction—a rich series of fossil finds in mid-Devonian rocks, bridging the gap between fishes and amphibians. Here he gives us a graphic exposition of the science and art of fossil hunting. Rocks 385 million years old contain no land vertebrate fossils, but by 365 million years ago, land animals existed. So the right place to look for intermediate forms would be in rocks 375 million years old. Fossil hunting requires bedrock exposures, bare of topsoil or overbuilding, and such exposures had been identified on Ellesmere Island, in the Canadian Arctic. This is where they looked, and their search, as Shubin describes, was richly rewarded. The most famous single find is probably *Tiktaalik*, the fish with a wrist, and in a highly dramatic passage, Shubin compares this discovery to the experience of dissecting the wrist of a cadaver when a medical student, in both cases "uncovering a deep connection between my humanity and another being."

This is what is sometimes called "gross anatomy," and the deeper theme of Shubin's book is how this relates to anatomy at finer levels, the molecular and the developmental. Here, the past 20 years or so have seen a coming together of different kinds of information, from molecular biology, from genetics, and from the study of development, in the related new areas of "evo-devo" and molecular palaeobiology. It was news to me, and I'm sure it will be news to many readers, how far the concept of common descent can usefully be stretched, to include separate organs in the same individual, as well in separate species, and how closely related, early in development, the future head and throat of a human are to the gill arch structure of the lamprey or the shark. At times here I would have wished for more detail—exactly how, for example, is the mouse eye gene persuaded to trigger formation of an extra (fly-type) eye on a fly's back—but it is hardly a weakness in a book of this kind that it leaves the reader wanting to know more.

Shubin's book simply bypasses the so-called controversy about the validity of the evolutionary narrative, which is the subject matter of Coyne's. Here, one hopes, few readers of the *Beacon* will need any convincing, but all readers will, I think, find much to inform and enjoy. Coyne singles out for discussion the core concepts of "evolution, gradualism, speciation, common ancestry, natural selection, and non-selective mechanisms of evolutionary change," and explores each of these in turn. All the usual arguments are presented, but with a level of detail and background knowledge that could only come from someone who has thought long and hard about the subject (Coyne's own speciality is the study of how new species come into existence). For example, it is no surprise that the 18th century "argument from design," which both "Intelligent Design" theorists and more traditional creationists keep trying to revive, is countered by the argument from the imperfections of design. What is both illuminating and surprising is the way in which Coyne is able to trace such imperfections to our evolutionary history. Thus the tortuous path followed by the left laryngeal nerve in humans, or by the urethra of mammal males, can be directly traced to the relative movement of organs between our fish-like ancestors (and ourselves as early stage embryos) and our adult forms.

Some will find the use of the word "true" in the title contentious, since all our scientific opinions are subject to revision in the face of fresh evidence. I disagree. Our scientific opinions are in principle revisable, but then so are our opinions on any subject whatsoever. We are as much entitled to use the language of certainty— words like "true," "know," "fact," and even, for specific events, "proof"[1] —in the context of biological history as we are in the context of human history. Indeed, I see us as duty-bound to do so. Lack of dogmatism should not present itself as lack of conviction.

I am more concerned about some of the other words that Coyne chooses, such as "Darwinism," "evolutionists," "missing link." As I have argued elsewhere,[2] such terms play into the hands of the enemies of reason, some of them lawyers, philosophers, and politicians who understand the importance of labelling very well. "Darwinism" is an inadequate name for modern evolutionary biology,

embracing as it does such areas of genetics and molecular biology, of which Darwin had no inkling. To speak of "evolutionists" is to suggest, however unintentionally, that there is an intellectually respectable alternative; true in 1830, but not today. As Coyne himself explains very clearly, "missing links" are likely to remain missing or at best unidentified, and our opponents continue to claim this as a weakness. Far better to stick with the technical term "last common ancestor," just one among the many known transitional forms, each one of which undermines creationism.

In the last resort, however, people will believe what they want to believe. Coyne addresses this issue directly in his final chapter, where he argues that acceptance of a scientific worldview (and nothing less than this is at stake) depends on appreciating its emotional, as well as its logical, grandeur. These books do much to make that grandeur manifest.

Suggested additional resources:

http://evolution.berkeley.edu/evosite/evohome.html (includes teaching suggestions and discussion of the "objections" to evolution science)

www.**devoniantimes**.org/ (changing views of the fish-to-land transition)

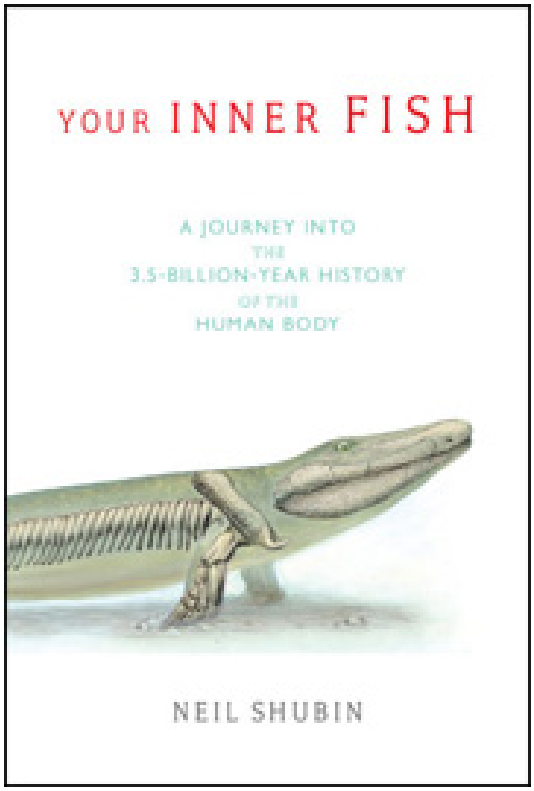
http://scienceblogs.com/pharyngula/2006/04/tiktaalik_makes_another_gap.php (P.Z. Myers on the many intermediate fish/land forms now identified)

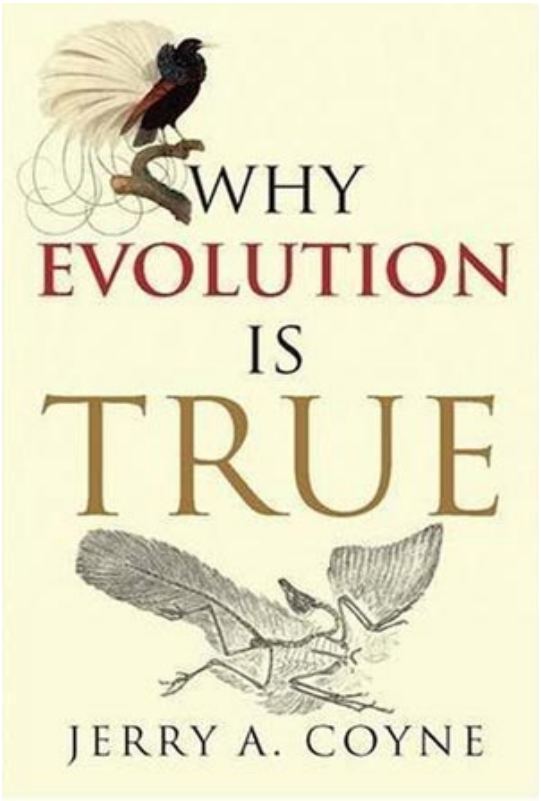
Molecular Palaeobiology, Kevin J. Peterson, Roger E. Summons, and Philip C. J. Donoghue, Palaeontology, Vol. 50, Part 4, 2007, pp. 775–809

[1] For instance, the Ellesmere Island fossils *prove* that fish-to-tetrapod evolution occurred in the Devonian, just as surely as forensic evidence might prove that a particular crime occurred last Tuesday.

[2] Putting Darwin in his Place; the Need to Watch our Language, P.S. Braterman and J.B. Holbrook, *American Biology Teacher* (2009), 71(2), 84 - 88

Dr. Paul Braterman





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CESE Annual Meeting

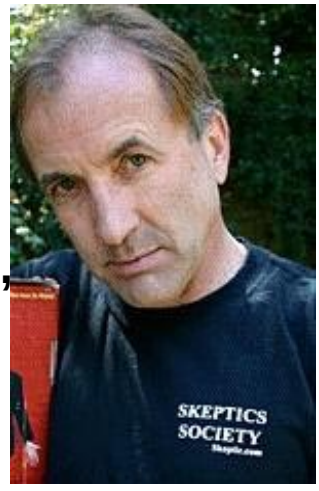
Saturday, June 13, 2009 1:00 P.M. to 4:00 P.M

UNM Anthropology Building (Maxwell Museum)

Lecture Hall (Room 163) North End

Near the traffic light at Las Lomas and University.

(Huge parking lot.)



Speaker, Michael Shermer,

Publisher of SKEPTIC Magazine

"The Mind of the Market—Compassionate Apes, Competitive Humans, and Other Lessons from Evolutionary Economics"

See Wikipedia for Michael Shermer bio.