Science & Math CESE Education

The

BEACON

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PRESIDENT'S MESSAGE

I'm Back! And, I don't mean as in the "Nightmare on Elm Street!" (Well, a few people out there may argue that point.) But, I really am back as this year's President of CESE. It is an honor and a privilege. And, I believe we all owe Marshall Berman, our outgoing and founding president, many, many thanks for all his very hard and effective work since 1996/7.

I'm back and so are the local creationists (they've never left). As David A Thomas (David E. Thomas's father) once said, creationists are like ducks in a shooting gallery. No matter how many times you shoot them, they just keep popping back up again. Well, we just have to keep shooting them down. Our ammunition is limited only by our own stamina.

If anybody thought the "evolution war" in New Mexico was winding down after acceptance of some of the best science standards in the country approved by our former State Board of Education—think again! Our victory in helping to produce these science standards has been co-opted and subverted by local Intelligent Design (ID) creationists, who loudly proclaim that the standards encourage teaching "problems with evolution and addressing alternate theories of origins." National media outlets almost invariably include New Mexico among those states where ID creationists have won. (See, for one example, New York Times, August 21 article by Jodi Wilgoren, "Ohio, New Mexico, and Minnesota have embraced the [Discovery] institute's approach.) This is galling, to say the least, and is straight out of the Discovery Institute's propaganda (http://www.discovery.org/scripts/viewDB/index.php?command=view&program=CSC%20-%20Views%20and%20News&id=2543).

This consistent misrepresentation of facts implies that CESE and others, when playing in this arena, which we must do, need to think more like publicists, just as the Discovery Institute does. They hire a PR firm! Imagine a real scientist doing that to get a paper published. We're up against some of the best "spinners" around, and it's clear that "logical" and "scientific" arguments alone won't carry the day. We must adapt our strategy to their tactics. New Mexico isn't the only example of the well-worn ID creationist tactic of claiming victory after defeat. We must keep our cool, maintain our vigilance, and present our message in places and in ways that get it across.

And nationally, while we were watching developments in Cobb County, Georgia, and Dover, Pennsylvania, President Bush plunged into the controversy. His stance was no surprise, but in making it more public, the "evolution war" was taken to a new level. This has set off a

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Dr. David Johnson, Webmaster

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veritable firestorm of ID creationist activity and has encouraged action across the nation. That includes New Mexico.

The scene of battle in New Mexico has now shifted from the state level to the local level. CESE hereby offers assistance to those in any part of our state who would like support. New Mexico's official state public school science standards explicitly require the teaching of evolution, and do not provide for "teaching alternate theories," thanks to tireless efforts by a few members of the State Department of Education (now Public Education Department), some members of the State Board of Education (now the Public Education Commission), members of CESE, and several national science organizations who wrote letters of support to the state board. So all New Mexico science teachers may be confident that they stand on firm ground when they teach evolution! That is their charter. They are encouraged by the standards to acknowledge to their students that "*[students shall u]nderstand 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).*" And that is it as far as acknowledging religiously motivated ID creationism is concerned. Of course, a teacher may choose to answer questions about ID creationism "data" that supposedly invalidate evolution, but not to the detriment of teaching to the state standards' requirements.

CESE has been active in sharing information and strategies with like-minded people in other states, and will continue to do so. This keeps us abreast of evolving ID creationist strategies in other areas of the country. It also allows us to pass on our experiences. If you wish to help track national issues and contribute ideas, please discuss this with one of our officers. But more importantly, we need your help at our state level. You must be vigilant and watch for examples of subversion of the state science standards in the public schools. We know very well

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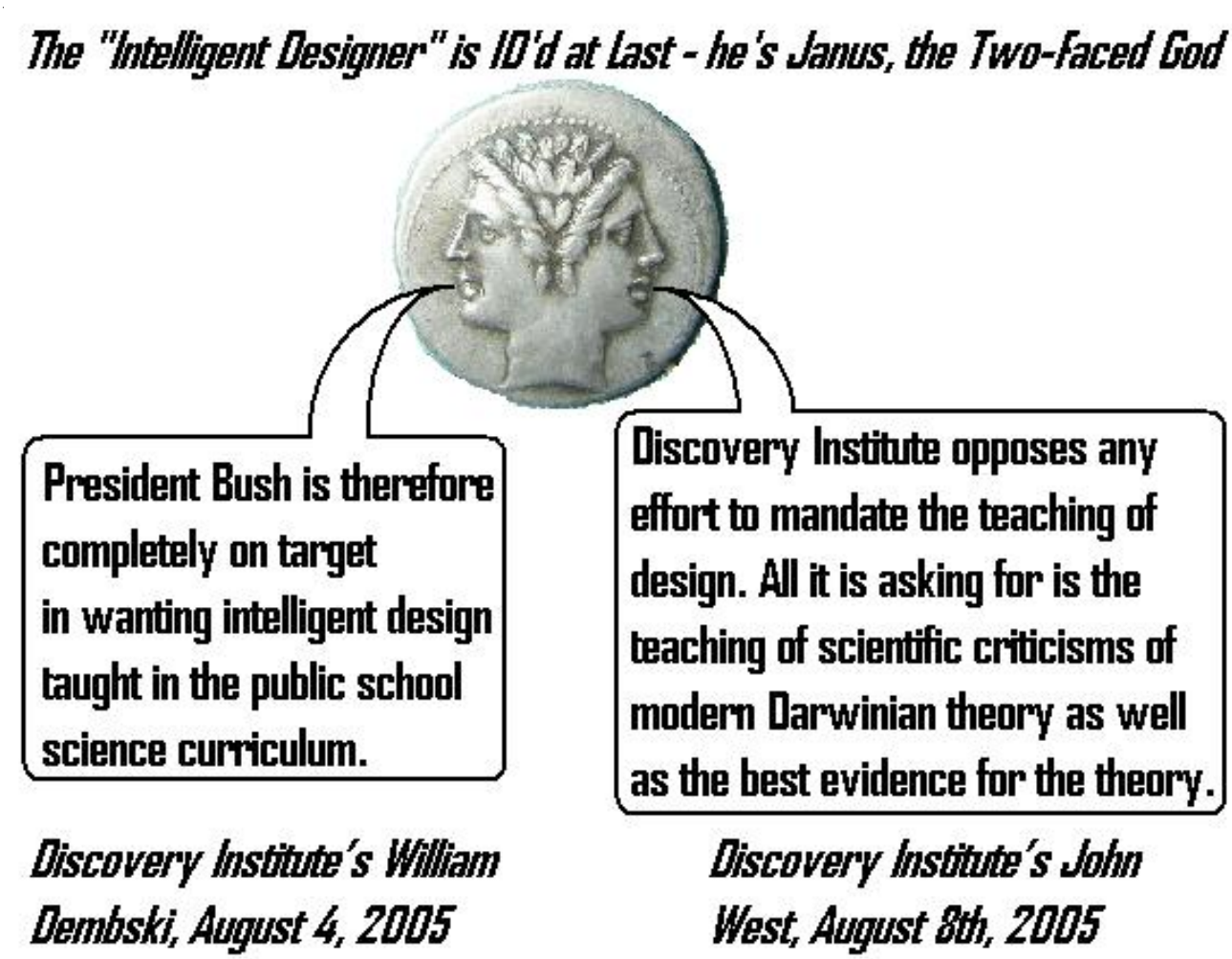
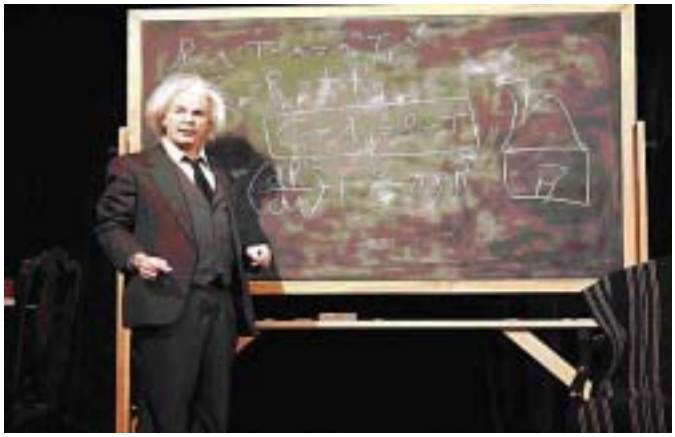
that some science teachers continue to aggressively teach ID creationism and denigrate evolution in their classrooms. We also know there very well may be ongoing movements in local school boards to subvert the state science standards. But please be aware of this: only parents/guardians of children in that classroom are allowed to legally challenge such teaching. CESE can pursue such cases, and/or enlist the help of others; but only if a parent is willing to make an official or legal complaint. Many parents are not willing to incur the wrath of their neighbors, teachers and school administrators, and their children's friends by creating an "issue." They often do not want to incur the expenses. We can help! We can only take these cases on as they arise, and each, though similar, always has unique aspects associated. We can do nothing, however, if we are unaware of them. So please, be vigilant. Keep your eyes open and ears to the ground.

We hope this will be a good year for science and math in New Mexico. It will certainly be better with your help!

Kim Johnson
CESE President





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THE PUBLIC

New Mexico Academy of Science Annual Conference
Saturday, November 19, 2005, 1:00 PM to 4:00 PM
Albuquerque Academy – Simms Auditorium

Please mark your calendar to attend the Academy of Science's Annual Conference on Saturday, November 19, 2005, 1:00 to 4:00 PM in the large Simms Auditorium at the Albuquerque Academy. Last year we celebrated the 50th anniversary of Watson's and Crick's discovery of the structure of DNA. This year we will celebrate the centennial of Einstein's "Miracle Year." In 1905, the young (26 years old) and obscure physicist, working in the Swiss Patent Office published five scientific papers that shook the world of science to its core. In that year, Einstein challenged Isaac Newton and 19th century physics by inventing relativity, proposing that the speed of light is constant, postulating the equivalence of mass and energy, supplying a convincing proof for the existence of atoms, and arguing that light behaved as both a particle and a wave. All of these ideas were questionable and uncertain in 1905, but are bedrock scientific concepts today.

To mark this anniversary, the Academy will feature a performance by Tom Schuch entitled "Einstein: A Stage Portrait." http://www.spoli.com/ The year is 1946, the Bomb has been dropped, the world has forever changed and Albert Einstein has invited the audience over to his home to set the record straight about his life. Join Dr. Einstein for an evening of humor, introspection, science and a little violin. Find out why his theories are being proven correct to this day. You'll walk away with an understanding of the man who solved many of the world's most difficult puzzles with astounding creativity and a delicious sense of humor.

This award-winning one-man show (Dramalogue, Best Playwright) brings to life a brilliant, dedicated and sometimes controversial theoretical physicist who TIME magazine called their Person of the Century. Einstein was "a much too famous man whose reputation grew so out of proportion." He was a reluctant celebrity who set the science world on its collective ear at the astonishing age of twenty six with his Special Theory of Relativity. His passion was deciphering nature's puzzle and spent his entire life "trying to fit the pieces together". Yet, he didn't begin speaking until the age of three and was considered to be a slow learner by his teachers. He abhorred all forms of authority, which made his school years difficult and finding work as an adult even harder. Despite all that, not a day passes when we fail to hear some reference to Albert Einstein.

This event will be jointly sponsored with the University of New Mexico Physics Department. In addition to this performance, the Academy will supply refreshments and door prizes. Bring your whole family.

Marshall Berman
Past President

WHEN EXPERIMENTS GO BAD

Every experiment would have clean results in an ideal world. We would run the experiment and know right away whether the experimental outcome shows either that our hypothesis was tenable, or was false, or that any apparent results are probably due to chance. Unfortunately, lots of things can go wrong. We can work around some of those, but some problems will doom the experiment to the wastebasket. It's even worse if we thought the experiment was meaningful when it actually was not. We hope that it's rare to deliberately pass off an invalid experiment, but it does happen. We need to be vigilant when reading experiment reports.

Nuisance variables are always with us. These are variables that we can't, or didn't, plan for in the experiment, but that have an unknown effect on outcome. For example, in testing students, their physical and psychological health at the time of the test is a nuisance variable that probably can't ever be accounted for. Blocking is one way to account for nuisance variables at least partially. You set up blocks of experimental units according to the variables you think might be having a nuisance effect. For example, you could match blocks by having the same number of Anglos and minorities for each testing condition. You're often stuck with nuisance variables. Sometimes you need to go to considerable lengths to control nuisance variables. In testing, you ought to make the environmental conditions as near alike as possible for every test administration. That is often impossible. The environmental conditions under which a standardized test is administered in school are never the same as the conditions under which the normalization sample took the test.

When you read honest reports, nuisance variables will at least be mentioned. A really good report describes the controls for isolating nuisance variables. Maybe the report describes probable nuisance variables and at least makes some estimate of their importance. If the report doesn't even mention them, don't assume that none were present. It doesn't always mean that the study is faulty, but you should be suspicious.

Reliability effects often come into play. For example, in testing, extremely low and extremely high scores are less reliable than mid-range scores because the extremes are scantily represented. Also, scores have absolute minima and maxima. The lower reliability of extremely low scores, coupled with the fact that scores cannot be lower than some minimum floor, means that some low scores could overstate the student's "true" state of knowledge. Some high scores could be lower than the "true" state of knowledge. That causes scores to cluster more closely to the mid-range – "regression to the mean." Many other phenomena have absolute bounds, along with lower reliability near the bounds.

Deliberate **sabotage** is not unknown in education testing. For example, resentment by teachers or students can lead to spurious results. Sabotage is almost impossible to discover and difficult to prevent.

For cleanest results, every combination of experimental conditions will have the same number of subjects. That is often not practical. Suppose you want five levels of one factor, five levels of a second factor, and five levels of a third factor. That's 125 treatment combinations. If you need 100 experimental units for each treatment combination, and you can't use different treatments on the same subjects, you need 12,500 subjects. With a total pool of just 1,000 subjects, it looks as if you're out of luck. There are experimental designs to get around this. You can run an **unbalanced** experiment, with more units for the most important treatment combinations and fewer for combinations that are probably less important. There are analysis procedures for unbalanced experiments. In **confounded** experiments some treat-

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ment combinations don't get tested at all. Nuisance variables are one cause of unintentionally confounded experiments. There are also experimental designs in which confounding is used intentionally. Of course, this reduces the amount of information you get from the experiment. The analysis of confounded experiments is fuzzier than for clean experiments, but they require fewer experimental units. Sometimes it's the only way to go.

Here is an example of an experiment with inherent unintentional confounding. Suppose you want to test the effect of teaching styles. Teacher A uses one style on class Alpha. Teacher B uses another style on class Beta. Are differences in learning due to teaching style, or to difference in teacher competence, or was one class smarter than the other? We cannot have confidence in a simple setup like that. A design that controls for the confounding is much more complicated. Let's use four groups of students, Alpha-1, Alpha-2, Beta-1, and Beta-2, all matched by ethnicity, status, and so forth. Teacher A uses one style on group Alpha-1 and the second style on Alpha-2. Teacher B does the same with the Beta groups. If the experimenter tries to hide the confounding and doesn't control at all, you might assume that the study is less than perfectly honest or that the experimenter is pretty dumb. However, a design with good control will be considerably more costly and time consuming.

The table below shows a simple design with one empty cell. This might have been done deliberately because prior studies had shown that the combination A2B2 was not important, or because it is known to be impossible. It might also have been unintended because all the data from A2B2 was lost. The report should give reasons for using an incomplete design. The results of an experiment with one or more missing cells are more difficult to interpret and some possibly valuable information cannot be derived.

Variable A → Variable B ↓	Level A1 ↓	Level A2 ↓
Level B1 →	A1B1, N units	A2B1, N units
Level B2 →	A1B2, N units	not used

There is a temptation to **over-parameterize** experiments. That means you try to get more information out of the experiment than the data and the experimental design allow. In almost every situation, the simplest design is best. Only a few independent variables with few treatment levels will usually give the cleanest results. Unfortunately, you can't find out about interactions with a single independent variable. That is, the action of one independent variable on the outcome might be different in the presence of a second independent variable. However, an experiment with many independent variables is often counterproductive. The solution is to reduce the number of independent variables to the minimum that will serve the experimental goals. Maybe a few preliminary "fishing experiments" will demonstrate which variables are most likely to be important. The real experiment is then run with a reduced variable set

Most of us won't be running education experiments. However, some of us will be reading study reports. Some things to look for are whether the controls for nuisance variables are described and whether the reasons for using confounded or other unusual designs are spelled out. They ought to tell us why the independent variables were chosen and why they are all thought to be necessary. On the other hand, if only a single independent variable was used, the report ought to tell us why that was thought to be sufficient. If they don't make these things clear, you can't decide whether they are technically naïve or are hiding something. Good control is expensive, requires lots of subjects, and takes more time. We don't expect to see it very often.

Walt Murfin
CESE Statistician

Rio Rancho school board okays alternatives to evolution

Last Update: 08/23/2005 9:53:00 AM
By: Associated Press

RIO RANCHO, N.M. (AP) - Rio Rancho's school board has adopted a policy allowing alternative theories to evolution to be discussed in the city's public school science classrooms.

The board voted three-to-two Monday in favor of the policy.. . .

NEW MEXICO ACADEMY OF SCIENCE STATEMENT ON RIO RANCHO SCIENCE POLICY 401

By Jayne Aubele

The New Mexico Academy of Science recommends that the Rio Rancho School District take prompt action to rescind "Science Education Policy 401," which was adopted on Monday, August 22nd by the Rio Rancho Board of Education.

This policy is unfair to science, to Rio Rancho's public school students and teachers, and could be detrimental to Rio Rancho's science- and technology-based business community. The policy *says* it adheres to New Mexico's current Science Content Standards, Benchmarks, and Performance Standards. However, a clear reading of those standards reveals the new policy is *not* based on them, but is instead a subtle loophole for the introduction of non-scientific ideas like "Intelligent Design" and unscientific "evidence against evolution" into public school science classrooms.

For those who have not followed these arguments closely, "Intelligent Design" is, despite its supporters' public denials, a faith-based view of the creation of life; its advocates reject all or much of evolution. The Academy is not opposed to any religion, but our position is that religious topics such as "Intelligent Design" are better suited to comparative religion or philosophy classes than to science classes. Furthermore, the National Academy of Sciences has also stated that "No body of beliefs that has its origin in doctrinal material rather than scientific observation, interpretation, and experimentation should be admissible as science in any science course." (http://www.nap.edu/books/0309064066/html/25.html)

In the August 21st edition of the Rio Rancho Observer, a Rio Rancho school board member who supports this policy wrote:

> "Although evolution will certainly continue to be taught, as the standards require, it's unfortunate, and unwise, for the state to force-feed any one, and only one, interpretation concerning origins to our students, not because it violates someone's philosophical views, but because it violates the state standards and Benchmarks for science in the classroom. Examining alternative explanations is not just a good idea, folks - it's the law.
>
> "To quote the last sentence of the proposed policy, which in turn has been taken **directly from the State Content Standards:** ' . . . *discussions about issues that are of interest to both science and individual religious and philosophical beliefs will acknowledge that reasonable people may disagree about the meaning and interpretation of data.*' What are we teaching our kids if all sides in this current policy dialogue do not model respect for intellectual diversity?"

This new policy appears innocent. But the most dangerous part is the sentence in italics, which is **NOT** in New Mexico standards. Instead, these actually say:

> *9-12.16 Understand that reasonable people may disagree about some issues*

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> *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).*

The standards note that reasonable people may disagree about some *issues*; they say *nothing* about entertaining all possible "*meanings and interpretations of data*."

Even the word "discussion" does not appear anywhere in New Mexico's science standards. And discussion at the August 22nd Board meeting clearly demonstrated the ideology and intent of the policy's supporters—making design-based claims against evolution one of Rio Rancho's school policies.

The Academy opposes policy 401 because it proposes a completely inaccurate definition of science itself. Saying that "*reasonable people may disagree about the meaning and interpretation of data*" obscures the fact that, in science, all ideas and observations are *not* created equal. Alternative ideas *are* tested in science every day— but if they fail, they are discarded for better explanations and conclusions.

Science is not an ideology, but rather a way of understanding the natural world. It is very different from other ways of decision-making. In everyday pursuits such as legal hearings or newspaper editorials, advocates can peruse available knowledge, and end up with a handful of facts that appear to support their particular argument. In science, however, inconvenient facts cannot be casually discarded. Scientists must choose among various *explanations*, looking for those that best handle *all relevant data*. Explanations that don't work *must be replaced* with better ones. This process has resulted in a handful of powerful and general explanations that bring sense to the universe, including the theories of chemistry, electromagnetism, relativity, quantum mechanics, and, yes – the theory of evolution.

If scientists simply agreed to disagree about "the meaning and interpretation of data," scientific progress would cease. Science is about testing ideas and claims, not pretending that all "interpretations" are equally valid.

If the new Rio Rancho Science Policy "has been taken directly from the State Content Standards," why isn't the Academy taking this issue up with the New Mexico Public Education Department (PED), instead of the Rio Rancho Public Schools? The answer is that Policy 401 adds new language to the standards, and changes the definition of science itself in the process.

Furthermore, New Mexico's education officials have described in no uncertain terms that the new standards do not allow "alternative explanations" such as Intelligent Design: Dr. Richard Reif, science consultant for the PED, wrote this opinion for the record:
"... 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***... Fundamental to science and the New Mexico science standards is the role of inquiry in learning about the 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."

"Intelligent Design" has no explanations of its own other than "These things are so complex, there's *no way* they could have developed naturally." The "alternative explanations" provided by Intelligent Design "theorists" bring confusion to science, not clarity. They have been reviewed extensively by the scientific community and found to be without merit. Some biological phenomena remain unexplained, of course, but

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(Dues and Donations cheerfully accepted year 'round)

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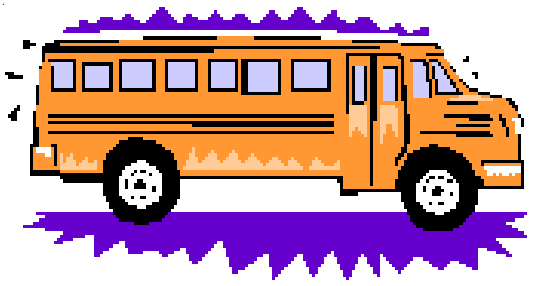
there are currently **no scientific data that contradict the theory of evolution.**

Rio Rancho's students and teachers deserve real science in their classrooms, not the anti-evolution spin of Intelligent Design's many pundits and lawyers. The New Mexico Academy of Science urges the Rio Rancho School Board to reconsider this unnecessary policy that has no basis in science.

This statement was approved by the board members of the New Mexico Academy ofScience on August 25, 2005



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percentage of incoming college students who are prepared for college-level biology.

TIME Magazine–August 29, 2005, p. 18

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