

***X20 – EXchanging Worldviews, 20:  
EXploring Prospects for Peace & Prosperity, 12:  
EXtricating Humanity from EXcruciating Problems by, 6:  
EXpediting Cultural Change, via 2:  
EXpelling Educational Myths, Fantasies, and Hoaxes  
through Voluntary, Controlled, Educational EXperiments***

Dear: In the previous chapter, I outlined five “barriers” or “problem areas” that detract from extracting evaluative-thinking skills from science classes:

- 1) Poorly Trained Teachers,
- 2) Poor Science Programs,
- 3) Inadequate Exams,
- 4) Misunderstandings about Public School Financing, and
- 5) Interference from Religious Fundamentalists.

In this chapter I want to suggest some actions that are being taken and that might yet be undertaken to overcome those barriers, to try to solve some of the problems that they cause. Before starting to describe those actions, however, I want to try to make two new points and repeat another.

### **MISLEADING MYTHS ABOUT EDUCATION**

My first point is that behind all five of the identified “barriers” or “problem areas” is a single, common theme: they’re all derived from various misleading myths (or even hoaxes) about education. To illustrate, consider the following “myths”, some of which I’ve tried to expose in earlier X-chapters and others that I’ll outline in this chapter:

- That students can extract evaluative-thinking skills from subjects other than science without climbing up relevant thinking pyramids,
- That teaching is a profession,
- That for students to learn, teachers are critically important,
- That schools of education are generally producing competent teachers,

- That government schools are generally run by competent administrators,
- That members of local School Boards are competent to define curricula,
- That government Departments of Education don't "play politics",
- That the best way to teach science (or any subject) is known,
- That existing exams are meaningful and provide useful measures of student performances and capabilities,
- That kids are entitled to an education,
- That parents pay for their kids' education,
- That the public pays for "government-funded" education,
- That parents don't want their kids indoctrinated, and
- That solutions to problems in education and its administration can be solved in the public domain *via* reason and dialogue.

Now, Dear, I don't expect either that you understand what I mean by every one of the above short descriptions of those educational myths or, if you do understand, that you agree that they are myths. In what follows, I'll try to explain what I mean, to argue my case that they are common myths, and to show you that some are so contrived and promoted that they would be better described as "hoaxes." For now, all I wanted to do was explain what I mean by claiming that there is a common feature in the five problem areas introduced in the previous chapter, namely, that they're all derived from various myths about education. In turn, as I'll try to show you in this chapter, these myths have lulled the majority of the people in the US (and many other countries – of course including all Islamic countries) into adopting a comparable number of fantasies about public education.

### **THE NEED TO APPLY THE SCIENTIFIC METHOD**

The second point I want to make is more general. It's that, in general, the best way to dispel any myth is not to try to replace it with another (e.g., in the case of religious myths, not to replace, e.g., Christianity with Islam or *vice versa*), but to confront any myth's adherents with knowledge.

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In turn, the best way to gain knowledge is *via* the scientific method. Consequently, the best way to dispel, in particular, educational myths is to perform controlled experiments in education. In general, however, it's immoral to conduct experiments dealing with people (especially children) without their knowledge and permission. Therefore this chapter's title: "Expelling Educational Myths, Fantasies, and Hoaxes through Voluntary, Controlled, Educational Experiments."

And immediately I should admit that, in earlier X-chapters, I, too, have been promoting "educational myths", i.e., ideas that don't have adequate experimental support. For example, from essentially the beginning of these chapters dealing with education, I've been promoting Schopenhauer's idea that kids should learn by what I've been describing as "extrapolating from their own experiences." I've also been promoting the idea that the best way for kids to develop evaluative-thinking skills is *via* studies in science. But meanwhile, I hope that your skeptical response was: "Show me the data!" And so now, Dear, I finally admit that (as far as I know) the needed experimental tests of predictions of those two "hypotheses" have not yet been performed.

And if you're thinking something similar to "Shame on you!", then my (defensive) response would be something similar to the following. Recall, Dear, that the first steps in any scientific investigation (e.g., to determine the best way to develop kids' evaluative-thinking skills) are to analyze available data and then to develop a succinct hypothesis that summarizes the data, that (usually) doesn't conflict with well established principles, and that has predictive capabilities.

Such conditions are satisfied by the hypotheses that kids will be "better educated" (a concept needing a clear definition and a method to measure it!) if they learn by extrapolating from their own experiences and if they learn evaluative-thinking skills from studies in science. Yet, I heartily agree with criticism that formulating such hypotheses is just the first step in the scientific method for developing understanding – and I admit that, until experimental tests of well-defined predictions of these hypotheses are conducted, then I, too, have been promoting little more than just more educational myths.

A similar point was well made by Sharon Begley (one of my heroines!) in her 17 December 2004 weekly column in the *Wall Street Journal*:

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## To Improve Education, We Need Clinical Trials To Show What Works

If there is one thing about science that educators and scientists wish students would learn, it *isn't* the difference between an isotope and an isomer or any of the hundreds of other facts that pepper textbooks and tests. It is how to think critically about scientific data and concepts, and be able to synthesize and apply them.

So for today's quiz, class, identify the problem with this study: In one class, the teacher encourages the 30 students to be active learners, engaging in scientific inquiry alone and in a group. That's not very likely without some structure. So the teacher – who has a solid mastery of science and has volunteered for extra training so she can run an innovative class like this one – helps students formulate questions and devise experiments or observations likely to lead to answers.

In another class, the teacher parrots the textbook, instructing the students explicitly in science facts and principles. He focuses on the acquisition of knowledge, not its synthesis or use.

By year-end, kids in the first class are doing better than kids in the drill-and-memorize classes. You conclude that the first approach is superior.

We pause here to allow you to ponder where you tripped up.

Let David Klahr of Carnegie Mellon University explain. “Studies of classrooms where teachers use discovery-based learning show that the kids do a little better” learning science, he says. “But to run a discovery-learning class, you need a teacher who really knows the material, who's creative and knowledgeable. If you had that same teacher do traditional instruction, might the kids do just as well?”

...that's the gap in education's research base: well-controlled studies with large numbers of students that account for factors such as the superior knowledge and extra training of teachers in some classes, or even high expectations of student achievement on the part of teachers using a “new and improved” curriculum. Without such controls, observations – including those in our hypothetical study – are inconclusive about what really makes the difference in how well kids learn.

“There is not as much good research on what works as [educators] need,” says Grover Whitehurst, director of the US Education Department's Institute of Education Sciences. “In science education, there is almost nothing of proven efficacy.” The result, says Rodger Bybee, executive director of the Biological Sciences Curriculum Study, a nonprofit corporation in Colorado Springs that develops curriculums, is that “*practices in science education can have a mythical quality* [italics added], or be justified because ‘it makes sense’.”

In asking what works in science education, I don't mean to ignore the very real controversy over what we mean by "works." Most tests, notably international comparisons, assess recall and comprehension of facts, notes Richard Duschl of Rutgers University, who chairs a National Academy of Sciences committee on K–8 science. Maybe we want our kids to be able to synthesize and explain science, which is harder to gauge. Nor do I mean to denigrate the solid discoveries in cognitive science, developmental psychology, and neuroscience about how people learn, nor the NAS science education standards that reflect what successful teachers do.

The trouble is, those discoveries have rarely been put to the acid test we demand when discoveries in basic biology serve as the basis for new drugs. Just because a drug looks as though it will cure some disease, based on experiments in test tubes and mice, doesn't mean it will. "Sometimes," says NAS education expert Lisa Towne, "basic principles don't translate as expected" – not into drugs, not into classrooms.

Dr. Whitehurst's group at the Education Department is therefore "trying to bring evidence to bear on education decision making," he says.

*There are already some robust principles of learning science. "Time on task" matters; students have to put in the hours. Students need challenges – instruction that aims just beyond what they already know. Also, says Harold Pratt, former president of the National Science Teachers Association, teachers must address students' misunderstandings about how the world works before introducing new information, teach facts and ideas in context rather than in isolation, and have students monitor their own learning...* [Italics added]

When might we? "Optimistically," says Dr. Whitehurst, "in five to 10 years we might know" the most effective ways to teach science. Medicine is finally becoming evidence-based. Surely it is long past time for education to do so, too.

Thereby, Dear, a huge amount of work is needed, performing experiments to determine "the best way" to teach kids and determining what's meant by "best" (i.e., how to measure "best"). If you choose teaching as a career, you could spend your entire career formulating and testing hypotheses about the best way to teach!

## HOW THE "PROBLEM AREAS" MIGHT BE ADDRESSED

And finally for this "introduction", Dear, my third point is to repeat what I've written before. Applied to the need to dispel educational myths, I repeat: I ain't gonna do it! That is, although I'm convinced that an enormous amount of work is needed to dispel such myths and although I might be able to convince at least myself that maybe I have some useful ideas of how to do it, yet in so far as a certain trouble-making grandchild

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<http://zenofzero.net/>

asked me “only” why I don’t believe in god (not how to solve all the problems in the world), my plan is therefore to do little more than mention some of the myths in education. After that, I’ll focus on how to dispel educational myths associated with the crazy idea that everything is under the watchful eye of some magic man (or giant Jabberwock) in the sky.

Yet, I wouldn’t feel comfortable if I totally ignored all the other myths in education, because so much is connected. That is, as a part of my thesis that “**belief in god is bad science and even worse policy**”, I’ve been trying (in these X-chapters) to suggest both how “the god idea” inhibits progress toward worldwide peace and prosperity and what might be done about it. In turn, that led to the obvious idea (espoused by many people) that more and better education is critical. And thus, to try to overcome the policy problems caused by the god idea, it’s necessary to address the issue of how to improve education – and one way to do that is to replace educational myths with scientifically established hypotheses. Stated differently, as John Muir said:

*Whenever we try to pick out anything by itself, we find it hitched to everything else in the universe!*

So in that spirit, I’ll at least mention some ideas about how at least some of the listed educational myths might be dispelled. And although you might expect me to now go through the list of “problem areas” starting with #1 (problems arising from poorly trained teachers) and continuing on through to #5 (problems caused by religious fundamentalists), yet for reasons that I trust will become clear, I want to start with problems (and associated myths) dealing with “problem area” #4, i.e.,

### **Misunderstandings of Public School Financing.**

I want to address such misunderstandings, first, not only because everything is “**hitched to everything else**” but also because the resulting coddling of unmotivated students seems to be especially tightly “hitched” to other educational problems.

For example and to start, let me remind you of a concept in the article “Philosophy of Science Education” by Sara Abbot, which I quoted and referenced in the previous chapter:

*In order to make the cooperative relationship a functional one, the teacher assumes many duties. Foremost, the teacher is charged with conveying and enforcing clear*

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*behavioral expectations in order to maintain a predictable and secure environment conducive to learning. Once a safe, comfortable setting has been established* [italics added], one of the science teacher's chief responsibilities is to help students make the connections of relevancy that are necessary to foster motivated inquiry...

Of course I agree with the author, but surely an objective observer (say from another planet!) would ask:

*Say what? "Foremost, the teacher is charged with conveying and enforcing clear behavioral expectations in order to maintain a predictable and secure environment conducive to learning"? What on Earth is going on?!*

And if you don't see my point, Dear, let me first describe some additional personal experiences, complete with admitting another error in my thinking.

As I mentioned in an earlier chapter, I previously thought that my experiences teaching at various universities were irrelevant to solving problems associated with teaching students in lower grades: that in lower grades, one teaches students, but in universities, one teaches courses. I now withdraw that idea. In all grades, in kindergarten through graduate school, only courses should be taught; it's the student's job to learn! Further, I think that a major flaw (maybe even "the" major flaw) in American schools is not so much that their funding or teachers or curricula or testing or administration are inadequate (as many people suggest), but that teachers no longer have authority commensurate with their responsibility – which is an almost-guaranteed recipe for failure of any system.

Let me give you a contrasting example. I remember that once in each of several first-year courses that I taught at universities, near the start of the term, some students would begin talking to other students (or otherwise "clowning around") while I was lecturing (in some cases, to literally hundreds of students). In each case, I immediately confronted the disrupting students with something close to:

*Hey, you! What the devil do you think you're doing? You're in university now. If you talk in my class, talk to me. Otherwise, if you just want to talk, take it outside. I don't care if you don't come to class, I don't care if you don't do your assignments, I don't care if you skip all your exams, and I don't care if you fail this class and all your other classes, finding yourself out digging ditches for a living. So, either shut up or get out.*

After such an outburst from me (about which I was very serious), I'd never have any disciplinary problems in the class. And of course I wouldn't – because if it ever happened again and if I didn't call the campus police, I'd just walk out and let the rest of the students take care of the problem. No university prof worth her pay or her position will put up with students who aren't in class to learn. Similarly, Dear, I have zero doubt that all teachers, regardless of student ages, should demand that the prime goal of all students is to learn to the utmost of their abilities.

Yet, of course I agree: young kids must be treated more gently (because they're not yet fully responsible for their behavior). Nonetheless, all kids and their guardians must quickly learn to become responsible. Therefore, I'm certain that all teachers must have authority to immediately (i.e., instantaneously) expel children who disrupt classes, expelling them into “detention classes” or similar, whose prime purpose is to teach kids to behave, to motivate themselves, and to take responsibility for their own future. If such detention classes don't work, then the student should be expelled from school. No teacher should ever need to deal with disciplinary problems: they should immediately call in some “policing force” to deal with the problem – or immediately quit their jobs.

In fact and more generally, it's unconscionable that there are problems maintaining discipline in American schools. Our Constitution's Preamble is:

We the People of the United States, in Order to form a more perfect Union, establish Justice, insure domestic Tranquility, provide for the common defense, promote the general Welfare, and secure the Blessings of Liberty to ourselves and our Posterity, do ordain and establish this Constitution for the United States of America.

That's the essence of our Constitution (and, therefore, of America). Consistently, I'd therefore suggest, to **promote the general Welfare** (by promoting education), **secure the Blessing of Liberty** (by having well-educated citizens), **insure domestic Tranquility** (in every classroom in the country), and **establish Justice** (for every child who desires to learn), that **we the people... provide for the common defense** by having, e.g., our Defense Department reassign returning veterans (who are having difficulty finding jobs) to schools throughout the country (in numbers solely defined by school principals) *charged with conveying and enforcing clear behavioral expectations in order to maintain a predictable and secure environment conducive to learning*, relieving all teachers of a task that they never should have accepted and that they should never again need to accomplish.

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Let me put it still another way, starting with the observations that, if there are only two things certain in this world, one is that there's no shortage of small blobs of protoplasm (also known as babies) and another is that most big blobs of protoplasm have great fun engaging in the activity that leads to such little blobs of protoplasm (i.e., most big people enjoy sex). If such people then "think" that the rest of us are responsible for their little blobs (which they had so much fun creating), for their learning both how to behave and how to earn a living, then a whole lot of people should respond in a manner that can be summarized with: "**Blow it out your ear!**"

As for what the above has to do with "misunderstandings about public school financing", it's why I included the parenthetical remark "and associated coddling of unmotivated students." But more directly to the point dealing with misunderstandings of financing: currently and throughout the world, there's a monstrous myth that such funding is provided by existing taxpayers (or whatever is the source of each government's revenue, e.g., in Saudi Arabia and Iran, the sale of oil). Certainly it's true that parents don't pay for the education of their kids. For example, not only do your parents not pay for the education of their five children, your parents collect a ~\$50,000 per year "entitlement" from the rest of us for free education for their kids – plus they claim substantial "tax credits" for so many dependents!

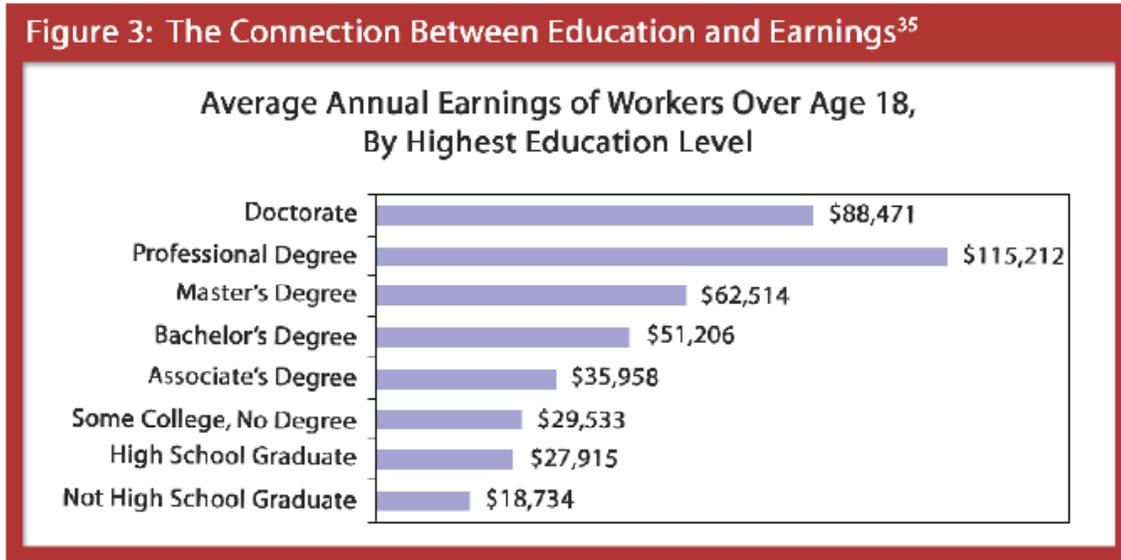
But there's even more to it than that. I consider it to be a fundamental misunderstanding of the nature of education to assume (as is done essentially everywhere) that current taxpayers (or other sources of government revenue) pay for current educational expenses. Instead, with their taxes (or through depleting their nation's natural resources), people are repaying loans made to them for their own education, when they were kids.

That is, Dear, I strongly advocate universal acceptance of the idea that, in reality, education is a cross-generational loan. For example, taxpayers are now providing you with a "free education", but you'll be required to repay the loan when you start paying taxes. Similarly, kids in Saudi Arabia and Iran now obtain a "free education", but when they're adults, if they don't repay for their education *via* their taxes, they'll pay through a loss in the value of their "inheritance" (i.e., depletion of their nation's oil reserves).

To see what I mean by claiming that education is only a loan to students (that's to be paid back!), consider the following chart, entitled "The

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Connection Between Education and Earnings”, taken from the indicated reference. It provides quantitative values for what’s expected: the more education people obtain, then on average, the higher their salaries.



<sup>35</sup> US Census Bureau, *Educational Attainment in the United States: 2004*, Table 9, 2005. Available at: <http://www.census.gov/population/www/socdemo/education/cps2004.html>.

Next, consider income taxes. If the tax rate were “flat” (e.g., 25% of a person’s income), then obviously, the more people earn, the more they pay in taxes. Actually, though, the tax rates in this country (and most countries) are “progressive”, in that, the more a person earns above certain amounts, those amounts are taxed at higher rates – currently to a maximum rate of 33% in this country, but before President Reagan pushed his tax bill through Congress, the maximum tax rate in the US was up near 90%!!

But even ignoring the complications (and injustices!) of progressive taxes, you can begin to see how people pay back the “loans” they took out for their education: at a flat-tax rate of 25%, the average high-school dropout would pay at most 25% of (from the above chart) \$18,734 per year – although no doubt it would actually be much less, because of a variety of “deductions”. Meanwhile, the average high-school graduate would pay 25% of \$27,915. Without accounting for deductions, that’s roughly \$2,500 more (per year) for the high-school graduate than for the high-school dropout; thereby, the high-school graduate soon pays back the “loan” for additional education.

And then, Dear, if you think about this “taxing situation” a little more, I expect that you’ll rather quickly conclude that the whole system is “crazy”! From the above chart you can get an indication (even without progressive tax rates) of how much more people earn (and therefore, how much more they pay in taxes) if they obtain more education beyond high school; yet, society doesn’t provide “free” college education! In fact, it’s the opposite: society charges people (plenty) for (the privilege?) of going to college – not only for tuition, but in higher taxes for the rest of their lives! It’s crazy – or maybe better, it’s criminal; it’s robbery; it shows one more terrible failure of any democracy, in which the majority manages to have its way at the expense of different minorities (in this case, those earning more money).

Thereby, I trust you see there are multiple myths and misunderstandings dealing with funding education. Certainly parents don’t pay for their kid’s education. Also, although it’s easy to argue that the public pays for public education, it’s just as easy to argue that people aren’t paying for the education of current youngsters; instead, they’re repaying the inter-generational loan they received for their own education.

But then, when that line of reasoning is pursued, it’s easy to reach the conclusion that the system is crazy: insofar as any society desires (for its own economic benefit!) that every citizen is working (and paying taxes!) to the utmost of each citizen’s capabilities, then why isn’t each youngster provided with sufficient loans (in the form of “free” education) to enable the youngster to gain as much education as the youngster can master? The more education provided, then generally, the more the person will earn and the more that the person will pay in taxes, not only repaying the “loan” in full, but providing a hefty profit to the public to boot – and not only “just” *via* taxes, but in many cases, creating jobs for other citizens, including jobs for high-school dropouts (who pay at least a little in taxes).

The myth that current taxpayers are paying for education (rather than repaying loans given to them for their own education), the myth that kids aren’t required to repay loans they receive for their own education, has led to another massive set of fantasies, throughout the world. I won’t provide details of such fantasies; once I prod you a little with what follows, you’ll probably recognize even more fantasies than those I could detail. Instead, I’ll just summarize with the assessment: all governments in the world are in the business of making educational loans to kids – and they’re running their businesses (i.e., their countries) into bankruptcies!

That is, Dear, any banker who made loans so irresponsibly would be fired (or would soon lead his or her bank to financial ruin), because in the current method, assessments aren't made of the probability that the loans will be repaid! I would therefore strongly recommend (and if I had the opportunity, even dictate!) that all governments get entirely out of the business of controlling such loans. What bureaucrats are doing, now, throughout the world, is automatically approving all educational loans. The result is a massive amount of coddling of unmotivated students (especially in the West and oil-rich Muslim nations).

If you would consider this issue for a while, Dear, I expect that you, too, would both hope for a more rational, realistic system and maybe even conceive of one, similar to the one I'll outline in a later chapter (entitled "EXtrapolating Laws"). In that chapter, X26, I'll "look at the limits" to try to discern potential laws to extricate humanity from some of the "Catch-22s" that I've been describing. But I want to delay showing you my suggested ways to expel the myth of educational funding, because I agree that my suggestion is "kinda far out", i.e., unlikely to be accepted in the near future – but maybe you'll agree that it's a potential method, "in the limit".

In outline, my view is that, to dispel prevailing myths about how education is funded, to remedy associated problem, and not unimportantly, to try to incorporate more "fairness" in the system, I think that what's needed is more Accountability, better Banking, and more Competition (which I call the ABC Method for rectifying school financing). Yet, even if such improvements were enacted, still another huge problem would remain, namely, the one now existing that I listed as

### **Inadequate Exams.**

At present there are (and in the future, there almost certainly will continue to be) major problems associated with developing appropriate exams. The myth is that current exams provide a measure of student accomplishments and potentials.

A stunning example that should help to dispel that myth is the assessment that a teacher gave to Einstein's father: "It doesn't matter what he [the young Einstein] does; he will never amount to anything." Other "famous failures" include Newton (who did poorly in grade school), Beethoven

(who's music teacher said that, “as a composer, he is hopeless”), Thomas Edison (whose teacher told him he was too stupid to learn anything), and Winston Churchill (who failed 6<sup>th</sup> Grade).<sup>1</sup> Three other famous examples that come to mind are Howard Hughes and the “college drop-outs” Bill Gates and Steve Jobs.

The myth that essentially all current exams in essentially all schools in the world provide useful and meaningful measures (of either the capabilities or the potentials of students) leads to a huge set of fantasies about how to improve schools. For example, almost certainly, the current “international math and science exams” are inadequate (since, when testing a large number of students, it's almost impossible to test student capabilities on other than the lowest level on the “thinking pyramid”). It may be that such exams are so inadequate they should be junked.

Meanwhile, though, politicians (and other “leaders”), worldwide, demand “student performance measures”. Yet what's needed, first, is some measure of the value of such “performance measures” – besides the value to politicians who, as someone else wrote, take credit when such “performance measures” increase, and blame others when the measures go down!

If you dig into the problems of developing and administrating “adequate” exams, then as I wrote in the previous chapter, you may conclude that the problems is so difficult that it can't be solved – except, when a person is dead, by examining the person's life-long accomplishments! That option, however, provides help neither to the student in choosing a “career path” nor to society in deciding how much to support a particular student financially. Consequently, insofar as society can't afford to fund all people “merely” to study all their lives, it seems necessary to develop some “sensible” educational “performance measures”, to help societies decide when “**Enough is enough: it's time for the kid to get out of school and get to work!**”

As a start toward designing sensible exam systems, surely the first step should be to seek agreement upon objectives – for students, for societies, and for humanity. If agreement could be found, then such goals could be used to develop goals for any exams.

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<sup>1</sup> Dear: On the internet, of course you can find many such anecdotes (the veracity of which I didn't check); I obtained these from <http://www.lostsoulcompanion.com/newsletter/newsletter2p3.php> and [http://divadirectories.com/Library/HEALTH\\_&\\_SELF\\_IMPROVEMENT/Famous\\_Failures/](http://divadirectories.com/Library/HEALTH_&_SELF_IMPROVEMENT/Famous_Failures/).

But, as I tried to show you in an earlier X-chapter, although many such objectives have been proposed, it's clear from their differences that it's difficult even for a single society to agree on objectives of educating their children – and therefore, on how to examine them. For example, surely in every society there are some people who have concluded that it's most important for students to develop evaluative-thinking skills, but simultaneously, obviously there are many people who have concluded (or, better, who have been indoctrinated to “believe”) that it's most important for students to become “good” Catholics or Muslims or Mormons or whatever. This leads to the same vicious cycle (or Catch 22) that I've already outlined.

Yet, insofar as so many societies have chosen (or are choosing) to enter in economic (and other) competition against other societies and thereby have chosen (or are choosing) that a prime goal of education is to train students to help their nation become more economically competitive, then at least some general features of consistent examinations can be discerned – and which would be consistent with my proposed ABC method of funding kids to attend school. The fundamental goal (or question) of all exams, for each student at any educational level, would then be: “Should the public loan more money to continue the kid's education?” or “By funding this kid's continued education, will the public get a decent return on its investment?”

If answering questions of that type were the bases of exams for all students, then obviously, the entire educational system would be turned “upside down”: all exams would then contain, not questions for each student, but questions for each teacher, and the dominant challenge for students would then be, not competition among students, but against standards set by each teacher. Of course this would give enormously more authority to each teacher – but I'm certain that such is exactly what should occur.

I'll try to show you what I mean in a later X-chapter, after showing you what I mean by the ABC Method of funding kids to attend school. Immediately I should admit, however, that my proposed examination scheme presupposes teacher competence, which returns me to another of my original “problem areas”, namely, the problem of poorly trained teachers – along with the associated myths that schools of education are producing competent teachers and that, for students to learn, teachers are critically important. I therefore now turn to the problem of

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## Incompetent Teachers.

In the previous chapter I showed you some data supporting the conclusion that, in general and even in the US, most teachers teaching science shouldn't be – especially for elementary- and middle-school kids, for whom teaching of the scientific method is (in my not-so-humble opinion) critical. To remove current incompetence in those who teach kids science, three obvious steps would be:

- 1) Improve schools of education (e.g., require faculty members who teach future teachers how to teach science to have their own PhDs, not in education, but in some science discipline, and also, change the procedure from accepting the bottom 10% of college applicants to accepting only the top 10%),
- 2) Tighten the certification process (e.g., require all teachers of science to have at least their bachelor's degree in some science discipline), and
- 3) Get serious (e.g., have teachers with at least a bachelor's degree in some scientific discipline take over even elementary-school classes and certainly middle-school classes during times when the kids are being introduced to science).

Meanwhile, Dear, given the requirements of America's *No Child Left Behind Act of 2001*, if you think something similar to, “Well, soon the situation will get better”, then I'm sorry to respond: just because politicians proclaim that something will occur, doesn't mean it will! To illustrate, below is a 26 July 2006 editorial published in *The New York Times*.

The story of the *No Child Left Behind Act* is all about the huge gap between setting standards and creating the conditions in which those standards can be met. One of the law's most critical provisions requires that all public school teachers in core academic courses be “highly qualified” by this year. But as *The Times's* Sam Dillon reported yesterday, not a single state has met the deadline.

The fault lies partly with the early appointees of the Bush administration who controlled the Education Department when the law was passed. They virtually ignored the teacher qualification provision, and the states got the message that they could follow the bad old *status quo* as long as they wished. Happily, the current education secretary, Margaret Spellings, appears to be taking the law at its word. She recently required states to submit plans showing how they would supply impoverished students with qualified and more experienced teachers.

But changing the teacher preparation and assignment systems as they stand today will be far more difficult than compiling the reports. The states fought tooth and nail when Congress first approached the teacher quality problem in the 1990s – before *No*

*Child Left Behind* ever came on the scene. At that point, in a compromise, Congress reverted to another dodge that equates transparency with progress. It attempted to improve the often dismal quality of colleges of education by simply requiring the schools to make public how many of their students had failed teacher certification tests. That clearly hasn't worked. Colleges of education are still much in need of improvement.

In addition, many of the states have adopted what some have described as an elaborate shell game, setting allegedly high standards for teachers that are then ignored at hiring time. This is especially common in inner-city school districts, which typically have more than twice as many uncertified teachers as affluent districts in the suburbs do.

We hope that Secretary Spellings is serious about solving this problem. To do so, however, she will need to hold the line against a long-established pattern of misrepresentation and foot-dragging in the states. That will mean leveraging the billions of dollars that the federal government spends on education in a way that actually rewards the states that perform well while punishing those that don't.

But actually, Dear, it'll require far, far more than is suggested by the above editorial. To see what I mean, I'd encourage you to dig into details dealing with the meanings for "teacher certification" and "well qualified". If you do, you'll find, for example, that to gain certification for teaching science in high school, the typical requirement in American States is a bachelor's degree *in education* with the inclusion of 30 semester hours (typically, 10 courses) in the chosen "science specialty". In contrast, to qualify even to be permitted to take a professional engineering exam, typically requires, first, a degree from an accredited engineering school, which in turn requires about 200 semester hours of relevant courses (i.e., ~ 60 courses). Furthermore, if you look into details about what "certification" entails, wondering how (as I showed you in the previous chapters) ~50% of middle-school teachers of "physical science" and ~40% of similar high-school teachers could be "certified" without having "majored" in "physical science" in college, then you may become as shocked as I was at the idiocy of the current certification process.

In the National Academy's draft report<sup>2</sup> quoted in the previous chapter, the panel recommended a number of steps to improve the number of competent science teachers. For example, their first (and presumably their highest priority) recommendation is:

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<sup>2</sup> *Rising Above The Gathering Storm: Energizing and Employing America for a Brighter Economic Future* at <http://www.nap.edu/catalog/11463.html>.

**Action A-1: Annually recruit 10,000 science and mathematics teachers by awarding 4-year scholarships and thereby educating 10 million minds.** Attract 10,000 of America’s brightest students to the teaching profession every year, each of whom can have an impact on 1,000 students over the course of their careers. The program would award competitive 4-year scholarships for students to obtain *bachelor’s degrees in the physical or life sciences, engineering, or mathematics* [italics added] with concurrent certification as K–12 science and mathematics teachers. The merit-based scholarships would provide up to \$20,000 a year for 4 years for qualified educational expenses, including tuition and fees, and require a commitment to 5 years of service in public K–12 schools. A \$10,000 annual bonus would go to participating teachers in underserved schools in inner cities and rural areas.

Immediately I should add that I’m totally in favor of the above “action item” proposed by this Academy panel – even though I expect that it’ll have only a marginal impact.

And I say “only a marginal impact”, Dear, because if you look at the details, then when the program is “up and running” after 4 years (operating at a cost in scholarships of about \$1 billion per year), then the resulting better-educated 40,000 teachers, each teaching ~25 students, will influence ~1 million students, i.e., roughly 1% of the students in the country. [The panel’s estimate of “educating 10 million minds” assumes that these teachers will continue for ~30 years in education, but I expect that, with their bachelor degrees in some branch of science, the majority of such teachers would refuse to work in such a poorly paying job in which they receive so little respect.] Nonetheless, I repeat that I’m totally in favor of the Academy panel’s Action [Item] A-1, for it would do some good (and it certainly wouldn’t do any harm) to provide merit-based scholarships for kids to get their bachelor’s degrees in science.

I also heartily support the Academy panel’s second recommendation:

**Action A-2:** Strengthen the skills of 250,000 teachers through training and education programs at summer institutes, in master’s programs, and in Advanced Placement (AP) and International Baccalaureate (IB) training programs. Use proven models to strengthen the skills (and compensation, which is based on education and skill level) of 250,000 current K–12 teachers.

But I think that, in addition, a new plan should be promoted – experimenting with “digital-based learning” or “e-learning”, seeking ways to overcome the problem of poorly trained teachers:

To introduce this plan, let me mention some of my experiences during my 21 years of experience as a classroom student and more than 10 years teaching at universities. One is my observation that, in spite of all the rhetoric (and even some studies) to the contrary, it's a myth that the most important role of teachers is to convey knowledge. Instead, my experience has been that **the more important role of educators is as motivators and facilitators** (using a variety of techniques, from “task-masters” to “tender-loving-care givers”, and from someone that kids hate and fear to some one that kids love and admire).

And with that claim that the prime role of teachers is as motivators and facilitators, I'm not contradicting the results of studies (and my own experiences) showing that kids can learn more from competent, inspiring teachers. Rather, I'm claiming that such differences are “at the margins” and that the dominant factor that determines how much and how well kids learn any subject is how much the kids apply themselves, which in the limit, can be done almost entirely on their own. And of course I agree that this hypothesis of mine needs to be tested experimentally – but 1) before performing experiments, it's wise to formulate an hypothesis to be tested (☺), and 2) I have tested the hypothesis – at least with myself as the subject!

Let me give you some such examples. From among the literally hundreds of my teachers, I admit that I had some teachers who seem to have made a difference. I remember that my seventh grade home-room teacher congratulated me for showing common sense, my first-year university math prof (and subsequent president of the university) taught me not to take life too seriously but nonetheless to finish what I started, my master's thesis advisor taught me that there's no such thing as a stupid question (unless you already know the answer), and when I was working on my PhD, one prof (not on my committee of three, but who was former head of the department of my major) taught me to try to make sure that I knew what I was talking about. And yes, Dear, it's amazing how much of what I've taught I've now forgotten. [**Smart aleck kid!**]

Otherwise, what I learned was, not from my teachers, but from my own studies. For example, I fondly remember that one of the most satisfying and thorough course I ever took was a course in English Grammar: when I was in high school and for a reason that I don't recall (possibly there was a course conflict), I took it as a “correspondence course”, i.e., entirely by mail.

It was great! What I was required to learn was clearly spelled out, the material was complete, and it was always available for review. [In fact, my nearest age brother completed his entire first year “at university” taking correspondence courses – except for the (next to useless) physics and chem labs that he took with “help” from the local high-school science teacher.]

As another example, after I graduated with my bachelor’s degree in Engineering Physics, I felt that my understanding of physics was weak (even though I had graduated in the top 10% of my class); so, that first summer, I read 50 years’ worth of relevant articles in *Scientific American*. Then, after I failed my first attempt at my PhD qualifying exam (I didn’t realize that I was expected to “cram” for it!), the advice of my three examiners (and advisors) was as follows. Each of my advisors identified a book that they considered fundamental in each of my three fields of concentration (aerospace engineering, plasma physics, and applied math), i.e., fundamental texts in fluid mechanics, electromagnetism, and math for scientists and engineers. During the subsequent 12 months (and while I was taking a full course load plus working on my research assistantship, to earn my keep), I read the three books from “cover to cover” and did all the problems in them. At my next attempt at my qualifying exam, after explaining to my committee members how I had prepared (by reading the recommended books from cover to cover), one of my advisors (whom I liked least, a very caustic character from England) derided me for not having read the “dust jacket” – whereupon I demonstrated to him that I used the expression “cover to cover” only figuratively, and proceeded to demonstrate to him that I had read the dust jackets as well. Within a few hours, I had passed the qualifying exam with “no problem” (left unanswered).

And I’ll add that, subsequently, my “bible” was Morse and Feshbach’s *Methods of Theoretical Physics*, I never would have completed my PhD thesis (which I did, on my own, during the 3 years after I had left the University) without immersing myself in what Nobel laureate Chandrasekhar had written, and I taught courses (e.g., in hypersonics and meteorology) in which I had never, myself, taken courses – but I learned the material on my own, by reading additional text books (cover to cover). All such experiences then lead me to the hypothesis that teachers aren’t essential, save for two critical functions. One is to point students in the right direction (e.g., assign texts and work), and the other function is as examiners (or gatekeepers): to determine if the kids completed their assignments.

I therefore suggest that the desired cultural change, teaching kids how to think critically by teaching them science (starting in kindergarten), can be expedited (without firing a large fraction even of all US teachers!) by providing all teachers (in Kindergarten through Grade 12 – and even beyond) with well-designed and “complete” curriculum material. Which then leads me to comment more on another “major problem area” that I listed in the previous chapter and at the start of this chapter, namely, poorly designed and poorly executed K–12 science programs, i.e.,

### Poor Science Programs.

To improve the K–12 science curricula, substantial resources will be needed to develop and deploy tools and techniques that would give all kids access to all relevant information (plus guidance on how to acquire such knowledge). Let me immediately add, however, that by “substantial resources”, I mean less than 10% of the money that’s currently spent in this country on K–12 education (approximately \$500 billion per year).<sup>3</sup>

Substantial competence, however, will also be required. As I outlined in the previous chapter, already substantial effort has been invested (e.g., in the AAAS Project 2061), but in my opinion, one topic needing substantial additional work deals with integrating math and science “standards”. If you look into details of such proposed “standards”(for the US), you may become as disappointed as I was to see that mathematicians seem to have “gone off on their own” to develop “math standards”,<sup>4</sup> apparently without paying attention to the associated “science standards”.

I suffered through similar stupidity for essentially all 21 years at school (especially in my 9 years of classes at universities). Of the many possible solutions that I considered when I was a student (e.g., shoot all mathematicians, send all mathematicians to prison for 10 years until they demonstrate willingness to cooperate with scientists, fire all mathematicians and let scientists teach all mathematics, etc.), perhaps the most sensible solution (the one that I found worked best for me when I was both a student and a professor) is to let the mathematicians play their games (inventing and teaching their logical constructs), but in all science courses, require that the

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<sup>3</sup> See, e.g., <http://nces.ed.gov/ccd/pubs/npefs03/findings.asp>.

<sup>4</sup> See, e.g., <http://standards.nctm.org/>.

teachers and profs assume that their students know zero about the needed mathematics, and therefore, that it must be taught (also) in the science class. That way, the students gain both two perspectives on the subject and two opportunities to learn how to use the needed tools.

And, Dear, in case you're thinking that I'm referring to "higher math", I'm not! For example, starting with learning about numbers, let mathematicians guide elementary-school teachers to show kids how to play "new-math games" (based on set theory), but simultaneously, as I showed you some in the **I**-chapters, have scientists guide elementary-school teachers in showing kids how to kick trees (to establish that things exist and are distinct) and how people have chosen conventions to label such existences and distinctiveness with what are called numbers.

Similarly, in middle- and high-school, have mathematicians continue to guide teachers how to introduce negative and imaginary numbers, vectors, matrices, etc., based solely on reason, probabilities *via* set theory, etc., but meanwhile, have scientists guide teachers how to (simultaneously) calculate probabilities using common sense (as I tried to show you in **Ih**), calculate areas and define instantaneous rates of change by looking at limits (the method originally used by Archimedes, Leibniz, and Newton), introduce vectors as ordinary physical quantities such as velocity, acceleration, and forces (**there are no such things as negative scalars!**), perform operations on vectors (**there are no such things as imaginary numbers!**), and so on, including teaching the physical significance of tensors of all orders. Thereby, students will have a better chance of seeing what's real (as taught by scientists) also seems to be reasonable (as taught by mathematicians) – and with a little bit of luck, students might even get the sneaking suspicion that what's reasonable (e.g., some stuff that some mathematicians and some clerics teach) isn't necessarily real (because what's rational may be constructed upon faulty premisses).

But beyond developing improved science and math curricula, and given the scientific incompetence of so many teachers, obviously there's a huge need to improve the teaching of especially elementary- and middle-school students about science. So now, putting those two pieces together (that the primary role of teachers is not as lecturers and the need for well designed programs for teaching science), let me try to explain what I meant by advocating "digital-based" or "e-learning".

\* Go to other chapters *via*

The vision that I have (and not just for American kids but for kids throughout the world) includes the following:

- Every elementary-school student in the world possessing a voice-activated personal computer loaded with software from which kids could learn their letters, how to type them, and then their 3Rs and basic ideas in science,
- Every middle-school kid in the world with a personal computer, wirelessly connected to designated instructional sites on the internet, and
- Every high-school student in the world wirelessly connected to all educational sites on the internet.

Simultaneously, the primary roles of teachers (whose numbers might then dwindle and whose competences in specific areas of knowledge would be less important) would then be as role models (as learners), task monitors, guidance counselors, generally as facilitators, and most importantly as guarantors of honesty and integrity. I would hope, furthermore, that any parent could competently assume such roles and responsibilities; therefore, “home schooling” could become a viable alternative for other than religious kooks, provided that all kids made appropriate progress as measured by standardized exams.

In this envisioned scheme (which might be dubbed “digital-based learning” but on the internet is usually labeled as “e-learning”),<sup>5</sup> the critical step is obviously curriculum development. Software and website developments (as well as appropriate computer designs, manufacture, and deployments) would of course be essential, but with the commitment of appropriate resources, accomplishing such steps are certainly feasible.

Thus, already, many private companies have developed tremendous “learning software” (as you know from “the Reader Rabbit” math programs that you started on when you were about three years old!) as well as tremendous websites (e.g., the math-learning website at <http://www.heymath.net>, developed and located in India). What’s primarily needed, therefore, is to put both available- and yet-to-be-developed pieces together in a sound “whole”, for K–12 education (and even beyond).

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<sup>5</sup> Dear: At Google, I got about 10 “hits” for “digital learning” and 125 million “hits” for e-learning! Try it yourself – and soon see how huge the “e-learning” field is!

If you do search on the internet to learn more about “e-learning”, you’ll find that major programs of this type are already underway. For example, according to Google, there are 695,000 web sites that contain the identifiers “e-learning” + “K–12”. In particular, you may want to read about such e-learning K–12 programs already underway in Arizona, Oregon, and Michigan – as well as those underway in Brazil and S. Korea.

And let me add that I was really quite shocked that the authors of the National Academy’s report *Rising Above the Gathering Storm* made essentially no reference to the potentials for improving K–12 science education through the use of e-learning. Adding to my amazement, the authors of that report did mention the potentials for e-learning. Thus, in the Panel’s final recommendation, the authors state:

**Action D-4: Ensure Ubiquitous Broadband Internet Access**

Several nations are well ahead of the United States in providing broadband access for home, school, and business. That capability can be expected to do as much to drive innovation, the economy, and job creation in the 21<sup>st</sup> Century as did access to the telephone, interstate highways, and air travel in the 20<sup>th</sup> Century. Congress and the administration should take prompt action – mainly in the regulatory arena and in spectrum management – to ensure widespread affordable broadband access in the near future.

In support of this “Action Item”, the text states (on pp. 8–15):

As the Internet becomes more dominant in communication, information access, commerce, *education* [italics added], and entertainment, the key infrastructural factor will be broadband access. The potential effects on society and individuals of *distance learning* [italics added], telemedicine, Internet entertainment, and delivery of government services demonstrate how great the impact of broadband on the competitiveness of any country could be.

And yet the authors apparently didn’t realize what they had written! Would that someone on the Academy’s panel would have been as troublesome as I know I was on a number of National Academy panels (I found that it’s sometimes necessary to “shock people” to get their attention!), blurting out something similar to:

Hey, guys, wait a minute: it’s one thing to have your heads buried in the sand, but at least you might notice that the sand is mostly silicon. The future is digital-based or e-learning! Kids have been bored with analog lectures at least since the time of Moses and Plato, but modern kids are in the digital age. It’s time to talk about a paradigm shift!

Let's talk about the possibility of firing all the teachers in the country, closing all the schools, and passing out free computers, education software, and high-speed internet access for everyone! How can the Federal government stimulate the development of e-learning that's consistent with available "standards"? Can we help avert duplication of efforts made by different states? In addition to developing software and websites, what about hiring online mentors, tutors, and advisors? What "certification" would be appropriate? Which jobs could be outsourced? How could we stimulate retired Americans to serve? What about the huge question of exams? If we can find good answers to such questions, I'll bet that we can design an education system that's twice as good as and half the cost of the present one!

Now, Dear, perhaps obviously I'm disappointed in "same-old, same-old" thinking revealed in the Academy's *Gathering Storm* report, whose first two "Action Items" President Bush promoted in his 2006 State of the Union Address:

... to keep America competitive, one commitment is necessary above all: we must continue to lead the world in human talent and creativity. Our greatest advantage in the world has always been our educated, hardworking, ambitious people – and we're going to keep that edge. Tonight I announce an American Competitiveness Initiative, to encourage innovation throughout our economy, and to give our nation's children a firm grounding in math and science.

First, I propose to double the federal commitment to the most critical basic research programs in the physical sciences over the next 10 years... Second, I propose to make permanent the research and development tax credit... Third, we need to encourage children to take more math and science, and to make sure those courses are rigorous enough to compete with other nations. We've made a good start in the early grades with the *No Child Left Behind Act*, which is raising standards and lifting test scores across our country. Tonight I propose to train 70,000 high school teachers to lead advanced-placement courses in math and science, bring 30,000 math and science professionals to teach in classrooms, and give early help to students who struggle with math...

Probably equally obvious is that much work is needed to enhance e-learning. But without digging deeper (investigating both how much has already been done and how much yet remains to be done developing school curricula), perhaps you can already begin to appreciate the enormity of what I consider to be the main task: developing software and websites that will take over (from incompetent teachers) the task of teaching kids how to think scientifically, i.e., to develop and hold opinions only as strongly as relevant evidence warrants.

Cost would be only a few billion dollars per year (pocket change in the educational budget!) to produce excellent K–12 digital-based learning programs (including both hardware and software) for every kid in every subject in Kindergarten through Grade 12 (and even through the first few years of university or trade school) provided that government bureaucrats and schools of education don't do it! The job should be left to private enterprise software and hardware companies. Have government bureaucrats only write, let, and monitor contracts, and have school teachers and faculty members of schools of education only serve as consultants to the companies.

The result of such a development would be that each student in the US, from Kindergarten through the first two-years of college, would have at the student's "beck-and-call" (i.e., on each student's computer) the best designed education programs delivered by American's best educators. Concurrently, the archaic and astoundingly inefficient practice of having each teacher lecture and/or lead (processes that currently are duplicated throughout the country – and throughout the world) could be essentially abandoned. Instead, school teachers would primarily serve as advisors, mentors, helpers, monitors of progress – and loan officers (in my ABC Method of student financing that I'll detail in a later X-chapter). But meanwhile, there are the damnable problems caused by religious fundamentalists (throughout the world) and by associated incompetence of those who control school systems, i.e., the problem area earlier identified as

### **Interference from Religious Fundamentalists.**

The major cause of problems from religious fundamentalists is not derived from misunderstandings of school financing, teacher incompetence, inadequate exams, or poorly designed science curricula, but control of school systems by religious kooks. In different societies, there are different types of "school controllers". In most Muslim countries, the clerics are in control – just as the clerics controlled education in Europe during its Dark Ages. In dictatorships, of course the dictators keep tight control on public education (in schools and *via* the mass media). In democracies, the people theoretically control school policies, but exactly how (and to what extent independently from those who have indoctrinated – and continue to indoctrinate – the people in their worldview) varies among different democratic societies.

\* Go to other chapters *via*

In the US, the situation is bizarre: the “Religious Right” (better, the “Religious Wrong”) has demonstrated that scientific ignoramuses can gain control over local school boards (and legislatures and the presidency!) “simply” with sufficient beating of the bushes to “get out the vote” of similarly ignorant people. In Kansas, not only did the Religious Wrong thereby gain control of local school boards [as they have in school districts at locations throughout the country, especially in “the (Backward) Bible Belt”], they gained control of the State’s Board of Education, which has authority to define the State’s K–12 curriculum. To see more, consider the following assessment, which was written by Thomas G. Donlan in his 21 August 2006 *Editorial Commentary* in *Barron’s* (on line).

Officials in charge of public education ought to be well-educated themselves. It should be impossible to oversee the education of thousands of children without having the clearest available picture of the history of the Earth and the creatures on it.

Kansas, like most states and localities, appoints credentialed teachers, but elects local and state school boards without insisting that they be qualified to set public education policy.

Ten people serve on the Kansas Board of Education. Sample their resumes:

- A used-car saleswoman with years of service on PTAs and a local school board, but with no educational achievement listed on her official biography;
- A real-estate saleswoman who is a veteran of PTAs and a local school board, who has a bachelor's degree in social work;
- An accountant and former city councilman, with a bachelor's degree in accounting;
- A Ph.D. in history who is a member of a university faculty;
- An elementary-school teacher (presumably a college graduate but her official biography does not mention it), who has written a book about recovering from domestic abuse;
- Another grade-school teacher with a master's degree in special education, who also operates a family farm with her husband;
- An insurance-company district manager with a bachelor's degree in political science;
- A former middle-school teacher and local school board member with a bachelor's degree in education;

- A farmer, broadcaster and minister's wife who has a degree in Christian education;
- A doctor of veterinary medicine who previously served on a local school board.

With the exception of the veterinarian, not one of the members of the Kansas state Board of Education has an advanced education in science. And the vet, Dr. Steve Abrams, says he believes that God created the universe 6,500 years ago. He adds, perhaps more accurately than he realizes, that his personal faith “doesn't have anything to do with science.” He supports the 2005 standards that promoted challenges to evolution.

The used-car saleswoman with no degree, by the way, opposes the changes even though she also believes in the biblical creation story. “I don't believe my beliefs should be taught in a science class,” she said.

Dr. Abrams has also been working to remove books he finds pornographic, such as *The Catcher in the Rye*, from school libraries. He says both issues are fundamentally the same: The right of parents and citizens to determine what is taught in public schools.

He has the issue right, but he's on the wrong side. Fundamentally, Kansas has a problem with a limitation of democracy. Even if the wisest statesmen create a representative republic of limited powers, citizens still will elect idealists, charlatans, ignoramuses and fools. They are hard to tell apart...

The political system changes truth according to electoral turnout. Reality remains. Scientists may change truth, but only to accommodate new understanding of reality. Scientific truth is determined by gathering facts, performing experiments, predicting results, testing and repeating *ad infinitum*. It is not handed down in a book or a lecture series or a state standard of learning.

Of course the problem is not unique to Kansas. Further, the possibility that the Religious Wrong will gain control over even more school districts and school boards in the US is quite real. As New York Times' columnist Paul Krugman wrote in his 5 August 2005 column:

The important thing to remember is that like supply-side economics or global-warming skepticism, intelligent design doesn't have to attract significant support from actual [scientific] researchers to be effective. All it has to do is create confusion, to make it seem as if there really is a controversy about the validity of evolutionary theory. That, together with the political muscle of the religious right, may be enough to start a process that ends with banishing Darwin from the classroom.

And as I illustrated in the previous chapter, the situation is even worse in Islamic nations, where teaching anything that conflicts with the silly ideas in the Quran will get teachers killed.

Fundamentally, the objections of religious fundamentalists are not simply to the teaching of evolution, or the age of the Earth (or even the shape of the Earth!), sexual health, or whatever other topic they attack; fundamentally, their objection is to anything that challenges their worldview. They want their children indoctrinated in the same archaic worldviews in which they were indoctrinated, which in turn can be traced to the primitive worldviews developed in ancient Egypt, Mesopotamian, Persia, and India.

The essence of their simplistic worldview (now that it's been simplified even more than what the ancient Egyptians, Mesopotamians, Persians, and Indians taught their kids!) is that there's a magic man in the sky who's in control. In America, for example, kids are to place their hands over their hearts and say, every day, that this is “one nation under [a magic man in the sky]”. For understandable reasons, religious fundamentalists don't want their children to be told that their parents' views are silly, they don't want teachers to label them as fools, and they don't want their (or their children's) heavenly hopes smashed on rocks of realism.

As for what to do about such a sad situation, which reveals both fundamental inadequacies with democracies (or more accurately, fundamental incompetence of the electorate) and some of the many horrors with theocracies, I'll offer some suggestions in subsequent X-chapters. To end this chapter, let me just show you some steps being taken to try to eliminate such ignorance, at least in the US.

Objections from religious fundamentalists (be they Jews, Christians, Muslims, or Mormons) to scientifically sound teaching of various aspects of human sexuality will almost certainly continue so long as “the fundies” promote literal interpretations of their “holy books”, since such silly books provide ample “evidence” that Yahweh, Jehovah, God, Allah... approves only the sexual behavior that was the norm (or the clerics' desire!) for Mid-Eastern cultures ~2,000 years ago. Then, humans weren't individuals but members of patriarchal families, racist clans, and tyrannical kingdoms and empires. To overcome such backwardness, my guess is that, in general, it would be best for scientists and educators to “stay out of the fray”, leaving the fights to the politicians and clerics.

\* Go to other chapters *via*

For example, in the case of sex education in the US, I recently saw that a high school in Los Alamos, New Mexico, chose a simple “solution”: they have students deliver a note to their parents that describes topics to be discussed and that provides opportunity for parents to approve their kids’ skipping those classes. Such a (politically-astute) method places authority and responsibility (to behave as fools or as responsible adults) squarely where it belongs, i.e., on the parents.

In the case of the teaching of evolution, scientists can perform useful community services by exposing all hoaxes, such as the recently promoted hoax labeled “intelligent design”. A great example is the following op-ed contribution to the 28 August 2005 issue of *The New York Times* by Daniel C. Dennett.<sup>6</sup>

*Show Me the Science*

By DANIEL C. DENNETT

PRESIDENT BUSH, announcing this month that he was in favor of teaching about “intelligent design” in the schools, said, “I think that part of education is to expose people to different schools of thought.” A couple of weeks later, Senator Bill Frist of Tennessee, the Republican leader, made the same point. Teaching both intelligent design and evolution “doesn’t force any particular theory on anyone,” Mr. Frist said. “I think in a pluralistic society that is the fairest way to go about education and training people for the future.”

Is “intelligent design” a legitimate school of scientific thought? Is there something to it, or have these people been taken in by one of the most ingenious hoaxes in the history of science? Wouldn’t such a hoax be impossible? No. Here’s how it has been done.

First, imagine how easy it would be for a determined band of naysayers to shake the world’s confidence in quantum physics – how weird it is! – or Einsteinian relativity. In spite of a century of instruction and popularization by physicists, few people ever really get their heads around the concepts involved. Most people eventually cobble together a justification for accepting the assurances of the experts: “Well, they pretty much agree with one another, and they claim that it is their understanding of these strange topics that allows them to harness atomic energy, and to make transistors and lasers, which certainly do work...”

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<sup>6</sup> Daniel C. Dennett is a professor of philosophy at Tufts University and author of the books *Freedom Evolves* and *Darwin’s Dangerous Idea*. The article appeared in the 28 August 2005 issue of and is copyrighted by *The New York Times*.

Fortunately for physicists, there is no powerful motivation for such a band of mischief-makers to form. They don't have to spend much time persuading people that quantum physics and Einsteinian relativity really have been established beyond all reasonable doubt.

With evolution, however, it is different. The fundamental scientific idea of evolution by natural selection is not just mind-boggling; natural selection, by executing God's traditional task of designing and creating all creatures great and small, also seems to deny one of the best reasons we have for believing in God. So there is plenty of motivation for resisting the assurances of the biologists.

Nobody is immune to wishful thinking. It takes scientific discipline to protect ourselves from our own credulity, but we've also found ingenious ways to fool ourselves and others. Some of the methods used to exploit these urges are easy to analyze; others take a little more unpacking.

A creationist pamphlet sent to me some years ago had an amusing page in it, purporting to be part of a simple questionnaire:

**Test Two**

Do you know of any building that didn't have a builder? [YES] [NO]

Do you know of any painting that didn't have a painter? [YES] [NO]

Do you know of any car that didn't have a maker? [YES] [NO]

If you answered YES for any of the above, give details:

Take that, you Darwinians! The presumed embarrassment of the test-taker when faced with this task perfectly expresses the incredulity many people feel when they confront Darwin's great idea. It seems obvious, doesn't it, that there couldn't be any designs without designers, any such creations without a creator?

Well, yes – until you look at what contemporary biology has demonstrated beyond all reasonable doubt: that natural selection – the process in which reproducing entities must compete for finite resources and thereby engage in a tournament of blind trial and error from which improvements automatically emerge – has the power to generate breathtakingly ingenious designs.

Take the development of the eye, which has been one of the favorite challenges of creationists. How on earth, they ask, could that engineering marvel be produced by a series of small, unplanned steps? Only an intelligent designer could have created such a brilliant arrangement of a shape-shifting lens, an aperture-adjusting iris, a light-sensitive image surface of exquisite sensitivity, all housed in a sphere that can shift its aim in a hundredth of a second and send megabytes of information to the visual cortex every second for years on end.

But as we learn more and more about the history of the genes involved, and how they work – all the way back to their predecessor genes in the sightless bacteria from

which multicelled animals evolved more than a half-billion years ago – we can begin to tell the story of how photosensitive spots gradually turned into light-sensitive craters that could detect the rough direction from which light came, and then gradually acquired their lenses, improving their information-gathering capacities all the while.

We can't yet say what all the details of this process were, but real eyes representative of all the intermediate stages can be found, dotted around the animal kingdom, and we have detailed computer models to demonstrate that the creative process works just as the theory says.

All it takes is a rare accident that gives one lucky animal a mutation that improves its vision over that of its siblings; if this helps it have more offspring than its rivals, this gives evolution an opportunity to raise the bar and ratchet up the design of the eye by one mindless step. And since these lucky improvements accumulate – this was Darwin's insight – eyes can automatically get better and better and better, without any intelligent designer.

Brilliant as the design of the eye is, it betrays its origin with a tell-tale flaw: the retina is inside out. The nerve fibers that carry the signals from the eye's rods and cones (which sense light and color) lie on top of them, and have to plunge through a large hole in the retina to get to the brain, creating the blind spot. No intelligent designer would put such a clumsy arrangement in a camcorder, and this is just one of hundreds of accidents frozen in evolutionary history that confirm the mindlessness of the historical process.

If you still find Test Two compelling, a sort of cognitive illusion that you can feel even as you discount it, you are like just about everybody else in the world; the idea that natural selection has the power to generate such sophisticated designs is deeply counterintuitive. Francis Crick, one of the discoverers of DNA, once jokingly credited his colleague Leslie Orgel with "Orgel's Second Rule": Evolution is cleverer than you are. Evolutionary biologists are often startled by the power of natural selection to "discover" an "ingenious" solution to a design problem posed in the lab.

This observation lets us address a slightly more sophisticated version of the cognitive illusion presented by Test Two. When evolutionists like Crick marvel at the cleverness of the process of natural selection they are not acknowledging intelligent design. The designs found in nature are nothing short of brilliant, but the process of design that generates them is utterly lacking in intelligence of its own.

Intelligent design advocates, however, exploit the ambiguity between process and product that is built into the word "design." For them, the presence of a finished product (a fully evolved eye, for instance) is evidence of an intelligent design process. But this tempting conclusion is just what evolutionary biology has shown to be mistaken.

Yes, eyes are for seeing, but these and all the other purposes in the natural world can be generated by processes that are themselves without purposes and without intelligence. This is hard to understand, but so is the idea that colored objects in the world are composed of atoms that are not themselves colored, and that heat is not made of tiny hot things.

The focus on intelligent design has, paradoxically, obscured something else: genuine scientific controversies about evolution that abound. In just about every field there are challenges to one established theory or another. The legitimate way to stir up such a storm is to come up with an alternative theory that makes a prediction that is crisply denied by the reigning theory – but that turns out to be true, or that explains something that has been baffling defenders of the *status quo*, or that unifies two distant theories at the cost of some element of the currently accepted view.

To date, the proponents of intelligent design have not produced anything like that. No experiments with results that challenge any mainstream biological understanding. No observations from the fossil record or genomics or biogeography or comparative anatomy that undermine standard evolutionary thinking.

Instead, the proponents of intelligent design use a ploy that works something like this. First you misuse or misdescribe some scientist's work. Then you get an angry rebuttal. Then, instead of dealing forthrightly with the charges leveled, you cite the rebuttal as evidence that there is a "controversy" to teach.

Note that the trick is content-free. You can use it on any topic. "Smith's work in geology supports my argument that the earth is flat," you say, misrepresenting Smith's work. When Smith responds with a denunciation of your misuse of her work, you respond, saying something like: "See what a controversy we have here? Professor Smith and I are locked in a titanic scientific debate. We should teach the controversy in the classrooms." And here is the delicious part: you can often exploit the very technicality of the issues to your own advantage, counting on most of us to miss the point in all the difficult details.

William Dembski, one of the most vocal supporters of intelligent design, notes that he provoked Thomas Schneider, a biologist, into a response that Dr. Dembski characterizes as "some hair-splitting that could only look ridiculous to outsider observers." What looks to scientists – and is – a knockout objection by Dr. Schneider is portrayed to most everyone else as ridiculous hair-splitting.

In short, no science. Indeed, no intelligent design hypothesis has even been ventured as a rival explanation of any biological phenomenon. This might seem surprising to people who think that intelligent design competes directly with the hypothesis of non-intelligent design by natural selection. But saying, as intelligent design proponents do, "You haven't explained everything yet," is not a competing hypothesis.

Evolutionary biology certainly hasn't explained everything that perplexes biologists. But intelligent design hasn't yet tried to explain anything.

To formulate a competing hypothesis, you have to get down in the trenches and offer details that have testable implications. So far, intelligent design proponents have conveniently sidestepped that requirement, claiming that they have no specifics in mind about who or what the intelligent designer might be.

To see this shortcoming in relief, consider an imaginary hypothesis of intelligent design that could explain the emergence of human beings on this planet:

About six million years ago, intelligent genetic engineers from another galaxy visited Earth and decided that it would be a more interesting planet if there was a language-using, religion-forming species on it, so they sequestered some primates and genetically re-engineered them to give them the language instinct, and enlarged frontal lobes for planning and reflection. It worked.

If some version of this hypothesis were true, it could explain how and why human beings differ from their nearest relatives, and it would disconfirm the competing evolutionary hypotheses that are being pursued.

We'd still have the problem of how these intelligent genetic engineers came to exist on their home planet, but we can safely ignore that complication for the time being, since there is not the slightest shred of evidence in favor of this hypothesis.

But here is something the intelligent design community is reluctant to discuss: no other intelligent-design hypothesis has anything more going for it. In fact, my farfetched hypothesis has the advantage of being testable in principle: we could compare the human and chimpanzee genomes, looking for unmistakable signs of tampering by these genetic engineers from another galaxy. Finding some sort of user's manual neatly embedded in the apparently functionless "junk DNA" that makes up most of the human genome would be a Nobel Prize-winning coup for the intelligent design gang, but if they are looking at all, they haven't come up with anything to report.

It's worth pointing out that there are plenty of substantive scientific controversies in biology that are not yet in the textbooks or the classrooms. The scientific participants in these arguments vie for acceptance among the relevant expert communities in peer-reviewed journals, and the writers and editors of textbooks grapple with judgments about which findings have risen to the level of acceptance – not yet truth – to make them worth serious consideration by undergraduates and high school students.

So, get in line, intelligent designers. Get in line behind the hypothesis that life started on Mars and was blown here by a cosmic impact. Get in line behind the aquatic ape hypothesis, the gestural origin of language hypothesis, and the theory that singing

came before language, to mention just a few of the enticing hypotheses that are actively defended but still insufficiently supported by hard facts.

The Discovery Institute, the conservative organization that has helped to put intelligent design on the map, complains that its members face hostility from the established scientific journals. But establishment hostility is not the real hurdle to intelligent design. If intelligent design were a scientific idea whose time had come, young scientists would be dashing around their labs, vying to win the Nobel Prizes that surely are in store for anybody who can overturn any significant proposition of contemporary evolutionary biology.

Remember cold fusion? The establishment was incredibly hostile to that hypothesis, but scientists around the world rushed to their labs in the effort to explore the idea, in hopes of sharing in the glory if it turned out to be true.

Instead of spending more than \$1 million a year on publishing books and articles for non-scientists and on other public relations efforts, the Discovery Institute should finance its own peer-reviewed electronic journal. This way, the organization could live up to its self-professed image: the doughty defenders of brave iconoclasts bucking the establishment.

For now, though, the theory they are promoting is exactly what George Gilder, a long-time affiliate of the Discovery Institute, has said it is: “Intelligent design itself does not have any content.”

Since there is no content, there is no “controversy” to teach about in biology class. But here is a good topic for a high school course on current events and politics: Is intelligent design a hoax? And if so, how was it perpetrated?

Another example, which goes even further, is the following 23 August 2005 article in *The New York Times* written by Verlyn Klinkenborg:

*Grasping the Depth of Time as a First Step in Understanding Evolution*  
By VERLYN KLINKENBORG

... accepting intelligent design means discarding science. Much has been made of a 2004 poll showing that some 45 percent of Americans believe that the Earth – and humans with it – was created as described in the book of Genesis, and within the past 10,000 years. This isn’t a triumph of faith. It’s a failure of education.

The purpose of the campaign for intelligent design is to deepen that failure. To present the arguments of intelligent design as part of a debate over evolution is nonsense. From the scientific perspective, there is no debate. But even the illusion of a debate is a sorry victory for antievolutionists, a public-relations victory based, as so many have been in recent years, on ignorance and obfuscation.

*The essential, but often well-disguised, purpose of intelligent design, is to preserve the myth of a separate, divine creation for humans in the belief that only that can explain who we are. But there is a destructive hubris, a fearful arrogance, in that myth. It sets us apart from nature, except to dominate it. It misses both the grace and the moral depth of knowing that humans have only the same stake, the same right, in the Earth as every other creature that has ever lived here. There is a righteousness – a responsibility – in the deep, ancestral origins we share with all of life. [Italics added.]*

Dear, I hope that you'll re-read Klinkenborg's final paragraph (above).

As I already wrote, the hubris of religionists (synonymously meaning “arrogance, conceit, haughtiness, pride, self-importance, egotism, pomposity, superciliousness, superiority”) is a horrible and dangerous combination of ignorance and arrogance. In the remaining X-chapters, I want to suggest possible ways to eXpedite cultural change by deflating the hubris of so many humans, to try to get them to become aware that they are merely humans, just like the rest of us, who (as far as we know) are the most intelligent species in a vast universe of ignorance. If such awareness would become widely appreciated (of course with appropriate modification if relevant data become available), then maybe humans could get busy with a little “intelligent design” of their own, using the scientific method (guess, test, and re-assess) to find pathways to green pastures of peace and prosperity, throughout the world. First, though, may I humbly suggest that you get some exercise?