X19 – EXchanging Worldviews, 19: EXploring Prospects for Peace & Prosperity, 11: EXtricating Humanity from EXcruciating Problems by, 5: EXpediting Cultural Change, via 1: EXtracting Evaluative Thinking from Science Education

Dear: I'd tend to agree with you, if you complained that I seem to be drowning and grasping at straws (for suggesting, as I did in the previous chapter, that prospects for peace and prosperity depend on competition for "fruits from the tree of knowledge", viz., science). Probably more securely, one could argue that prospects for peace and prosperity are, not only dim, but they get dimmer with increasing reliance on science and technology!

In that regard, reference could be made to the Mutually Assured Destruction (MAD) standoff between the US and the USSR, which during most of my lifetime resulted in severe environmental degradation, almost ruined the US's economy, arguably did ruin the USSR's economy, and nearly resulted in global-scale nuclear war. Further, and more relevant to events during your lifetime, reference could be made to:

- Technologically induced environmental degradation in China, India, and elsewhere,
- Current nuclear weapons in North Korea and Pakistan (draining already weak economies; thereby damaging prosperity), and
- The possibility of terrorists and terrorist states (e.g., Iran) using "scientifically advanced" weapons of mass destruction.

On the other hand, though, counter-arguments could be made that such cases illustrate dangers of political mismanagement of technology – although I admit that it's easier (and more common) to blame science and technology.

But both arguments can be labeled with the ultimate insult: they're academic! In reality:

- Approximately a billion people in China and another billion-or-so in India apparently relish consuming as much as Westerners do,
- Most Pakistanis and North Koreans are apparently convinced (mostly courtesy their leaders' propaganda machines) that they need nuclear weapons to deter threats, and

- Most terrorists are living in their version of the Dark Ages – courtesy their clerics (who've managed to convince the people that it's not they, the clerics, who are in control but some magic man or giant Jabberwock in the sky).

In reality, furthermore, there's "no way" that this poor old Earth of ours can support so many people consuming so much, and there's zero evidence to support the contention that some magic man in the sky will bail us out of our problems. Consequently, given that either "we the people" will solve our problems or our descendants (if there are any!) will suffer the consequences, the question is: How do we solve such problems?

More than anything else, the answer seems to be "slowly" – if at all. What's needed are major cultural changes throughout the world. Yet, the reality is: many basic aspects of any culture usually change only slowly. Certainly there's evidence to support the proposition that some aspects of some cultures change rapidly (e.g., associated with advances in technology, from the steam engine to airplanes, and from the printing press to the internet), but when you think of how the *jihadis* use the internet and airplanes to help them destroy, maim, and kill, then I expect you'll agree that basic aspects of most cultures change only slowly.

As a result, H.G. Wells's assessment haunts us: "Human history [or maybe better, "humanity's future"] becomes more and more a race between education and catastrophe." The comedian/ author/ culture-critic/ screenplay writer and movie director Woody Allen summarized the situation well:

> More than any other time in history, mankind faces a crossroads. One path leads to despair and utter hopelessness. The other to total extinction. Let us pray we have the wisdom to choose correctly.

In search of that "wisdom", the question I want to begin to address in this chapter is: How can changes in basic aspects of every culture be "expedited" (i.e., sped up) – for the better? An overview of "the message" that I want to convey is the following. To enhance prospects for peace and prosperity, to get more people to (as a certain grandchild would say) "Get real!", what's needed is to expedite: training in evaluative thinking, prohibition of all types of child abuse, liberation of women, suppression of violence, widespread appreciation and adoption of individual rights and collective responsibilities, and the replacement of supernatural worldviews with worldviews grounded in data.

Suggesting how all that might be accomplished will be the thrust of the rest of these **X**-chapters. For this chapter, emphasis will be on expediting improvements in education. In particular, I want to address how to expedite extracting evaluative-thinking skills from science classes, so that, worldwide, kids will gain improved capabilities to think critically.

IN PRINCIPLE *versus* IN PRACTICE

To start, I want to try to explain why I agree (in principle) with other authors who suggest that evaluative-thinking skills can be (and should be!) taught in essentially all subjects – but why, simultaneously, I advocate that (in practice) emphasis should be placed on extracting evaluative-thinking lessons from science classes.

Thus, in general and in principle, I agree with the statement by Paul and co-authors (which I quoted in an earlier chapter and partially re-quote below):[1]

> The result of the collective contribution of the history of critical thought is that the basic questions of Socrates can now be much more powerfully and focally framed and used. In every domain of human thought, and within every use of reasoning within any domain, it is now possible to question:
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> - ends and objectives,
> - the status and wording of questions,
> - the sources of information and fact,
> - the method and quality of information collection,
> - the mode of judgment and reasoning used,
> - the concepts that make that reasoning possible,
> - the assumptions that underlie concepts in use,
> - the implications that follow from their use, and
> - the point of view or frame of reference within which reasoning takes place.
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> In other words, questioning that focuses on these fundamentals of thought and reasoning are now baseline in critical thinking. It is beyond question that intellectual errors or mistakes can occur in any of these dimensions, and that students need to be fluent in talking about these structures and standards.

[1] From **A Brief History of the Idea of Critical Thinking** by Richard Paul, Linda Elder, and Ted Bartell, in *The California Teacher Preparation for Instruction in Critical Thinking: Research Findings and Policy Recommendations* (State of California, California Commission on Teacher Credentialing, Sacramento, CA, March 1997); available at http://www.criticalthinking.org/aboutCT/briefHistoryCT.shtml.

> Independent of the subject studied, students need to be able to articulate thinking about thinking that reflects basic command of the intellectual dimensions of thought: "Let's see, what is the most fundamental issue here? From what point of view should I approach this problem? Does it make sense for me to assume this? From these data may I infer this? What is implied in this graph? What is the fundamental concept here? Is this consistent with that? What makes this question complex? How could I check the accuracy of these data? If this is so, what else is implied? Is this a credible source of information?, etc., etc…"
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> With intellectual language such as this in the foreground, students can now be taught at least minimal critical thinking moves within any subject field. What is more, there is no reason in principle that students cannot take the basic tools of critical thought which they learn in one domain of study and extend it (with appropriate adjustments) to all the other domains and subjects which they study. For example, having questioned the wording of a problem in math, I am more likely to question the wording of a problem in the other subjects I study.
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> As a result of the fact that students can learn these generalizable critical thinking moves, they need not be taught history simply as a body of facts to memorize; they can now be taught history as historical reasoning. Classes can be designed so that students learn to think historically and develop skills and abilities essential to historical thought. Math can be taught so that the emphasis is on mathematical reasoning. Students can learn to think geographically, economically, biologically, chemically, in courses within these disciplines. In principle, then, all students can be taught so that they learn how to bring the basic tools of disciplined reasoning into every subject they study…

In brief, the authors basically state that kids can be (and should be) taught how to think critically in any subject area. Notice, however, that their summary sentence starts with "In principle…" Meanwhile, in practice, many problems arise when educators attempt to teach kids to think critically.

Below, I'll try to show you what I mean by the previous sentence. To do so, I'll divide such practical problems into two categories: educational and political. In this chapter, I'll emphasize the practical, educational problems (which are less controversial). In the next chapter, I'll emphasize political problems that impede students from developing evaluative-thinking skills even in science (e.g., objections by religious fundamentalists to teaching evolution). Summed, the (huge!) practical, educational problem (associated with trying to teach kids evaluative-thinking skills by digging into subjects other than science) can be succinctly stated as: It ain't easy! That is, in essentially all other subject areas, kids can't just "walk up to a subject" and start thinking critically: they first must learn what to think about!

PROBLEMS TEACHING CRITICAL THINKING

To begin to explain what I mean, consider the following quotation from an article entitled "Lost In Action – Are time-consuming, trivializing activities displacing the cultivation of active minds?".[2] This article was written by Gilbert T. Sewall, "co-author of the 1978 history textbook *After Hiroshima: The USA since 1945,* a former history instructor at Phillips Academy, and for more than a decade, president of the American Textbook Council, an independent organization that reviews history and social-studies textbooks."

> Hands-on classroom activities have expanded exponentially, because teachers think that's what they are supposed to be doing. Administrators, curriculum specialists, educational gurus, workshop presenters, psychologists, academic journals, and textbook publishers have told teachers that activities are the only way to engage students. "Chalk and talk" and "drill and kill" are the derisive names given to traditional approaches. Teachers, understandably, shudder at the thought of being associated with such dreary pedagogy. Should they resist the conventional wisdom, they may face scorn and intimidation for being instructionally out of date or insensitive to student needs.
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> Lack of variety and imagination in assignments does lead to dull classrooms. Whole-class, teacher-led instruction is not always of high quality. But it certainly can be, frequently is, and would be much more often if it weren't caricatured as inevitably boring and ineffective, thus discouraging teachers from perfecting the art, as Japanese teachers work so hard and successfully do…[3]
>
> In a false bow to so-called "critical thinking", history and social studies activities often embrace questions and events so complex and perplexing that the nation's greatest minds feel timorous in their presence, as the historian and essayist Paul Gagnon has noted. Prentice Hall's high school textbook *World History: Connections to Today,* for instance, asks students to ponder the question, "Is war ever justified?" based on very short observations about war from the ancient Chinese warrior Sun Tzu, the Aztecs, Catherine the Great, Jose Marti, Gandhi, and a member of Another Mother Against War… This is followed by an activity in which students "investigate" other points of view, finally expressing the viewpoint they "agree with most" in their own ways, which may be "an essay, a cartoon, a poem, a drawing or painting, a song, a skit, a video, or some other way." In the same book, students are supposed to follow the same steps to "decide" such issues as "Is technology a blessing or curse?" and "Does diversity strengthen or weaken a society?"…

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[2] The full article, published in the Summer 2000 issue of *American Educator,* is at http://www.aft.org/pubs-reports/american_educator/summer2000/LostInAction.htm.

[3] A footnote to the text states: "See 'Polishing the Stone: How Asian Teachers Perfect Their Lessons', by James Stigler and Harold Stevenson (*American Educator,* Spring 1991)."

> Balance is everything in education, and just as teachers should sometimes make judgments that land on the side of activity, so they must also often act as experts and leaders. Teachers have to ask themselves: Is writing an eyewitness journal entry on "what it was like to witness the signing of the Declaration of Independence" really the best way for eighth-graders to learn the principles of the Declaration? Do we give up making that mural of the Underground Railroad in order to get a more in-depth understanding of the Civil War through reading the Emancipation Proclamation or memorizing the Gettysburg Address? Which is doable in a shorter amount of time, and which is more valuable?
>
> In order to succeed, projects and activities take more planning, care, and work for teachers than standard lessons. In both successful and unsuccessful projects, teachers work very hard to make learning direct and lively. When successful, the inner satisfaction of developing the activity and fusing it to academic content drives teacher and student alike.
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> Teachers must define the scope, limit the things to be learned, and make sure students learn these things. If the subject is handled with planning and forethought, students will gain a sense of mastery from a project, not frustration.
>
> In designing activities and projects, teachers must ask: What do I want to accomplish by this? Is an activity the most effective and time-efficient way to achieve results? What evidence will stand to prove the desired end has been achieved? How is this project intended to advance what most or all students should know or be able to do?
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> Activities and projects work best when they are matched to the individual, stimulate intellectual growth in ways that the student cannot yet know, and build on knowledge that gives the endeavor depth and substance upon completion. Selection, arrangement, focus, presentation, practice, review – the mainstays of curriculum – must all be taken into account.
>
> Education is not a game. The only valid architecture for projects and activities is core knowledge. How to handle words, express yourself fluently, and listen are not educational electives. No substitute exists for the foundations of mathematics, history, and science. Individual deliberation, judgment, understanding, and the ability to take advantage of the present depend on an individual's storehouse of these fundamental facts and skills. They are the armature, skeleton, and building blocks on which continuing education depends…

To more fully appreciate what Sewall is describing, it might be useful to seek a different perspective – perhaps especially the perspective provided by my introducing "Bloom's taxonomy", which is a term used to describe what can also be called a "pyramid of intellectual inquiry" or "thinking pyramid".

Such a "thinking pyramid" exists in every subject area (history, science, English literature, social studies…). An outline of this "pyramid" or "taxonomy" (from the Greek word *taxis,* meaning 'arrangement', plus the Latin word *nomia,* meaning 'distribution') can be seen from the following quotations, taken from the indicated sources.

> **Bloom's Taxonomy**[4]
> Following the 1948 Convention of the American Psychological Association, B. S. Bloom took a lead in formulating a classification of "the goals of the educational process". Three 'domains' of educational activities were identified. The first of these, named the Cognitive Domain, involves knowledge and the development of intellectual attitudes and skills. (The other domains are the Affective Domain and the Psychomotor Domain, and need not concern us here.) Eventually, Bloom and his co-workers established a hierarchy of educational objectives, which is generally referred to as Bloom's Taxonomy, and which attempts to divide cognitive objectives into subdivisions ranging from the simplest behavior to the most complex.

Here, I'll insert a schematic of this taxonomy:[5]

Now, I'll continue with the description given in the first reference:

> It is important to realize that the divisions outlined above are not absolutes and that other systems or hierarchies have been devised. However, Bloom's taxonomy is easily understood and widely applied. [The pyramid levels are defined as follows.]
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> *Knowledge:* Knowledge is defined as the remembering of previously learned material. This may involve the recall of a wide range of material, from specific facts to complete theories, but all that is required is the bringing to mind of the appropriate information. Knowledge represents the lowest level of learning outcomes in the cognitive domain. Examples of learning objectives at this level are: know common

[4] From http://web.uct.ac.za/projects/cbe/mcqman/mcqappc.html.
[5] From http://www.officeport.com/edu/blooms.htm.

terms, know specific facts, know methods and procedures, know basic concepts, know principles.

Comprehension: Comprehension is defined as the ability to grasp the meaning of material. This may be shown by translating material from one form to another (words to numbers), by interpreting material (explaining or summarizing), and by estimating future trends (predicting consequences or effects). These learning outcomes go one step beyond the simple remembering of material, and represent the lowest level of understanding. Examples of learning objectives at this level are: understand facts and principles, interpret verbal material, interpret charts and graphs, translate verbal material to mathematical formulae, estimate the future consequences implied in data, justify methods and procedures.

Application: Application refers to the ability to use learned material in new and concrete situations. This may include the application of such things as rules, methods, concepts, principles, laws, and theories. Learning outcomes in this area require a higher level of understanding than those under comprehension. Examples of learning objectives at this level are: apply concepts and principles to new situations, apply laws and theories to practical situations, solve mathematical problems, construct graphs and charts, demonstrate the correct usage of a method or procedure.

Analysis: Analysis refers to the ability to break down material into its component parts so that its organizational structure may be understood. This may include the identification of parts, analysis of the relationship between parts, and recognition of the organizational principles involved. Learning outcomes here represent a higher intellectual level than comprehension and application because they require an understanding of both the content and the structural form of the material. Examples of learning objectives at this level are: recognize unstated assumptions, recognize logical fallacies in reasoning, distinguish between facts and inferences, evaluate the relevancy of data, analyze the organizational structure of a work (art, music, writing).

Synthesis: Synthesis refers to the ability to put parts together to form a new whole. This may involve the production of a unique communication (theme or speech), a plan of operations (research proposal), or a set of abstract relations (scheme for classifying information). Learning outcomes in this area stress creative behaviors, with major emphasis on the formulation of new patterns or structure. Examples of learning objectives at this level are: write a well organized theme, give a well organized speech, write a creative short story (or poem or music), propose a plan for an experiment, integrate learning from different areas into a plan for solving a problem, formulates a new scheme for classifying objects (or events, or ideas).

Evaluation: Evaluation is concerned with the ability to judge the value of material (statement, novel, poem, research report) for a given purpose. The judgments are to be based on definite criteria. These may be internal criteria (organization) or external criteria (relevance to the purpose) and the student may determine the criteria or be

> given them. Learning outcomes in this area are highest in the cognitive hierarchy because they contain elements of all the other categories, plus conscious value judgments based on clearly defined criteria. Examples of learning objectives at this level are: judge the logical consistency of written material, judge the adequacy with which conclusions are supported by data, judge the value of a work (art, music, writing) by the use of internal criteria, judge the value of a work (art, music, writing) by use of external standards of excellence.

Finally for this summary description of Bloom's Taxonomy, it might be useful if I added the following quotation from Huitt.[6]

> In general, research over the last 40 years has confirmed the taxonomy as a hierarchy with the exception of the last two levels. It is uncertain at this time whether synthesis and evaluation should be reversed (i.e., evaluation is less difficult to accomplish than synthesis) or whether synthesis and evaluation are at the same level of difficulty but use different cognitive processes. Anderson and Krathwohl revised Bloom's taxonomy and placed evaluating prior to creating. In my opinion, it is more likely that synthesis/creating and evaluation/evaluating are at the same level. Both depend on analysis as a foundational process. However, synthesis or creating requires rearranging the parts in a new, original way whereas evaluation or evaluating requires a comparison to a standard with a judgment as to good, better or best. This is similar to the distinction between creative thinking and critical thinking. Both are valuable while neither is superior. In fact, when either is omitted during the problem solving process, effectiveness declines…

Thus, Dear, critical- (or evaluative-) thinking skills (and also creative-thinking skills) are at the top of a hierarchy (or pyramid) of thinking skills – and if the lower levels are omitted, the entire pyramid commonly collapses into a rubble of "touchy-feely" emotional dribble, which unfortunately is all too common in many US classrooms (and which, it seems to me, is what Sewall was describing in his article quoted a few pages ago).

Thereby, Dear, probably you're beginning to see what I meant when I summarized that "it ain't easy" to overcome the "huge, practical, educational problem" in trying to teach kids critical- (or creative-) thinking skills in most subject areas. For example, in history, literature, political science, etc., students need to spend years of study, climbing up the "thinking pyramid", before reaching levels where they can think critically.

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[6] From http://chiron.valdosta.edu/whuitt/col/cogsys/bloom.html: Huitt, W. (2004). *Bloom et al.'s taxonomy of the cognitive domain.* Educational Psychology Interactive, Valdosta State University, Valdosta, GA; retrieved 19 June 2006.

Thus, even if there were no political obstructions, how could kids sensibly evaluate, for example, a Shakespearian play or a Steinbeck novel, the "real cause" of America's Civil War, inadequacies of American-style democracy, difficulties in establishing democracies in Islamic countries, the silliness of all supernatural worldviews… without first mentally climbing to the top of appropriate "thinking pyramids"?!

TEACHING CRITICAL THINKING *via* SCIENCE

In contrast to attempts to develop and apply "critical-thinking skills" in such other subject areas (history, literature, social studies, etc.), in most science – and especially in the most important part of science (viz., the scientific method) – the case is dramatically different. Thus, as I tried to show you in earlier chapters, kids (on their own) start learning the scientific method when they're still in their cribs. They continue to use the scientific method, on their own, throughout their childhood, as they learn how to talk, walk, bounce a ball, ride a bike, etc. That is, kids continuously apply the essence of the scientific method: guess, test, and reassess.

As a result and starting immediately in kindergarten (or even pre-school), teachers can continue to do what the kids' parents probably started: show kids how to apply the scientific method to solve personal and inter-personal problems, i.e., by obtaining data, trying to make sense of it with an hypothesis, designing tests of predictions of their hypothesis, obtaining more data, and so on. Similar can (and should) continue throughout school: kids can learn about "how the world works" by extrapolating from their own experiences (as Schopenhauer recommended), i.e., by performing experiments on a huge variety of topics: relating the change in the weather to barometric pressure, measuring the growth rates of plants as a function of soil moisture and nutrients, measuring masses and velocities to determine if momentum is conserved during collisions, and so on, on and on. Stated differently, although kids become critical/ evaluative/ scientific thinkers while they're still in their cribs, this learning how to think critically can be (and should be) continuous – for as long as they live!

Thereby, Dear, I hope you can see why I agree with what Sewall wrote – except in the case of the most important part of science, i.e., the scientific method. Thus, I can agree with a history teacher's (e.g., Sewall's) criticism:

> In a false bow to so-called "critical thinking", history and social studies activities often embrace questions and events so complex and perplexing that the nation's greatest minds feel timorous in their presence, as the historian and essayist Paul Gagnon has noted. Prentice Hall's high school textbook *World History: Connections to Today,* for instance, asks students to ponder the question, "Is war ever justified?" based on very short observations about war from the ancient Chinese warrior Sun Tzu, the Aztecs, Catherine the Great, Jose Marti, Gandhi, and a member of Another Mother Against War… This is followed by an activity in which students "investigate" other points of view, finally expressing the viewpoint they "agree with most" in their own ways, which may be "an essay, a cartoon, a poem, a drawing or painting, a song, a skit, a video, or some other way." In the same book, students are supposed to follow the same steps to "decide" such issues as "Is technology a blessing or curse?" and "Does diversity strengthen or weaken a society?"…

That is, I agree that kids can't engage in such critical thinking in history (or social studies or literature or…) until they've climbed a fair distance up the thinking pyramid, with a "back-pack" loaded with "core knowledge".

Meanwhile, though, I have the impression that Sewall doesn't have a clue about the essence of science (i.e., the scientific method). Let me try to show you what I mean. Thus, based on what he wrote, I suspect that Sewall would promote that elementary-school kids be instructed in the "core knowledge" that the Earth is more like a ball than a flat plate (in spite of the contrary claims in the Bible and in the Quran). Such "core knowledge" could probably be conveyed by a teacher to her students in a minute or so (complete with pictures of the Earth taken from space), leaving lots of time in "the lecture" to convey other "tidbits" of "core scientific knowledge" (e.g., dealing with plate tectonics, ocean currents, potential sea-level rise from global warming, dominant greenhouse gases, etc., etc.). Teachers can keep on cramming their kids heads full of such "core knowledge" for at least the next 21 years, and from personal experience, I know that kids would then "know" only a small fraction of what can be classified as "scientific facts". But in my opinion, such an "educational plan" (cramming kids' heads full of "scientific facts") is, in a word, stupid: it entirely misses the essence of science, i.e., the scientific method – and entirely misses the opportunity for kids to develop evaluative-thinking skills.

Instead, as Schopenhauer recommended, kids should learn science (and other subjects) by extrapolating (or generalizing) from their own experiences. For example, an obvious first generalization from a huge number of experiences (common to all of us) is that the Earth is NOT like a ball but more like a flat plate!

But even elementary-school kids can be steered toward experimenting with additional data, from which the hypothesis that the world is like a flat plate would probably begin to seem dubious. Thus, kids can be challenged to try to explain why, when a ship heads out to sea, the ship appears to sink, until only the top of the tallest mast can be seen. They can then be challenged to try to determine the radius of the Earth, knowing the distance out to sea when a ship of known size vanishes below the horizon. Then, they might be challenged to try to estimate the radius of the Earth by measuring the angle of elevation of the Sun at noon at their latitude and learn of the Sun's similar elevation from kids who live at different latitudes (e.g., by contacting them on the internet). Similarly, although kids' experiences may lead them to conclude that rain comes from "a vault [or reservoir] in the sky" (as stated in the Bible), experiments dealing with evaporation and condensation in a closed beaker partially with water can be designed to lead kids to question the validity of that hypothesis, too.

No doubt my point is obvious: "core knowledge" in science (or "scientific facts"), such as "the facts" that the Earth is more like a ball than a flat plate and that precipitation is a result of evaporation and then condensation, aren't nearly so important as how such "facts" are obtained, i.e., *via* the scientific method. And similarly for a huge number of other "facts", from the nature of light to the resilience of ecosystems: with the help of intelligently designed experiments that kids can perform by themselves (under guidance), they can begin to see that they should hold opinions only as strongly as relevant evidence warrants, i.e., they can learn the essence of evaluative thinking.

TEACHING, NOT SCIENCE, BUT THE SCIENTIFIC METHOD

Yet, I admit that such a plan is not so simple as is sketched above. In reality, care is needed in designing and implementing appropriate science programs, perhaps especially for kids in elementary school.[7]

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[7] Dear: In the modern vernacular (as you probably know) this method (advocated by Schopenhauer) is called the "inquiry approach to science education." Many articles on this "inquiry method" are available on the internet, e.g., see the recent article by Pamela R. Aschbacher and Ellen J. Roth entitled *What's Happening in the Elementary Inquiry Science Classroom and Why? Examining Patterns of Practice and District Factors Affecting Science Reforms*.

In some cases, it seems fairly straightforward to expose students to experiences that lead them to agree with some significant generalization of science. Above I provided an example in which students would obtain evidence supporting the conclusion that the Earth is more like a ball than a flat plate. As another example, to test the hypothesis that the Earth goes around the Sun (rather than as is claimed in the Bible), kids can follow in Galileo's footsteps (observe Saturn's moons through a telescope and ponder if similar happens elsewhere in the solar system), and then the kids can be challenged to explain the cause of the seasons and how the observed motions of the planets might be explained.

In many cases, however, there would be major challenges to try to expose kids to experiences that adequately support the knowledge contained in significant generalization of science, such as Darwin's theory of evolution, Einstein's theory of relativity, and Heisenberg's quantum theory. But on the one hand, kids wouldn't normally be expected to think critically about such generalizations until high-school or college years, and on the other hand, some experiments can be designed for kids in earlier grades that can at least begin to provide them with supporting evidence, obtained from their own experiences. As examples:

- In preparation for understanding Darwin's generalization, elementary-school kids can start by finding and wondering about fossils, by learning about the ages of rocks and fossils, and by taking trips to museums to see reconstructions from the bones of dinosaurs.[8] Then, middle-school students can compare anatomies of animals and humans, and junior-high school students can at least study the data for the DNA molecules of different species. Thereby, by the time kids take biology classes in high-school, they'll likely see (based on their own experiences) that a substantial number of lines of evidence point to the validity of Darwin's generalization.

- Similarly, for the case of Einstein's special theory of relativity, elementary-school kids can learn that there are such things as nuclear reactors and "atomic" bombs, middle-school kids can perform experiments on how energy can be changed from one form to another, and high-school kids can repeat the Michelson-Morley experiment, be challenged to try to explain why a null-result is obtained, perform the elementary algebra that follows from Einstein's assumptions, and derive $E = mc^2$.

[8] Provided, however, that the kids aren't taken to deceitful displays shown at the recently opened "Creation Museum" in Kentucky, which shows Adam and Eve sharing a forest with dinosaurs! In support of this deceitful display, the president of the Institute for Creation Research, John Morris, stated: "Americans just aren't gullible enough to believe that they came from a fish" – but apparently many Americans are "gullible enough" to get hooked into shelling out money on creationists' con games.

- As for preparing kids to appreciate quantum mechanics, elementary-school kids can start learning about light, middle-school kids can start learning about light from transitions of electrons and about the photo-electric effect, and high-school kids can start working with lasers and radioactivity (under supervision) – and be stimulated to ponder how such strange behaviors might be explained.

All of which enforces a fundamental point, to which I'll repeatedly return, namely, there's an important difference between scientific literacy and scientific (or critical) thinking. A scientifically literate person probably knows that the Earth is more like a ball than a flat plate, that precipitation results from evaporation and condensation, that the Earth goes around the Sun, that life-forms evolve, and maybe even that $E = mc^2$. And though I hope that most people would know such "elementary" concepts (none of which was known by the silly people who wrote all the "holy books"), yet I would immediately add that there are 10,000 and more other "scientific facts" available, and it's not at all clear which of them a "scientifically literate" person "should" know. Furthermore and more significantly, the knowledge of any "scientific facts" isn't anywhere near so important as knowledge of how to think scientifically, i.e., to hold opinions only as strongly as evidence warrants. Consequently:

> It's critically important, not to teach kids "scientific facts", but to teach them how to "think scientifically".

Such ideas about teaching science are well described in a 22 July 2003 article, quoted below, entitled "Philosophy of Science Education" by Sara Abbot.[9]

> The prescription for the most effective method of teaching is fundamentally influenced by what education aspires to accomplish. Thus, a philosophy of science education must naturally begin with a statement of purpose for the existence of science education in the first place. Education itself exists on the premiss that the quality of our lives as human beings is significantly enhanced when we possess the knowledge and skills to make sense of the world around us and to reflect upon our place within it. Science education, as a subset of general education, aims for this same end, but is set apart by the unique means by which it attempts to do so. The distinctive elements of the scientific discipline are 1) a methodical approach to innovative inquiry and 2) an extensive collection of knowledge assembled from this style of inquiry. Thus, science confers an appreciation for both the simplicity of the process and the complexity that emerges from the compilation of findings.

[9] Available at http://www.duke.edu/~sea6/science_education.html.

This dual nature of science – process and content – emphasizes its essential inclusion in a well-rounded education that requires not only knowledge and comprehension but also higher order, more critical cognitive applications. Paradoxically, this dual nature is also the greatest obstacle in evolving a comprehensive science curriculum. We want students to master the skills of process while simultaneously acquiring mass amounts of exposure to the end products of the process. One starts with a question, the other with an answer. Reconciling this inconsistency in the classroom is the art of science education and the focus of the recommendations that follow.

The primary tactic of effective science instruction is to have the students reconstruct the process of discovery for each of the already achieved ends they are to realize. This is not to say that the students must reenact the exact investigative pattern on the same scale of magnitude as the original inquiry. Rather the instruction should be designed such that students invent or follow a process of inquiry that stems from what they already know or question knowing from personal experience. Instead of serving as a transmitter of knowledge, the teacher serves as a guide who, through individualized relationships with his or her students, monitors these inquiries and directs them toward the known end. Thus, science education becomes a cooperative process between teacher and student. Teachers cannot impose learning and students cannot expect that it will passively occur.

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 behavioral expectations in order to maintain a predictable and secure environment conducive to learning. Once a safe, comfortable setting has been established, one of the science teacher's chief responsibilities is to help students make the connections of relevancy that are necessary to foster motivated inquiry. It is also both time-consuming and necessary that the teacher generate a variety of assignments and activities to that will stretch beyond a conventional knowledge base and also cater to the needs of diverse interests and learning styles. Additionally, a teacher in the science classroom must have a solid understanding of the subject material presented. As a result of fulfilling this prerequisite, the teacher will have the expertise and insight to call attention to times throughout the curriculum when it is appropriate to compare similarities and differences within and across material in order to identify general trends and themes describing the natural world. Finally, a science teacher must deliberately model the life-long learning that he or she is advertising for his or her students to buy. This is essential not only to influence student opinion, but also to maintain the "expertise and insight" mentioned earlier that can become elusive in such a dynamic field of study.

In return, students must transform from knowledge receptacles into knowledge generators. *All students were scientists before they were formal students.* [Italics added] This inherent potential is an invaluable resource if it can be tapped, which often requires coaxing students into surrendering the barriers that repeated episodes of traditional education have placed in the way of their instincts. Once students emerge, they will be more likely to assume responsibility for their own learning.

> Perhaps one of the most influential avenues to creating student accountability for learning, however, is through assessment. Assessment must be designed and implemented such that it reflects the purposes of education before contamination from bureaucratic priorities and mandates. If the purest forms of education serve self-enriching ends, then assessment methods should rely heavily on student input and reflection. Furthermore, the evaluative criteria should be clearly communicated and openly shared with the students so that they have defined objectives whose limits provide a sense of accomplishment and preparedness…
>
> I believe that an influential philosophy of science education must account for prevalent concerns in the current state of education, lest it be abandoned or lost sight of once one sets a figurative mental "foot" in the demanding arena of the classroom. Thus, there is a need to both include and conclude this philosophy with an acknowledgement that perhaps the most indispensable element in today's science classroom is a discerning teacher, able to balance energies (or perhaps more appropriately, distribute energies according to their proportional value) between appeasing educational authorities and procedures and keeping alive those ideals and virtues of science education that led them down this path to begin with.

Later in this chapter and the next, I'll turn to some problems encountered when trying to put the above philosophy into practice, but first, I want to point out another prime educational reason for my promoting the extraction of evaluative-thinking skills from science.

Thus, beyond overcoming the huge, practical, educational problem that "it ain't easy" to teach evaluative-thinking in subjects other than science (because kids aren't ready for it, until they've climbed a "fair distance" up the "pyramid of thought"), there's the enormous advantage of teaching critical thinking in science (over all other fields of study) that, in science, disagreements can be (should be, and are to be) resolved by obtaining more data. For comparison, Dear, imagine that some disagreement arises in some other subject in which kids have reached the capability for evaluative thinking: one kid concludes that Shakespeare meant… while you're certain that he meant…, the teacher maintains that the "true cause" of the America's Civil War was… while your readings convince you that the cause was…, one group of kids claim that all… are… while another group of kids claim that all… are…, and so on. In these other subjects (literature, history, social sciences, etc.), how are such disagreements to be resolved?

In my experiences, usually such disagreements can't be resolved (even by "experts" in their fields!), because they're all "just" opinions. In some subjects (e.g., history), perhaps additional records can be found that support

one opinion over another, but even then, almost invariably the additional records will reveal just someone else's opinion. Further, although history is a branch of science, it's a branch in which it's extremely difficult (if not impossible) to test predictions of hypotheses.

Science, however, is as solid as a tree trunk. For example, if you hold the firm opinion that momentum isn't conserved in frictionless collisions, or that the total entropy doesn't always increase, or that… then there's a "sure-fire" method of settling the dispute: do the experiment over again, and then over again, and then… until you're either convinced you're wrong or you're awarded a Nobel prize for your discovery! That is, again, differences in opinion in science are settled by what I'd claim to be the most compelling (and I would add, the most sensible and even the most honorable) way: by obtaining more and more-reliable data!

Thus in summary, extracting evaluative-thinking skills from science (i.e., developing kids' skills to hold opinions only as strongly as relevant evidence warrant) simultaneously solves two "huge, practical, educational problems", namely: 1) it can be done (because kids can relatively quickly climb to the top of the intellectual pyramid in so many topics), and 2) it can be done well (with kids learning by extrapolating form their own experiences and by settling questions and arguments by obtaining more data). In essentially all other subject areas, in contrast, getting to the top of relevant intellectual pyramids can take years and years of study – and when the kids finally get there, they'll find that the majority of opinions are just that, i.e., opinions, swinging in the winds, without a firm base in data.

POLITICAL AND OTHER PROBLEMS

Yet, whatever subject is chosen in which to try to teach kids evaluative-thinking skills, teachers can encounter (or introduce by themselves) some major, political problems. Of course, an illustration in the case of a science topic is the teaching of evolution (a case that I'll address later in this chapter and in the next chapter), but you've probably had relevant personal experience with similar problems in other subjects (e.g., controversies over the inclusion of specific novels in English classes, controversies over what plays to perform in Drama classes, controversies over topics to be included in Sex-Education or Personal-Health classes, etc.).

Other cases that you might want to investigate (e.g., on the internet) are controversies over the new "history standards" [to your internet search, add the words "Lynne Cheney" (as I write this, she's the current Vice-President's wife)] and controversies over various topics in sociology and "political science" [e.g., inclusion of discussion about same-sex marriages and about communist economic policies (for which, in an internet search, you might want to add words such as "censorship" and "indoctrination"].

Further, given such controversies associated with attempting to develop students' critical-thinking skills even in the US, think about the controversies that can (and do) erupt in other nations and internationally. As a case in point, you might want to investigate international tensions that have arisen over how Japanese kids are being taught about Japan's involvement in WWII. And as for trying to develop critical-thinking skills for kids in "the Islamic world", by having them dig deeply into specific topics in subjects such as Islamic history, literature, politics, sociology, and so on (which would provide wonderfully fertile fields for critical thought), well – ya gotta be kidding: the clerics would have a field day writing *fatwas*!

But again for the case of science (with exception for some topics to be addressed later), generally, few political objections arise, worldwide, and therefore, generally, it's possible in all cultures to extract lessons for kids on how to think critically by digging into details of most science topics. For example in the case of physics topics, no group in the world (as far as I know) raises objections to kids learning about the principles of mechanics, thermodynamics, electrodynamics, relativity, quantum mechanics, solid-state physics, plasma physics, low-temperature physics, high-energy physics, etc., and similarly for most topics in anatomy, biology, chemistry, dentistry, engineering, forestry…

Thus, Dear, although there can be major political problems associated with kids' learning evaluative-thinking skills in science when they're taught specific topics (such as evolution and personal health), there can also be similar major political problems with teaching kids evaluative-thinking skills in any subject (e.g., in history, politics, psychology, sociology, religion, etc.). And again, the political problems associated with kids learning evaluative-thinking skills from in-depth studies of science topics will (I'm sure) prove to be simpler to solve than similar political problems associated with topics in other subjects – because in the long run, the winning side of any argument will be the one with the most and the most-reliable data.

Therefore, with politicians (and parents) throughout the world clamoring for "more and better science education" (to increase their children's and their nation's "competitiveness", as I outlined in the previous chapter), then it appears that scientists should be able to help educators develop evaluative- and creative-thinking skills (plus a reality-based worldview) in the minds of children throughout the world. The result could expedite (and in fact is already expediting) one of the most profound cultural changes that humanity has ever experienced – a cultural change that should enormously advance the prospect for worldwide peace and prosperity. But before trying to show you what I mean (by suggesting that scientists should be able to help educators extract evaluative-thinking skills for kids from their studies in science), let me back up, to try to make my position clearer.

Thus, Dear, I'm totally in favor of kids learning critical- (or evaluative-) thinking skills in any and all subjects. And I totally agree that such skills can be (and should be) taught in essentially all subjects, including history, literature, music, etc. But science is essentially the only subject for which there are no insurmountable political obstacles that need be overcome to permit teachers to stimulate kids to think critically, that political leaders throughout the world are clamoring for (to enhance their nation's "competitiveness"), and that "from the get-go" (in kindergarten), kids have the necessary perquisites to be able to think critically. Therefore, Dear, it's not that I advocate teaching science so that more kids will understand scientific topics (although I certainly have no objection if that's a consequence!); instead, I advocate teaching kids science and especially the scientific method, starting in kindergarten, so that kids will become competent critical-thinkers, i.e., they'll learn how to EVALUATE! If more kids, throughout the world learn how to evaluate, then I hope and actually expect (and even feel quite confident) that the chances will substantially improve for more peace and prosperity, worldwide.

PROBLEM AREAS

So then, an obvious question is: "What's wrong? Why isn't science education yielding people with more competence in applying creative-thinking skills in their own lives? Why, for example, do somewhere around 90% of Americans (and more than 99% of all Muslims) claim belief in God when there is no evidence to support such a belief?"

Well, Dear, in response to that question, I'd say that there isn't a simple answer. There's a host of things that are "wrong", including:

1) Fear of being ostracized (or in the case of Islam, fear of being put to death) for applying critical-thinking skills to evaluate "culturally-approved" beliefs, myths, and other fantasies (as I've mentioned in earlier chapters),

2) Various forms of "educational corruption" (as I outlined in chapter **X-17**), and

3) Specific barriers to kids extracting evaluating-thinking lessons from science classes, as I'll outline below.

In the remainder of this chapter and continuing into the next, I'll comment on five specific "barriers" (or "problem areas") that inhibit the extraction of evaluative thinking from science classes. I'll identify these five problem areas with the short titles:

1) Poorly Trained Teachers,

2) Poorly Designed and/or Poorly Executed Science Programs,

3) Inadequate Exams,

4) Misunderstandings of School Financing, and

5) Interferences by Religious Fundamentalists.

In the rest of this chapter, my emphasis will be on trying to explain what I mean by those "short titles"; in the next chapter, my emphasis will be on suggesting how to overcome such "barriers" in each of those five "problem area". And I probably should add that, in the main, I don't plan to dig very deeply into the first four of the above-listed "problem areas" – not because they aren't important, but because a certain trouble-making four-year old didn't ask me how to improve science education throughout the world; she asked me "only" why I didn't believe in god!

But even before I start to show you what I mean by the above "short titles", maybe I should comment on the relative importance of the different "problem areas". In general, their relative severity is different for different cultures, as I'll indicate in the following list.

1. *Poorly Trained Teachers.* I wouldn't be surprised if this problem is the most serious impediment to improving evaluative-thinking skills for American kids. It seems to be less severe in many Asian countries (Japan, S. Korea, Singapore, Taiwan…) and in some nations in Europe (Finland, Germany, Hungary, Sweden…); in under-developed nations (such as essentially all Islamic countries), the problem is even more severe than in the US. In turn, of course the problem of poorly trained teachers can be traced to poorly performing schools of education (in universities).

2. *Poorly Designed and/or Poorly Executed Science Programs.* I'm fairly confident that this is a worldwide problem; certainly it's a huge problem in clerically-suppressed and other under-developed countries; I know it's a major problem in the US, but during the past two decades, progress has been made trying to solve the problem – and many nations are now following the lead of American scientists and educators.

3. *Inadequate Exams.* This is essentially a worldwide problem: in essence the problem is that educators are too busy (and in many cases, too incompetent) to examine student performance except on (mostly) the lowest levels of the "thinking pyramid", i.e., mostly just on "knowledge". In the US, there is some examination of "understanding" and a little of student ability to "apply understanding", but beyond that (analysis, synthesis, evaluate…), essentially all exams in public K-12 schools are essentially useless – and an argument can be made that they're even worse than useless, damaging students.

4. *Misunderstandings of School Financing (and therefore coddling of unmotivated students).* Again, this is a worldwide problem, but perhaps it's worst in the US, because so much of the money spent on education (roughly half of all funding for education) is essentially wasted. The root problem seems to be lack of understanding that education is funded neither by parents nor by current taxpayers; instead, money to pay for kids' education is actually a loan to them, to be paid back by them when they start paying taxes; yet, there are no competent auditors, bankers, or loan officers controlling the loans; thereby, it has become a "free-for-all", costing future taxpayers a fortune. In turn, the cause of this problem can be traced to incompetent school administration (including school boards and state departments of education) and to education being, not just a "political football", but a "political football field".

5. *Interference from Religious Fundamentalists.* Political problems arise (to different extents in different cultures) associated with attempts to teach specific science topics (e.g., in Egypt and the US, teaching about evolution and about sex). In many Asian and European countries, such problems are of minimal importance, but in countries in which religious fundamentalists are gaining power (e.g., the US) or have gained power (e.g., essentially all Islamic countries), the severity of the associated problems range from major nuisances (e.g., in the US) to virtually insurmountable – at least until major revolutions occur (e.g., in essentially all Islamic countries).

That said, I'll now begin to address each problem area in a little more detail – although (again), because a certain trouble-making grandchild asked me a

specific question, I'll minimize commenting on solutions to the first four problems listed above and emphasize problems caused by religions.

Poorly Trained Teachers

I'll start with the first of the listed problem areas. As I already mentioned, I think that the problem of poorly trained teachers is the biggest barrier in the US to extracting evaluative-thinking lessons from science courses. I expect that similar is the case for those nations whose kids are doing even worse in international science exams than are American kids. Further, I wouldn't be surprised if poorly trained teachers is a problem needing attention even in nations whose kids are doing well on such exams (such as Ireland, Hungary, Finland, S. Korea, Japan, Taiwan, Singapore…), because I doubt the value of such exams (for reasons that I'll address later in this chapter).

Evidence supporting my claim about the poor training of American teachers can be seen in the following quotation.[10]

> One key to improving student success in science and mathematics is to increase interest in those subjects, but that is difficult because mathematics and science teachers are, as a group, largely ill-prepared. Furthermore, many adults with whom students come in contact seemingly take pride in "never understanding" or "never liking" mathematics.[11] Analyses of the teacher pool indicate that an increasing number do not major or minor in the discipline they teach, although there is growing pressure from the *No Child Left Behind Act* [of 2001] for states to hire more highly qualified teachers (see Table 5-1). About 30% of high school mathematics students and 60% of those enrolled in physical science have teachers who either did not major in the subject in college or are not certified to teach it. The situation is worse for low-income students: 70% of their middle school mathematics teachers majored in some other subject in college…

Now, Dear, before I show you the "Table 5-1" mentioned in the above-quoted National Academy report, please consider the following graph.

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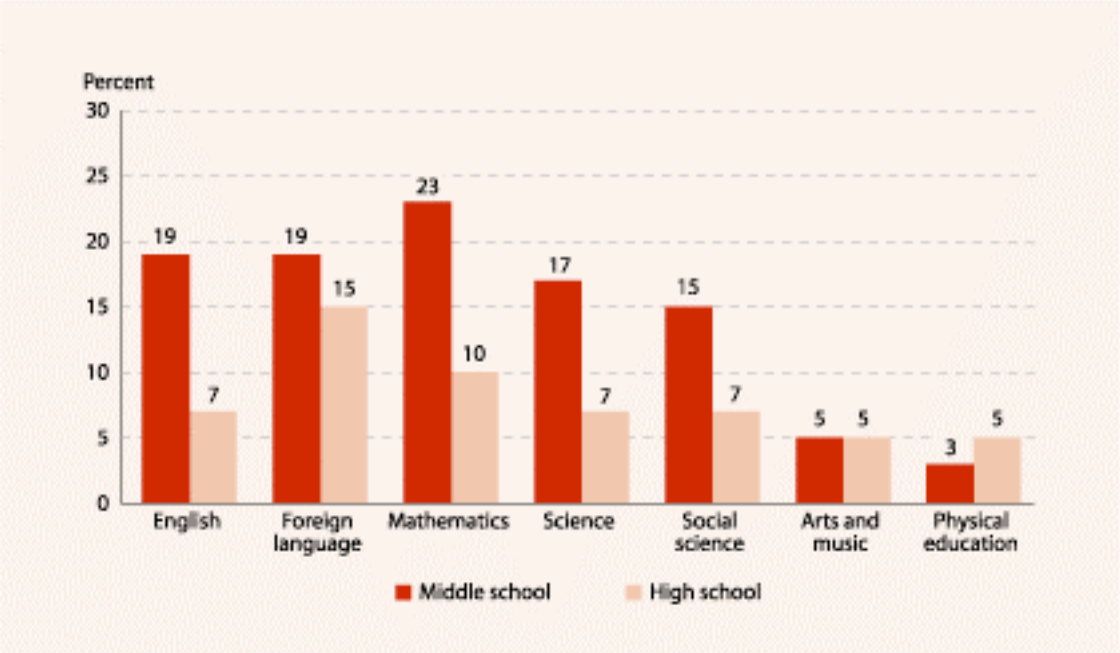
[10] From the draft US National Academy's report *Rising Above The Gathering Storm: Energizing and Employing America for a Brighter Economic Future* at http://www.nap.edu/catalog/11463.html.

[11] A recent, astoundingly horrible example of that was the comment by 2008 presidential candidate (and former Arkansas governor and Baptist pastor) Mike Huckabee: "[In college], I didn't major in mathematics; I majored in miracles." What a horrible example for kids! What a disgraceful excuse for a human!



OUT-OF-FIELD TEACHERS: Percentage of public school students in middle and high school grades [in the US] taught by teachers without a major or certification in the field they teach, by subject area: 1999–2000. Note: "Major field" refers only to a teacher's primary filed of study for a bachelor's degree.[12]

The above graph reveals quite a bit about the teaching "profession" in the US.[13] Thus, in the US there's a well-qualified pool of teachers trained in "arts and music" and "physical education" (only ~5% of such teachers are doing so without a major or certification); I would hope that most teachers with a baccalaureate degree in essentially any field from any US university should be able to teach English (or at least English Composition); and I assume that the ~15 – 20% of those teaching a foreign language without a major or certification have learned the foreign language on their own (or it's

[12] Dear: The source of the graph is given as follows: "Seastrom, M.M., Gruber, K.J., Henke, R.R., McGrath, D.J., and Cohen, B.A. (2002). *Qualifications of the Public School Teacher Workforce: Prevalence of Out-of-Field Teaching 1987–88 to 1999–2000* (NCES 2002–603), tables B-8 and B-9. Data from US Department of Education, NCES, Schools and Staffing Survey (SASS), *Public Teacher Questionnaire,* 1999–2000 and *Charter Teacher Questionnaire,* 1999–2000." For your additional information, the National Assessment of Educational Progress (NAEP), also known as "the Nation's Report Card", is conducted by the US Department of Education's National Center for Education Statistics. General information about NAEP is available at http://nces.ed.gov/nationsreportcard/about/; you can find the reports at http://nces.ed.gov/programs/coe/list/i4.asp.

[13] I put the word "profession" in quotes, Dear, because claims to the contrary notwithstanding, teaching isn't really a profession. Professionals (e.g., engineers, doctors…) police themselves, whereas normally, policing of teaching is done by school administrators. Also, professionals set their own "professional fees", while teachers unfortunately don't.

their native language). But how, pray tell, can 7 – 23% of the teachers teaching math and science do so adequately when they don't know what they're talking about?!

Such problems were well summarized in a "Talking Points Presentation" entitled *Science Education: The Challenges Today,* which was presented on 17 August 2004 at "Representative Rush Holt Educator Breakfast" by Dr. Gerald Wheeler. Below are quoted some of the points made by Wheeler; the boldface type in what follows is in the original report.[14]

> ***The percentage of subject-certified high-school teachers is down***.
> The Chief State School Officers [in the US] estimate that 83 percent of biology teachers nationwide were certified in 2002, down 7 percent from 1994; 82 percent of chemistry teachers were certified, down 10 percent; 75 percent of physics teachers are certified, down 11 percent; and 72 percent of earth science teachers were reported certified, down 9 percent.
>
> ***Only 58 percent of the science teachers in grades 7 – 8 were certified in science***.
> Many middle level science teachers are teaching on elementary certifications and will not meet the NCLB [No Child Left Behind (Act of 2001)] definition of "highly qualified". An NSF [National Science Foundation] funded study of elementary teachers shows us that 75 percent of the elementary teachers surveyed reported they felt well qualified to teach language arts and reading, and 60 percent said they felt qualified to teach mathematics**, but only about 25 percent of these elementary teachers reported they felt well qualified to teach science.**
>
> ***Pre-service teacher training in science is not valued.***
> A survey of deans of education and new pre-service teachers by the Bayer Corporation shows these deans give a higher grade to their English and math teacher preparation programs (76% and 56%, respectively) than they do their science teaching preparation (40%). Likewise, many more new teachers give an A grade to their English and math teacher preparation (39% and 28%, respectively) than they do to their science teaching preparation (18%).

Now, Dear, if such data don't alarm you, then I'd ask: Would it bother you if only 72% of the medical doctors in this country were licensed? Would it bother you if only 25% of the dentists in this country were "well qualified" or if only 18% of the pilots gave "an A grade" to their preparation?

In fact, if you look deeper into such data for the US, then I expect that you'll find that the situation appears to be even worse. For example,

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[14] The information given should enable you to find this "presentation" at many locations on the internet.

- In high school, only 36.9% of the teachers of any of the three identified "physical sciences" (chemistry, geology, and physics) are certified and have a major in the field (and taking only ~10 college courses in a subject area is sufficient to claim "a major"!), and

- In the middle school, only 6.8% of the teachers of "physical science" have a major in "physical sciences" and are certified.

Put differently, it's easy to argue the case that more than 60% of teachers of high-school physical sciences, and more significantly (for the critical task of getting the majority of American kids to learn how to think critically), *more than 90% of teachers of middle-school teachers of science* ***shouldn't be!***

Now, after those "introductory comments", I'll show you the "advertised" Table 5-1 from the National Academy report (quoted and referenced above). In this Table's title, notice the change from focusing on teachers (with no major or certification) to percentages of students being taught by such teachers (perhaps thereby suggesting that the most crowded schools, e.g., "inner-city schools", are staffed by teachers even more incompetent to teach science courses).

TABLE 5-1. Students in US Public Schools Taught by Teachers with No Major or Certification in the Subject Taught, 1999–2000.[15]

Discipline	*Grades 5 – 8*	*Grades 9 - 12*
English	58%	30%
Mathematics	69%	31%
Physical Sciences	93%	63%
Biology/Life Sciences	—	45%
Chemistry	—	61%
Physics	—	67%
Physical Education	19%	19%

Dear: please look at that Table again. It reveals, basically, that more than 90% of middle-school students in the US are being taught by "science teachers" who don't have a clue about what they're teaching!

[15] SOURCE [as stated in the referenced National Academy report]: National Center for Education Statistics. *Qualifications of the Public School Teacher Workforce: Prevalence of Out-of-Field Teaching 1987-1988 to 1999-2000.* Washington, DC: US Department of Education, 2003.

But, Dear, as bad as the above shows US science education to be (namely, so bad that I'm amazed that our courts aren't flooded with lawsuits against school administrators, school districts, and State Education Departments for damages caused by such incompetence), yet for the cultural change that I'm advocating (viz., develop evaluative-thinking skills in kids, starting in kindergarten, by showing them how to apply the scientific method in their own lives and by showing them how the scientific method is used to develop knowledge, i.e., science), then the situation is even worse.

Thus, notice that, in all the above, essentially no information was given dealing with the training in science of teachers for Grades 1 to 4 – save for the comment quoted above (from Wheeler): **only about 25 percent of these elementary teachers reported they felt well qualified to teach science.** [And who knows how appropriate were their "feelings" and what they consider to be "science"!] Thereby, Dear, think of the cultural change needed to accomplish the objective even in this country. Is the first step to fire (or re-train) *at least* 75% of all elementary school teachers?! Then, think of the changes needed in countries whose students are performing even more poorly (e.g., essentially all Islamic countries): I wouldn't be surprised if 99% of the teachers in Islamic countries (and not only teachers of elementary grades) aren't competent to teach science (or critical thinking) even in elementary school!

Now, Dear, based on your experience with my writing, you can probably well imagine how I could go "flying off on a tangent", here, suggesting how to remedy the problem of poorly trained teachers. But in the main I'll resist the temptation – except to point out to you a few ideas (in the next chapter) that you may want to explore by yourself (especially if you pursue your idea of becoming a teacher). I'll delay my suggestions until the next chapter, entitled EXpelling Educational Myths, because regardless of progress made overcoming the problem of poorly trained teachers, the need for tackling the other problems that I listed earlier will continue. Therefore, let me now turn to the next "problem area" on my list, dealing with curriculum development.

Poorly Designed Science Programs

In the US, major progress has already been made defining improved curricula, especially in science, math, and history. Examples include projects such as those mentioned in the previous chapter, i.e., the American Association for the Advancement of Science's (AAAS's) Project 2061 and various projects described by the US National Academy of Sciences

(NAS)[16] and funded by the US National Science Foundation (NSF). An overview of such progress in science education is contained in the following quotation from a paper by James D. Ellis of the University of Kansas.[17]

> Fortunately, curriculum development and national science education standards have co-evolved during the past two decades. The release of *A Nation at Risk* (National Commission on Excellence in Education, 1983) initiated the process of research and development and of consensus building (a political process) in the scientific and educational communities and the public that culminated in the *NSES* [National Science Education Standards]. More than 300 reports have been published that analyzed and commented on the need for a revised vision of science education. As reported by Cozzens (2000), starting in 1986, NSF began funding major initiatives – known as the Triad Projects – for the development of comprehensive programs in science and mathematics for the elementary grades (K–6), continuing until the present with projects to develop comprehensive materials for all science and mathematics in grades K–12. In addition to funding comprehensive programs, the IMD [? = Instructional Material Development] program has supported the development of a vast array of innovative units of instruction across all areas of science, which serve as models for a variety of approaches to designing high-quality, standards-based materials.
>
> By the mid-1990s, multiple national-level projects were undertaken to develop a new vision of science education. AAAS began by producing *Science for All Americans* (AAAS, 1989), which established a growing consensus of major elements for science literacy and the kind of approaches to curriculum and instruction required to achieve it. NSTA produced *The Content Core* (1992) and its vision of *Scope, Sequence, and Coordination*, emphasizing the need for a coordinated coherent curriculum. The Biological Sciences Curriculum Study (BSCS) collaborated with IBM on a design study for elementary school science and health (BSCS and IBM, 1989). The National Center for Improving Science Education (NCISE), in collaboration with BSCS, produced a series of frameworks for curriculum and instruction in science for the elementary years, middle years, and high school (NCISE, 1989, 1990, 1991). AAAS produced *Benchmarks for Science Literacy* (AAAS, 1993), which provided detailed specifications of science content to be learned at four stages in the K-12 program (K–2 , 3–5, 6–8, 9–12). BSCS produced *Developing Biological Literacy* (1993) and *Redesigning the Science Curriculum* (Bybee and McInerney, 1995). Therefore, the

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[16] Again, see http://www.nap.edu/catalog/4962.html, and for more general information, go to http://www7.nationalacademies.org/bose/, from which I quote: "The Board on Science Education (BOSE) is a standing board within the Division of Behavioral and Social Sciences and Education and the Center for Education at the National Research Council, the operating arm of the National Academies."

[17] The paper by Ellis (which you can find at the above National Academy website) is entitled "The Influence of the National Science Education Standards on the Science Curriculum"; it's contained in the *Workshop Summary: Reviewing the Evidence. What is the Influence of the National Science Education Standards?* Karen S. Hollweg and David Hill, Eds., Steering Committee on Taking Stock of the National Science Education Standards: The Research, Committee on Science Education K–12, National Research Council.

> science education community has been defining science literacy and engaged in curriculum development for at least a decade prior to the release of the *NSES*…

If you will look into details of such programs, Dear, and if you contemplate the competence and diligence that must have been invested in developing them, then I expect that you'll be almost overwhelmed.

Yet, even with so much already done, it's clear that a great deal more work is needed. In the next chapter, I'll suggest some improvements to existing US plans. For countries doing more poorly than the US in teaching kids about the scientific method, it would be a major advance if they tried to implement US plans (e.g., the AAAS plan – well named Project 2061, since almost certainly it won't be fully implemented before then!). And although I'm again tempted to suggest improvements to such plans, now, I'm going to constrain myself and turn instead to the next two "problem areas" on my list, i.e., the worldwide problem of inadequate exams and associated inappropriate funding.

Inadequate Exams & Inappropriate Funding

My summary assessment of essentially all current exams in essentially all public schools (and most private schools) is that it's not so much that students are failing the exams, it's that the exams are failing the kids.

What's routinely done, now, is to examine kids on what they know (or, better, what they've managed to cram into their heads the night before the exam, then to be regurgitated and, usually, quickly forgotten). Concocting such exams is relatively easy; at present, such exams are 'the norm" (worldwide); such exams usually even contain mostly "multiple-choice" questions – which are easy for teachers (or computers!) to grade and which represent a huge failure of the teaching "profession".

It will be extremely difficult to design and implement exams that determine what kids understand, their ability to apply what they know, their ability to analyze, synthesize, and evaluate (i.e., to examine how high they've managed to climb up on "the thinking pyramid"), and probably most importantly for future success, to exam each student's motivation and persistence. In the limit, maybe the best examination would be as done by proverbial Zen masters: assign the student a problem and have the student return (in a year or two or more) to supply the answer, when they've reached "enlightenment"! How to find a "happy median" between the two extremes

(regurgitating facts vs. demonstrating enlightenment), especially when the scientific competence of so many teachers is so inadequate, will be a stunningly difficult problem to solve.

But in spite of what you might expect, I don't plan to tackle the problem now. The problem is so difficult to solve and my suggested solutions require so much preparatory material that I want to delay showing them to you both to the next chapter and also to a still later chapter (**X26**, dealing with "EXtrapolating Laws"). Here, to introduce you to my suggestions, I'll just state: maybe the best way to examine all students in all subjects (as well as to examine their motivation and perseverance) is to have all examinations conducted by "the banker" – whom I'll introduce in the next chapter (as part of addressing the problem area of inadequate understanding of school financing and therefore coddling of unmotivated students). First, though, and leaving the entire "problem area" arising from misunderstanding of school financing until the next chapter, to end this chapter I'll comment on some problems caused by religious fundamentalists.

Some Problems Caused by Religious Fundamentalists

Illustrative of educational problems in the US caused by religious fundamentalists (or "fundies") is the furor they've raised over teaching evolution and specific topics in sex education. In this country, the current method of the fundies, nationwide, is to try to gain control of local school boards and then attempt to modify their school district's curriculum (especially on topics in sex education and evolution) – that step being the first in their attempt to drive everyone in this country back to clerically imposed Dark Ages. In most Muslim countries, the clerics control education policies, which is the prime reason that essentially all Muslim countries are still in their version of the Dark Ages.

For example, recently I saw that Islamic clerics in Egypt claim authority over what Egyptian kids can be taught about sexual health. As you can find on the internet, an 11 April 2005 Associated Press news report contained the following information.

> A senior Egyptian religious leader has rejected the idea of introducing sex education that includes discussion of contraception or abortion in the country's classrooms… Sheik Mohammed Sayed Tantawi – the head of al-Azhar, one of the oldest and most prominent Muslim academic institutions – said during a regular meeting of clerics that Islamic teachings already incorporate sex education in ways that do not "propagate sin or corrupt youth…" Students currently learn about sex "in a way that

> doesn't stir instincts or offend public morality ," he said, adding, "It is better than teaching sex to school students and permitting the so-called safe abortion and calling for equality between man and woman through gender culture."
>
> Government ministries and nongovernmental organizations recently have tried to find ways of incorporating reproductive health and HIV/AIDS prevention information in classrooms without religious objections, an effort that has prompted "widespread debate…" Tantawi said Islam – Egypt's official religion – only endorses sex in a marriage between a man and a woman, which eliminates the need for discussion of premarital sex, contraception, and abortion. In addition, Egypt's Grand Mufti Ali Gomaa last month said teaching children about pregnancy and disease prevention would encourage sexual activity…

Such ignorance, similar to the ignorance of Christian fundamentalists (not just Evangelical Christians but also including Catholics and Mormons) infuriates me: somehow, ways must be found (and I'll suggest some "ways" in later chapters) to drag such fools, no doubt kicking and screaming, into the 20th Century – leaving for later the task of dragging them into the 21st Century.

And although it's somewhat of an aside, let me add some of my opinions about the source of the religious fundamentalists' desire to control sex education. Such desire for control appears to have a long "history", stretching from animal instincts and leading to current opposition to "gay rights". No doubt a male's "genetic fitness" (i.e., the possibility that a specific male's genes will continue, albeit modified by females) profits from controlling the reproduction organs of females – and therefore, the behavior of apes, deer, and many other brute animals, such as religious fundies, follows! I expect that this instinct continued as the male chauvinism of most primitive tribes (e.g., the ancient Hebrews). Eventually, associated cultural traditions against "sodomy" and various "sexual perversions" were "solemnized" in various "holy books" and in some cases even "deified" (in various "sex cults"). I assume that religious fundamentalists who are males are opposed to female homosexuals both because they consider lesbians as a waste of good reproductive organs and because they're afraid of losing the genetic propagation available to them through their daughters. I assume that their opposition to male homosexuals is derived from fear of loss of their son's contribution to the continuation of their genes and maybe their fear of being raped. In any event, for religious fundies (who, fundamentally are control freaks), sex education (if not all sex!) is to be under their control.

In earlier **X**-chapters, I commented on the resulting ignorance and associated evil promoted by Catholic clerics (e.g., opposed to all physical methods of birth control – promoting only mathematical and chemical methods!), the evil promoted by "the Christian Reich" in this country (opposed to any procedure other than abstinence), and the evil promoted by Mormon leaders (for whom anything dealing with sex outside of marriage is just one more item in their long list of "abominations before the Lord"). Here, therefore, I'll just remind you that, when it comes to dealing with "political problems" associated with trying to teach kids about sexual health over the objections of religious fundies, then fundamentally, the problems can't be solved – because the fundies base their opinions not on data but on adherence to what's written in their musty old "holy books", in turn written by savages. In the fundies opinions, their "holy books" give them "the Truth" – which is the beginning and the end of any attempt to communicate with them. In later **X**-chapters, I'll suggest ways to fight such ignorance, i.e., to exterminate the damnable god meme.

Similarly, the objections of religious fundamentalists (whether Jews, Christians, Muslims, Mormons, or whatever) to teaching the theory of evolution are totally understandable, because evolution conflicts with the silliness written in their "holy books". As an illustration in the case of Judaism, consider the following comment by Carl Sagan (from *The Demon-Haunted World: Science as a Candle in the Dark*, p. 325):

> When the movie *Jurassic Park* was shown in Israel, it was condemned by some Orthodox rabbis because it accepted evolution and because it taught that dinosaurs lived a hundred million years ago – when, as is plainly stated at every Rosh Hashonhan and every Jewish wedding ceremony, the Universe is less than 6,000 years old.

Evolution similarly reveals Islam's silliness – and therefore the recent *fatwa* by Islamists claiming that the theory of evolution is false. Illustrative of such ignorance is the following gobbledygook, which I've copied from the website Islam-on-line.[18]

> **Falseness of the theory of evolution**
> 3/26/2004 8:26:00 AM GMT
>
> Question: "There are people who say that long ago man was a monkey and he evolved. Is this true? Is there any evidence?"

[18] At http://www.islamonline.com/cgi-bin/news_service/fatwah_story.asp?service_id=476.

Answer: Praise be to Allaah. This view is not correct, and the evidence for that is that Allaah has described in the Qur'an the stages of the creation of Adam. Allaah says (interpretation of the meaning): "Verily, the likeness of Eesa (Jesus) before Allaah is the likeness of Adam. He created him from dust, then (He) said to him: 'Be!' — and he was." [Aal 'Imraan 3:59]

This dust was moistened until it became sticky mud or clay that stuck to the hands. Allaah says (interpretation of the meaning): "And indeed We created man (Adam) out of an extract of clay (water and earth)." [al-Mu'minoon 23:12]

"Verily, We created them of a sticky clay…" [al-Saaffaat 37:12]

Then it became dried (sounding) clay of altered mud. Allaah says (interpretation of the meaning): "And indeed, We created man from dried (sounding) clay of altered mud." [al-Hijr 15:26]

Then when it dried it became sounding clay like the clay of pottery. Allaah says (interpretation of the meaning): "He created man (Adam) from sounding clay like the clay of pottery." [al-Rahmaan 55:14]

Then Allaah moulded it into the form that He wanted and breathed into him (his) soul created by Him. Allaah says (interpretation of the meaning): "(Remember) when your Lord said to the angels: 'Truly, I am going to create man from clay'."

"So when I have fashioned him and breathed into him (his) soul created by Me, then you fall down prostrate to him." [Saad 38:71-72]

These are the stages through which the creation of Adam passed according to the Qur'aan. As for the stages of creation which the progeny of Adam pass through, Allaah says (interpretation of the meaning): "And indeed We created man (Adam) out of an extract of clay (water and earth). Thereafter We made him (the offspring of Adam) as a Nutfah (mixed drops of the male and female sexual discharge and lodged it) in a safe lodging (womb of the woman). Then We made the Nutfah into a clot (a piece of thick coagulated blood), then We made the clot into a little lump of flesh, then We made out of that little lump of flesh bones, then We clothed the bones with flesh, and then We brought it forth as another creation. So Blessed is Allaah, the Best of creators." [al-Mu'minoon 23:12-14]

With regard to the wife of Adam – Hawwa (Eve) – Allaah tells us that He created her from him, as He says (interpretation of the meaning): "O mankind! Be dutiful to your Lord, Who created you from a single person (Adam), and from him (Adam) He created his wife [Hawwa (Eve)], and from them both He created many men and women." [al-Nisa' 4:1]

Meanwhile, I hope that the person who asked the original question (which was "There are people who say that long ago man was a monkey and he evolved. Is this true? Is there any evidence?") noticed that the question wasn't answered. The questioner asked for evidence about evolution, and rather than describing evidence, the clueless cleric described only what was written in the Quran, as allegedly relayed to some ancient scribe by the madman Muhammad, who (understandable for when he lived) didn't have a clue about the origin of humans. What astounding ignorance (resulting in almost unbelievable evil) results when people accept what was written in some ancient book (or for that matter, what's written in any book!) to be the criterion for "truth".

In contrast to what that damnable cleric wrote, an honest and more useful answer to the question would have been something similar to:

> A very good question. As Muhammad allegedly said: "Knowledge is a locked closet whose key is the question. " It is necessary, however, to do more than just ask a question. To open the door to knowledge, you must dig out all relevant and reliable data. If you do, you'll find that there's a mountain of evidence supporting the theory of evolution – thereby demonstrating that the Quran's statements about how life began are somewhere between silly and stupid. But rather than my trying to move the mountain of evidence supporting evolution to you, why don't you do as Muhammad is said to have done: go to the mountain yourself?! As he reportedly said: "The quest for knowledge and science is obligatory upon every Muslim man and woman" and "The acquiring of knowledge [are] bounden duties of each Muslim from the cradle to the grave."

And actually, Dear, if you do dig into details by yourself, you'll find that the clerics of the "Christian Reich" cling to the "science" of ancient Egypt and Mesopotamia even more desperately than similar clinging by the above-quoted idiotic Islamic cleric!

Further, the reason seems clear. Thus, the "threats" from the theory of evolution to Christian fundies are more serious (than in the case of Judaism and Islam) because evolution undermines not only the literal meaning of the Bible and the Quran but also the "theoretical foundations" of the principal doctrine of Christianity. That is (as I've written before), if the Adam and Eve story is just a fable (as it is!), if people die not because they "fell from grace" but because death of individuals is Nature's way of promoting the evolution of any species (as it is!), then no "savior" or "redeemer" is needed.

Thereby, the entire foundation of Christianity, concocted by "Saint" Paul (viz., that Jesus died to redeem us from our sins), collapses into the silliness that it is. As Richard Bozarth wrote:

> …evolution destroys utterly and finally the very reason for Jesus' earthly life was supposedly made necessary. Destroy Adam and Eve and the original sin, and in the rubble you will find the sorry remains of the son of god. [It takes] away the meaning of his death[:] if Jesus was not the redeemer who died for our sins (and this is what evolution means) then Christianity is nothing!

Although not identical nonsense permeates Mormonism and Islam, both collapse (at least in theory) if evolution (and not God) led to humans.

Consequently, fundamentalist Christian clerics (including such con artists as Pope John Paul II and the current pope, Benedict XVI) refuse to accept the enormous scientific evidence supporting the theory of evolution, because if they did accept the evidence, then their con games would collapse. For example, in his "homily" in his "Inaugural Mass" on 24 April 2005, Pope Benedict XVI stated:

> We are not some casual and meaningless product of evolution. Each of us is the result of a thought of God.

Of course it's clear why he would make such an unsupported statement: if evolution is correct then Christianity is a crock (there's no need of a "savior" for "the fallen" if humans never fell); thereby, Christianity in general (and Catholicism, in particular, as well as Mormonism) is revealed to be nothing but a con game. Therefore, all fundamentalist (con-artist) clerics (be they Jewish, Christian, Islamic, or Mormon) continue to promote their nonsense – and their followers (either unable to think for themselves or too greedy for the promise of "eternal life" to want to think for themselves) do what their clerics demand, including obstructing the teaching of evolution.

In this country, the most recent form of this obstructionism is the attempt to introduce the teaching of "intelligent design" (a camouflaged form of "creationism") as an alternative "scientific theory". In the US, this obstructionism has a long history, as is suggested by the following brief outline.[19]

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[19] Copied from an article entitled "How the Evolution Debate Evolved" by Anya Litvk, published in the 31 July 2005 issue of *The Missourian* (Columbia, Missouri).

1925: In the Scopes "Monkey" Trial, high school teacher John Scopes is convicted of violating Tennessee law by teaching evolution to high school students.[20]

1961: John C. Whitcomb Jr. and Henry Morris publish *The Genesis Flood,* supporting the biblical account of creation with interpretations of scientific evidence.

1963: Morris and colleagues launch the Creation Research Society, which publishes the creationist journal *Creation Research Society Quarterly.*

1968: In Epperson v. Arkansas, the US Supreme Court strikes down an Arkansas statute prohibiting the teaching of evolution.

1972: Henry Morris founds the Institute for Creation Research in San Diego, an institution for creationist literature and advocacy.

1981: Stanley Weinberg founds the National Center for Science Education, a pro-evolution advocacy organization, now in Oakland, Calif.

1982: In McLean vs. Arkansas Board of Education, a federal court declares unconstitutional a "balanced treatment" statute requiring creationism to be taught alongside evolution.

1984: In response to mounting social challenges posed by creationists, the National Academies of Science distribute *Science and Creationism: A View from the National Academy of Sciences*, a booklet decrying creationism as a nonscience and instructing teachers on the importance of teaching evolution.

1986: Famed evolutionist and ardent atheist Richard Dawkins publishes *The Blind Watchmaker,* elucidating the case for evolutionary theory and blasting its challengers.

1987: The US Supreme Court rules creation science in public schools unconstitutional in Edwards v. Aguillard, striking down the Louisiana "Creation Act" as a violation of the Establishment Clause of the First Amendment.

1989: The Foundation for Thoughts and Ethics publishes *Of Pandas and People,* intended as a textbook supplement criticizing evolution and promoting intelligent design.

1991: Berkeley law professor Phillip Johnson publishes *Darwin on Trial,* the intelligent design manifesto credited with stirring the movement.

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[20] Dear: I hope you've seen the tremendous movie depicting this trial entitled *Inherit the Wind*, starring Spencer Tracy; if you haven't, do yourself a favor: watch it! – although be aware that the movie takes some "artistic license" with the truth (e.g., Scopes wasn't a biology teacher and Bryan wasn't such a bigot as depicted).

1996: Lehigh University biochemist Michael Behe introduces "irreducible complexity" as a challenge to natural selection in his book *Darwin's Black Box.* The Discovery Institute, a conservative think tank in Seattle, launches its Center for the Renewal of Culture and Science, the leader in the intelligent design movement.

1999: The Kansas State Board of Education de-emphasizes evolution in state science standards. The decision is reversed two years later.

2002: Intelligent design advocates launch the International Society for Complexity, Information, and Design, a professional organization with annual conferences and a quarterly online journal.

2004: A school district in Dover, Pa., orders teachers to present intelligent design as an alternative to evolution; a lawsuit in federal court ensues.

2005: Lobbied by intelligent design advocates, the Kansas State Board of Education is again redrafting science standards to challenge evolution.

Thus, at the start of the 20th Century, the fundamentalists succeeded in having laws passed prohibiting the teaching of evolution; by the end of the 20th Century, the fundamentalists were successful in getting at least some school boards to force "equal time" for teaching what they deceptively call "intelligent design".

But, as the courts have recently ruled, such stupidity isn't science, because it violates the fundamental condition of any scientific theory: it must be falsifiable. In contrast, evolution can be demonstrated to be wrong by confining a (preferably, rapidly reproducing) species in a controlled environment, changing the environmental conditions, and demonstrating that the species doesn't change. In fact, such experiments have been performed – and demonstrate that the species does evolve, to become more "fit" for survival in its modified environment. Meanwhile, though, how does one even theoretically demonstrate that no "intelligent" giant Jabberwock in the sky wasn't involved, causing the species to evolve – or that, in reality, 72 invisible angels can dance on the head of a pin? Such bunk is so bad it amazes me that it's proposed even as the basis of a con game! Yet such fools continue to argue, apparently "feeling" that "the fate of their eternal souls" is at stake.

Further, another example is available in a response to what I mentioned in an earlier chapter. Thus, as I already mentioned, recently the largest professional science organization in the US (the American Association for

the Advancement of Science or AAAS) devoted substantial effort to try to define science topics that should be covered in Kindergarten through Grade 12 (K–12). As might be expected by anyone with even a rudimentary knowledge of science, the AAAS plan recommends (in "Project 2061") that evolution be taught as one of the fundamental and unifying principles of science, and as might been expected by anyone who has paid any attention to the news during the past century (!), that recommendation resulted in creationists crawling out from under their rocks.

Illustrative is the following from an article (which you can find at many places on the internet) by Mark D. Hartwig and Dennis A. Wagner entitled "Project 2061: Visions of Science, Visions of Ourselves" published in the (creationists') publication ***Origins Research*****,** Spring/ Summer 1991.

> Even more distressing than the treatment of evolutionary theory as fact is the evolutionary "mental framework" or worldview that Project 2061 promotes in the name of science. Throughout *Science for All Americans* and the panel report we find multiple references to the need for "mental visions of reality: or conceptual frameworks" on which to hang the facts of biology. Had this framework been some lower-level model for organizing specific concepts, we would have fewer concerns. But instead we find on the third page of the panel report that the goal of the new biology is to give each person "a sense of humankind's evolutionary place in cosmic time…" Implied in the text that follows [the authors mean "inferred from the text that follows"] is the conviction that if we have the right "mental vision of reality" we will then know how to properly deal with drugs, AIDS, abortion, and environmental problems. This point is driven home a few pages later:
>
> > Earth abounds in a diversity of living creatures, which all interact to some degree. Each type shares properties common to all life, and yet each is different, as a consequence of millions of years of chance evolutionary events. Identifying the differences and tracing their origins provides the mental framework for comprehending the place we humans have in the biosphere, as well as our present impact on it…
>
> This is not science. This is a worldview – namely, philosophical naturalism – masquerading as science: *We are a consequence of chance evolutionary events that took place over millions of years, and if we grasp this mental vision of reality we will be able to properly interact and react to life around us.*
>
> Organizing concepts are necessary and appropriate in science education. But when they are as broad as the ones in Project 2061, science becomes a tool for promoting philosophical and ideological viewpoints. Although science educators may find these viewpoints attractive, even compelling, they are not thereby warranted in passing off these views as science. Our students – and our society – deserve better than that.

To which I'd add only that I agree with their statement: "This is a worldview". I disagree, however, with their claim: "This is not science." It's a worldview developed from applying the scientific method: analyzing data, trying to identify hypotheses that summarize the data, and then performing experiments to test predictions of the hypotheses.

In contrast, the authors of this criticism[21] want people to accept their religious/creationist worldview (concocted by savages and that doesn't have a shred of data to support it), because… Well, I guess because it makes them feel good thinking that there's some magic man in the sky who'll reward them with an eternity of bliss, because they did what their mothers and their clerics told them to do. As James D. Watson (winner of the Nobel prize for co-discovery of the structure of DNA) said:

> Today, the theory of evolution is an accepted fact for everyone but a fundamentalist minority, whose objections are based not on reasoning but on doctrinaire adherence to religious principles.

But beyond such details, Dear, there's an important point that I hope you see. It's that the only one who really cares (or cared) if the theory of evolution is right is Charles Darwin (and maybe his mother) – and they're both long dead. Similar is true for all scientific theories. Thus, no living biologist worth her salt gives a damn if the theory of evolution is right; in fact, I'd bet good money that each and every competent biologist wishes they could devise an experiment and obtain reliable data to demonstrate that evolution is dead wrong – because it would virtually guarantee their designation as the world's greatest living biologist (not to dwell on all the prize money they'd get, including the Nobel prize). In contrast, though, the damn "creationists" and dumb "intelligent designers" desperately want evolution to be wrong – not that they've obtained a single shred of data to support their position and not to be proclaimed as the world's greatest living biologist, but because their mothers (or whoever) told them that there's a giant Jabberwock in the sky who's the "intelligent designer", who not only made people, but who'll whisk them off to never-never land after they die – if only they'll "believe" what their mothers told them. It's sick.

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[21] One of whom, Mark Harwig, was the co-author of the "Note to Teachers" added to the notorious book entitled *Of Pandas and People,* the centerpiece of recent court rulings against teaching "Intelligent Design" as science.

And it's getting sicker. Thus, recently the Christian fundies have changed their tactics, in a multi-pronged attack against science, against knowledge, against humanity, and specifically against children. Without going into too many details (which you can find for yourself), I'll just list some aspects of their tactics:

- Armed with passion stimulated by threats of having their day-dream of everlasting life for themselves and their children disrupted, Christian fundies have worked tirelessly and deviously to gain control of local school boards and then proceeded to try to modify the science curriculum to protect their creationist dreams.

- Fortunately for humanity, the Courts have generally thwarted the creationists' agenda, in a string of court cases stretching from the 1925 Tennessee "monkey trial" (the Scopes trial), through the 1987 Supreme Court decision (by a vote of 7 to 2) to strike down Louisiana's Creationism Act, and to court decisions so recent that they'll probably have occurred after I wrote this!

- With their prime goal to retake political power from the Roosevelt-Kennedy-Johnson Democrats, and realizing that the majority of Americans are brainwashed by Christian clerics,[22] the Republican party (guided by the goons who spoon-fed the actor-President Reagan his lines) had Reagan put on the following performance, as copied here from Tim Berra's book *Evolution and the Myth of Creationism,*[23] (which in turn references *Science,* 1980, vol. 209, p. 1214).

> Following a speech to a fundamentalist coalition in Dallas in 1980, then Republican presidential candidate Ronald Reagan held a press conference at which he was asked if he thought the theory of evolution should be taught public schools. He replied, "Well, it's a theory, it is a scientific theory only, and it has in recent years been challenged in the world of science and is not yet believed in the scientific community to be as infallible as it once was believed. But if it was

[22] For example, Dear, consider the following (from Adam L. Carley, *Free Inquiry,* Fall 1994); in fact, not only "consider" it, read it and weep! "From a Gallup poll of US adults: humans didn't evolve, 46%; evolution guided by God, 40% [totally 86% of the population of US adults!]; evolution occurred by itself, 10%."

[23] Dear: As you can find on the internet, "Dr. Tim M. Berra is Professor Emeritus of Evolution, Ecology, and Organismal Biology at the Ohio State University. He received the Ph.D. in Biology from Tulane University in 1969. [He] is the author of over 63 scientific papers and 5 books including *Evolution and the Myth of Creationism* published by Stanford University Press in 1990."

> going to be taught in the schools, then I think that also the biblical theory of creation, which is not a theory, but the biblical story of creation, should also be taught."

That a president of the US should make such an ignorant statement is mind-boggling! One would hope that the Reagan presidency was the limit to which this country can sink (by duping the 50% of the people who have below-average intelligence with a slick ad-campaign) – but the George W. Bush presidency shows that it ain't necessarily so!

- Finding that they were then thwarted by the courts (e.g., the 1987 Supreme Court ruling mentioned above), Christian fundies pressured the Republican party to appoint Federal judges (to all levels of the Federal Court) who would grant legal support for their ignorance (e.g., Reagan appointed the religious "nut cakes" Rehnquist and Scalia to the Supreme Court, and they were the two who dissented from the 1987 Supreme court decision, mentioned above; thus, writing for the minority, Scalia "conceded that the Louisiana law would be unconstitutional if there were truly nothing scientific to be taught under the rubric of 'creation science'. He felt, however, that 'creation science' is a body of scientific knowledge.")[24]

- Similar nonsense continues today, with Supreme Court Justice Clarence Thomas [a Catholic who supports state theocracy (!),[25] nominated by the bigot President G.H.W. Bush], with President G.W. Bush describing Scalia as "a model of the sort of judge I'd like to appoint", leading subsequently to the appointment of Chief Justice John Roberts [another Roman Catholic] and Justice Samuel Alito [nicknamed "Scalito", "His 15-year record on the 3rd US Circuit Court of Appeals indicates that, like justices Antonin Scalia and Clarence Thomas, he would limit the scope of the constitutional ban on establishment of religion",[26] leading to a majority of the justices now being "good Catholics"], and with Bush's remark to reporters on 1 August 2005 that "both sides [evolution and 'intelligent design'] ought to be properly taught [to school children]… so people can understand what the debate is about…"

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[24] Quoted from Berra, referenced in the previous footnote.

[25] For example, see http://blogcritics.org/archives/2005/06/12/142556.php.

[26] Copied from a 21 December 2005 article by Greg Stohr entitled "Alito Would Likely Be Religion's Best Friend on US High Court", available at http://pewforum.org/news/display.php?NewsID=5942.

And while such a remark by Bush-2 might sound okay if both sides are "properly taught" (i.e., if teachers demonstrated to kids why 'intelligent design' doesn't have anything to do with science!), that wouldn't happen so long as (as Bush advocated) "that decision should be made to local school districts", so long as the Religious Reich has control over local school districts, and so long as at least five members of the US Supreme Court are convinced that some magic man in the sky is in control of the universe, that the pope is infallible, and that it's perfectly acceptable to make decisions without the least concern about the total absence of evidence – instead basing their decisions on what "feels good" and what their mothers told them they should do to be "good little boys".

All of which leads me to two conclusions. One was stated well by Bertrand Russell: "There is no nonsense so errant that it cannot be made the creed of the vast majority by adequate governmental action." And the other, probably more important, is: You need to get more exercise!