

No. 08-56320

**IN THE UNITED STATES COURT OF APPEALS
FOR THE NINTH CIRCUIT**

**ASSOCIATION OF CHRISTIAN SCHOOLS INTERNATIONAL, et al.,
Plaintiffs-Appellants,**

v.

**ROMAN STEARNS, et al.,
Defendants-Appellees.**

On Appeal from the United States District Court
for the Central District of California (No. 05-06242)

**MOTION FOR LEAVE TO FILE BRIEF OF AMICUS CURIAE
CALIFORNIA COUNCIL FOR SCIENCE AND TECHNOLOGY IN
SUPPORT OF APPELLEES FOR AFFIRMANCE**

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The California Council for Science and Technology (“CCST”), respectfully move this Court, pursuant to Federal Rule of Appellate Procedure 29, for leave to file the brief submitted herewith, as *amicus curiae* in support of Defendants-Appellees in this appeal.

As more fully described in the brief, CCST is an organization devoted to and concerned with educational standards relating to science and technology education, and is interested in this matter because it implicates important issues underlying California’s high school and post-secondary education system.

Specifically, CCST, which was founded by unanimous consent of the California legislature in 1988, is a highly regarded nonprofit organization that has a fundamental interest in ensuring California’s high school students are equipped with the tools to grow as students at the university level and succeed as the scientists and engineers of tomorrow. CCST has authored numerous legislatively mandated reports, policy papers and symposia on California’s science and technology education system and workforce.

CCST, therefore, respectfully requests that this Court grant it leave to file the accompanying brief.

Respectfully submitted,

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I. CORPORATE DISCLOSURE STATEMENT

Pursuant to Federal Rule of Appellate Procedure 26.1, amicus California Council for Science and Technology states that it is a not-for-profit organization, it has no parent companies, and it has not issued shares of stock.

II. STATEMENT OF INTEREST

The California Council on Science and Technology (“CCST”) is a nonpartisan, impartial, not-for-profit 501(c)(3) corporation established via Assembly Concurrent Resolution (ACR 162) in 1988 by a unanimous vote of the California Legislature. It is designed to offer expert advice to the state government and private sector and to recommend solutions to science- and technology-related policy issues.

CCST is governed by a Board of Directors composed of representatives from CCST’s sponsoring academic institutions, from the corporate and business community, and from the philanthropic community. That Board is assisted by a larger CCST Council, an assembly of corporate CEOs, academicians, scientists, and scholars of the highest distinction, and by the CCST Fellows, a larger group that provides advice in their areas of expertise. Currently, seventy-eight members and fellows are also members of the National Academies, five are Nobel laureates, eight are National Medal of Science recipients, and two are recipients of the National Medal of Technology.

Part of CCST's mission is to ensure California remains at the forefront of science and technological innovation. Many of the most important problems facing state officials and business leaders cannot be solved without drawing on scientific and technological expertise. Throughout its history, CCST has devoted considerable attention to science, technology, engineering, and mathematics education through legislatively mandated reports, symposia, and research. California traditionally has prospered from its position as a technological leader, innovator, and generator of new industries. But technological leadership requires highly trained scientists and engineers and a skilled workforce, and in these vital areas, California is beginning to fall behind. California's institutions of higher learning and CCST have a fundamental interest in ensuring California's high school students are equipped with the tools to grow as students at the university level and succeed as the scientists and engineers of tomorrow.

III. STATEMENT OF RELEVANT FACTS

One of the ways through which a California high school student can qualify for admission to the University of California ("UC") is by achieving sufficiently high grades in a certain number of UC-approved classes in seven different subject areas, labeled "a" through "g" (in combination with standardized test scores). This includes two years of classes in laboratory science, subject area "d".

Plaintiffs challenge UC's refusal to grant "d" credit to biology courses that use *Biology for Christian Schools* (published by Bob Jones University Press) or *Biology: God's Living Creation* (published by A Beka Book) as their primary textbooks. Pre-eminent biologists Donald Kennedy and Francisco Ayala (SER0972-73, SER1183-84) testified that UC had correctly determined that both textbooks fail to teach essential scientific concepts adequately or accurately and thus fail to prepare students for college (SER967-68, SER1183). Plaintiff's expert, Michael Behe, purported to challenge UC's determination by simply counting the number of times the textbooks make reference to certain basic scientific concepts, but he conceded that he did not address the detail, depth, or accuracy of the textbooks' references to those scientific concepts. (ER972-73.) The District Court concluded that Behe did not refute UC's evaluation of the textbooks (as confirmed by Kennedy's and Ayala's testimony) or even raise any "genuine issue of material fact as to this issue." (ER018.)

IV. SUMMARY OF ARGUMENT

As a public institution of higher education, UC has the responsibility to produce college graduates who have satisfied its rigorous academic standards in all relevant disciplines, including science. In order to fulfill this responsibility, UC must be allowed to choose among applicants for admission into the UC system based on the applicants' demonstrated understanding of important foundational concepts. In the area of science, two such foundational concepts are the nature of

science and the theory of evolution. UC acted appropriately in not giving “d” credit to certain high school science courses that used the *Biology for Christian Schools* and *Biology: God’s Living Creation* textbooks because these textbooks do not teach either concept in an appropriate manner and in fact advance fundamental misconceptions about both concepts. Students educated with these textbooks will not be adequately prepared for science courses at UC.

The need for high-quality post-secondary science education has never been greater, either in California or the United States as a whole. Science and technology are recognized as key economic drivers. Unfortunately, both California and the United States are losing ground in these critical areas, in large part because of the inability of colleges and universities to produce enough highly qualified science and technology graduates. The prosperity of the state and nation in the 21st century depends on the reversal of this trend and the production of more university graduates well educated in science and technology. In light of this critical need, UC should be encouraged to take all reasonable measures to ensure that the students admitted into the UC system have a solid grounding in foundational scientific concepts upon matriculation.

V. ARGUMENT

A. **By Using Textbooks That Instill Fundamental Misconceptions About The Nature Of Science And The Theory Of Evolution, The Rejected Biology Classes Do Not Prepare Students Adequately For Higher Education**

1. The Nature Of Science And The Theory Of Evolution Are Two Of The Most Foundational Concepts In All Of Science

a. The Nature Of Science

As succinctly phrased in a publication issued by the National Academy of Sciences (NAS)¹, “Science is a particular way of knowing about the world.” NAS, *Teaching About Evolution and the Nature of Science* 27 (1998) (SER1014A).² Within this particular way of knowing about the world, “explanations are restricted to those that can be inferred from confirmable data—the results obtained through observations and experiments that can be substantiated by other scientists.” *Id.* Thus, “[e]xplanations that cannot be based on empirical

¹ The NAS was established by an 1863 Act of Congress to advise the nation on science-related matters. About the NAS, http://www.nasonline.org/site/PageServer?pagename=ABOUT_main_page. It “is composed of approximately 2,100 members and 380 foreign associates . . . who are elected in recognition of their distinguished and continuing achievements in original research; election to the [NAS] is considered one of the highest honors that can be accorded a scientist or engineer.” *Id.* Nearly 200 of the NAS’s members and foreign associates are Nobel laureates. *Id.*

² For non-legal sources cited in this brief, references are provided whenever possible to specific pages in the record or to Internet URLs where the cited material can be found. CCST would be happy to provide copies of any other cited material at the Court’s request.

evidence are not a part of science.” *Id.* Conversely, however, “[a]nything that can be observed or measured is amenable to scientific investigation.” *Id.*

Relatedly, any invocation of, or reliance on, the supernatural immediately fixes a matter outside of the realm of science. NAS & Institute of Medicine, *Science, Evolution, and Creationism* 10 (2008), available at http://www.nap.edu/catalog.php?record_id=11876. “Any scientific explanation has to be *testable*—there must be possible observational consequences that could support the idea *but also ones that could refute it.*” *Id.* While “[n]atural causes are, in principle, reproducible and therefore can be checked independently by others . . . , scientists have no way of either confirming or disproving” explanations based on the supernatural. *Id.*

Science is not limited to the mere *description* of observations; rather, “[s]cientific knowledge and understanding accumulate from the interplay of observation and *explanation.*” *Id.* (emphasis added). The NAS has aptly summarized the scientific method as follows:

Scientists gather information by observing the natural world and conducting experiments. They then propose how the systems being studied behave in general, basing their explanations on the data provided through their experiments and other observations. They test their explanations by conducting additional observations and experiments under different conditions. Other scientists confirm the observations independently and carry out additional studies that may lead to more sophisticated explanations and predictions about future observations and experiments.

Id.

Courts have repeatedly articulated a similar understanding of the nature of science. *See, e.g., Daubert v. Merrell Dow Pharm., Inc.*, 509 U.S. 579, 593 (1993) (“Scientific methodology today is based on generating hypotheses and testing them to see if they can be falsified; indeed, this methodology is what distinguishes science from other fields of human inquiry” (internal quotation marks omitted)); *Kitzmiller v. Dover Area Sch. Dist.*, 400 F. Supp. 2d 707, 735 (M.D. Pa. 2005) (“While supernatural explanations may be important and have merit, they are not part of science.”); *id.* at 742 (“[T]he ground rules of science . . . require testable hypotheses based upon natural explanations.”); *McLean v. Ark. Bd. of Educ.*, 529 F. Supp. 1255, 1267 (E.D. Ark. 1982) (“[T]he essential characteristics of science are: (1) It is guided by natural law; (2) It has to be explanatory by reference to natural law; (3) It is testable against the empirical world; (4) Its conclusions are tentative, i.e., are not necessarily the final word; and (5) It is falsifiable.”)

b. The Theory Of Evolution

Discussions about the theory of evolution often begin by noting the words of the eminent scientist Theodosius Dobzhansky: “Nothing in biology makes sense except in the light of evolution.” (SER1194.) The NAS has repeatedly echoed Dobzhansky’s sentiment, pronouncing evolution to be “the most important concept in modern biology,” *Teaching About Evolution and the Nature*

of Science, supra, at viii (SE0985A), “the central organizing principle that biologists use to understand the world,” *id.* at 3 (SER0990A), “one of the most important ideas of modern science,” *Science, Evolution, and Creationism, supra*, at 47, and “the foundation for modern biology,” *id.*, summary brochure.

Evolution is such a crucial concept because it successfully explains perhaps the most significant of all natural phenomena—the diversity of life on Earth. *See id.*; *Teaching About Evolution and the Nature of Science, supra*, at 1-3 (SER0988A-990A). Further, evolution explains the similarities between different organisms, the appearance of humans on the planet, the development of resistances to medication by viruses and bacteria, and many other features of the physical environment. *See Science, Evolution, and Creationism, supra*, at 4; *Teaching About Evolution and the Nature of Science, supra*, at 1-3 (SER0988A-990A). Thus, “[t]o teach biology without explaining evolution deprives students of a powerful concept that brings great order and coherence to our understanding of life.” *Teaching About Evolution and the Nature of Science, supra*, at 3 (SER0990A).

While evolution may remain controversial in other segments of society, the scientific community broadly accepts it as an accurate, testable scientific theory supported by vast amounts of empirical evidence. The NAS has left no doubt as to its position on evolution’s scientific soundness: “[M]any scientific explanations have been so thoroughly tested and confirmed that they are

held with great confidence. The theory of evolution is one of these explanations. An enormous amount of scientific investigation has converted what was initially a hypothesis into a theory that is no longer questioned in science.” *Id.* at 42 (SER01029A). Despite the speculative connotations that the term “theory” may have for the lay person, “[e]volution is supported by abundant evidence from many different fields of scientific investigation,” *Science, Evolution, and Creationism, supra*, at 47, having been “confirmed repeatedly through observation and experiment in a broad spectrum of scientific disciplines,” *id.*, summary brochure. In science, unlike in common usage, a “theory” is not a “guess” or a “hunch”; rather, it is “an overarching explanation that has been well substantiated.” *Teaching About Evolution and the Nature of Science, supra*, at 4 (SER0991A).

As with the nature of science, courts have recognized the centrality of the theory of evolution to the understanding and pursuit of scientific knowledge. *See, e.g., Kitzmiller*, 400 F. Supp. 2d at 743 (“[E]volution is more than a *theory* of origin in the context of science. To the contrary, evolution is the dominant *scientific* theory of origin accepted by the majority of scientists.”) (quoting *Selman v. Cobb County School Dist.*, 390 F. Supp. 2d 1286, 1309 (N.D. Ga. 2005), *vacated on other grounds*, 449 F.3d 1320 (11th Cir. 2006)); *McLean*, 529 F. Supp. at 1273 (“Evolution is the cornerstone of modern biology . . .”).

c. Students Should Learn About The Nature Of Science
And The Theory Of Evolution Well Before College

The nature of science and the theory of evolution are basic, foundational concepts that should be part of any K-12 science education. Two of the most ambitious and comprehensive efforts to establish national content standards for K-12 science education support this position. Both the National Resource Council's *National Science Education Standards* and the American Association for the Advancement of Science's *Benchmarks for Science Literacy* identify the nature of science and the theory of evolution as concepts to which all students should be exposed beginning at an early age, and with which all students should be intimately familiar by the end of high school. *See* American Association for the Advancement of Science, *Benchmarks for Science Literacy*, chs. 1 & 5.F (1993), available at <http://www.project2061.org/publications/bsl/online/index.php>; National Research Council, *National Science Education Standards* 109-11 (1996), available at http://www.nap.edu/catalog.php?record_id=4962.

Further, many organizations of science educators have issued statements that emphasize the importance of teaching evolution at the K-12 level. *See, e.g.*, California Science Teachers Association, *Policy Statement on the Teaching of Evolution* (2002), available at http://www.cascience.org/csta/res_evolution.asp (follow link in middle of page); National Association of Biology Teachers, *NABT's Statement on Teaching Evolution* (2008), available at

<http://www.nabt.org/websites/institution/index.php?p=92>; National Science Teachers Association, *NSTA Position Statement: The Teaching of Evolution*, available at <http://www.nsta.org/about/positions/evolution.aspx>; Society for College Science Teachers, *Position Statement on the Teaching of Evolution* (2007), available at <http://www.scst.org/SCST/Publications.html> (follow link at bottom of page).

2. *Biology For Christian Schools And Biology: God's Living Creation Instill Fundamental Misconceptions About The Nature Of Science And The Theory Of Evolution*

a. The Textbooks And The Nature Of Science

Beginning with the first page of its introduction, the third edition of *Biology for Christian Schools* makes absolutely clear that its perspective on the nature of science is irreconcilably at odds with that of the NAS and the scientific community in general. From the outset, the textbook instructs the student that everything in the Bible is literally true and that, therefore, any scientific observations or conclusions that conflict with the Bible are necessarily false “no matter how many scientific facts may appear to back them.” Thomas E. Porch & Brad R. Batdorf, *Biology for Christian Schools*, at xi (3d ed. 2005) (SER0567A). Similar statements appear throughout the textbook, drumming home the message that, with respect to any “fact” contained in the Bible, empirical evidence is irrelevant. See, e.g., *id.* at 197 (SER0572A) (“Because God is the source of all

truth, all accurate scientific knowledge will fit into th[e Bible's] outline. Anything that contradicts God's Word is in error or has been misunderstood."); *id.* at 201 (SER0576A) ("God's Word is the only true measuring stick of scientific accuracy."); *id.* at 204 (SER0579A) ("All scientific facts and the interpretation of those facts, therefore, must fit into the model prescribed by the Word of God. A scientific 'fact' that does not fit into the worldview outlined in the Bible either is in error (and therefore not really a fact) or is being misinterpreted."); *id.* at 251 ("[T]he Bible is the source of all truth, and everything, not just science, must be evaluated based on Scripture. If a hypothesis or scientific model seems to make sense and all of the evidence points to an answer that is contrary to the Bible, then the evidence, not the Bible, must be reevaluated and the conclusions changed.").

The second edition of *Biology: God's Living Creation* suffers from a similar flaw with respect to its presentation of the nature of science, instructing biology students that the Bible is literally true—regardless of any empirical evidence that may appear to be to the contrary. For example, a section titled "The Role of Scripture in Scientific Investigation," at the beginning of a subchapter titled "Biology and Scientific Investigation," teaches that "God has chosen to reveal some important scientific truths to man through His Word." Gregory Parker et al., *Biology: God's Living Creation* 350 (2d ed. 1997) (SER0630A). These "scientific truths," including the "facts of creation" are infallible; no evidence beyond Scripture itself is needed to support them and no non-Scriptural evidence

can ever debunk them. *Id.* Thus, the textbook later explains, “[t]he scientist needs the Bible . . . because it records vital facts about the history and future of the physical universe that he would not” (and could not) “otherwise know.” *Id.* at 358 (SER0638A). *See also id.* at 363 (SER0643A) (describing “the Scriptures as the starting point for science”).

In a chapter titled “The Scientific Method,” *Biology for Christian Schools* places another drastic limitation on the proper scope of scientific inquiry. The textbook states unequivocally: “Questions asking how or why are not measurable and are therefore beyond the scope of science. The scientific method cannot *explain* a phenomenon.” *Biology for Christian Schools, supra*, at 15. Highlighting this point further, an inset on the next page includes the following as one of the nine “Limitations of Science”: “Science can only describe, not explain.” *Id.* at 16. As discussed above, however, the scientific community views the explanation of the natural world—not just its description—to be at the heart of what the enterprise of science is all about.

b. The Textbooks And The Theory Of Evolution

In its one-page preface, *Biology: God’s Living Creation* lays out in no uncertain terms its staunch opposition to the teaching of evolution:

[E]volutionism poisons biology textbooks and distracts from God’s glory in creation. . . . The Christian teacher will find that the unique *A Beka Book* approach to biology eliminates the conflict which results when evolutionary philosophy is combined with truth.

Evolution is presented for what it is—a retreat from science. Students and teachers alike will feel more comfortable when they realize that it is not biology that is in conflict with Scripture, but rather the ungodly philosophy of some biologists.

Biology: God's Living Creation, supra, at iii (SER0627A).

As foreshadowed by the above passage, the one chapter in *Biology: God's Living Creation* that focuses to any degree on the theory of evolution is titled “Evolution: A Retreat from Science,” *id.* at 358 (SER0638A), with subchapters tellingly titled “Science and Faith,” *id.*, “Paleontology: Evidence against Evolution,” *id.* at 366 (SER0646A), “Biology: Evidence against Evolution,” *id.* at 381 (SER0661A), and “Evolution Is Not Science,” *id.* at 390 (SER0670A). In the chapter, consistent with their overall approach to the nature of science, the authors reject evolution because it conflicts with the literal creation account of the Bible. *See, e.g., id.* at 380 (SER0660A) (“*Man has always been man. . . . God’s account of how man was created is clear, concise, and complete. There is nothing in His record that would lead us to believe that man arose from the animals by evolutionary process. On the contrary, we are told that God Himself shaped and fashioned man from the ‘dust of the grounds’ and then ‘breathed into his nostrils’ to give him life (Gen. 2:7).*”); *id.* at 386 (SER0666A) (“It is important to remember that although God created genes for great variety within each kind, one kind does not change into another kind. . . . Rather, God ordained that living things should always reproduce ‘after their kind.’”).

In addition, however, the authors teach that, even putting the inerrancy of the Bible to the side, the theory of evolution simply is not supported by scientific evidence. In making this argument, they briefly mention and dismiss a few of the many pieces of supporting empirical evidence that have collectively led the scientific community to embrace evolution as a theory beyond dispute. *See, e.g., id.* at 367 (SER0647A) (“[T]he fossil record reveals a record of sudden death and destruction that is consistent with the Biblical teaching concerning a worldwide flood.”); *id.* at 383 (SER0663A) (“[I]t is only logical that [different organisms’] skeletons should have a general similarity, that nerves should be designed alike, and that muscles should be essentially the same. Of course, God could have created each organism with its own unique design, but that would not have accomplished anything more significant than what He accomplished by repeatedly using and modifying the same basic pattern.”).

Biology for Christian Schools takes the same basic approach to evolution. First, in the relatively brief portion of the textbook in which the theory is even mentioned, the authors reject it because it is irreconcilable with God’s creation of the world in six, literal, twenty-four-hour days. The authors plainly state that “Christians need not worry about the beginning of life, since it is clearly outlined in Genesis 1 and 2.” *Biology for Christian Schools, supra*, at 197 (SER0572A). Second, despite the scientific community’s firmly entrenched position to the contrary, the authors instruct that the scientific evidence does not

support the theory of evolution. *See, e.g., id.* at 232 (SER0607A) (“When the Christian views the scientific evidence carefully, he finds nothing in that evidence to seriously challenge the validity of the Christian worldview of the Bible’s record that the world was made by a direct act of God. Scientific evidence continues to support the creationist view rather than the evolutionary view.”).

3. These Misconceptions Leave Students Unprepared For Higher Education, Posing Substantial Barriers To Their Success In Undergraduate Science Classes And Negatively Impacting The Learning Experiences Of Their Classmates

High school science classes that use *Biology for Christians* or *Biology: God’s Living Creation* as their primary textbook do not prepare students for introductory-level college science classes. As discussed above, the nature of science and the theory of evolution are foundational concepts that should be key elements of any K-12 science education, and students should have a very solid working knowledge of both before the end of high school. However, neither *Biology for Christians* or *Biology: God’s Living Creation* adequately or accurately teaches either of these two basic building blocks of science.

Stanford education professor, Michael Kirst, testified that numerous studies support the intuitive proposition that high school course content is a “crucial variable” in preparing students for success at the college level. (SER2840-41.) Kirst went on to explain that “[s]tudents who lack vital content in their courses cannot keep up in class . . . [,] tend to have lower college course grades,

take longer to complete degrees, and drop out more frequently.” (SER2841.) One recent California Council of Science and Technology (“CCST”) report demonstrates, specifically with respect to UC science classes, that preparation at the high school level is a key predictor of subsequent success (or lack thereof) in the college classroom:

Several UC campuses report that high attrition rates in S&E [(“science and engineering”)] are due to the poor preparation, which many freshmen have in mathematics and science, leaving them unable to master the subject material. Many have difficulty with the entry-level core courses in S&E, and because of limited class availability, it is hard to make up for lost time when a student fails a class or requires additional remediation.

CCST, *Critical Path Analysis of California Science and Technology Education System (“CPACSTES Report”)* 70 (April 2002), available at <http://www.ccst.us/publications/2002/2002CPA.php>.

Biology for Christians and Biology: God’s Living Creation not only fail to provide sufficient exposure to the nature of science and the theory of evolution, but also instill fundamental misconceptions regarding both. It is widely accepted in the field of science education that students’ prior misconceptions serve as barriers to their understanding of new scientific concepts. See, e.g., Committee on Undergraduate Science Education, NAS, *Teaching Reconsidered: A Handbook*, Chapter 4: Misconceptions as Barriers to Understanding Science (1997), available at http://www.nap.edu/catalog.php?record_id=5287; Committee on the

Development of Science in Learning, NAS, *How People Learn: Brain, Mind, Experience, and School: Expanded Edition* 14-15 (2000), available at <http://www.nap.edu/openbook.php?isbn=0309070368> (“Students come to the classroom with preconceptions about how the world works. If their initial understanding is not engaged, they may fail to grasp the new concepts and information that are taught, or may learn them for purposes of a test but revert to their preconceptions outside the classroom.”); Brian Alters, *Teaching Biological Evolution in Higher Education: Methodological, Religious, and Nonreligious Issues* 31 (2005) (“One of the most fundamental problems with teaching evolution is the myriad misconceptions students bring with them from their precollege years.”). Thus, science teachers must take the time to identify and address their students’ relevant misconceptions in order to educate them effectively. This process is inherently difficult, and made all the more so when the students’ misconceptions about science are supported by religious authority. See Alters, *Teaching Biological Evolution in Higher Education*, *supra*, at 17 (“If strictly scientific evolutionary misconceptions engendered from formal education are not difficult enough on their own for college professors to rectify, add supernaturalism.”).

This leaves the introductory-level college science professor—who has a finite amount of class time and likely a relatively large number of students in her class—with two equally unappealing options if *Biology: God’s Living Creation* or

Biology for Christian Schools formed the basis of one of her students' pre-college biology education. First, she could simply ignore the student's unpreparedness and misconceptions and accept the fact that the student very well might not succeed in her class. Or, second, she could derail the rest of the class to identify and address the student's misconceptions and cover basic, remedial concepts that should have been learned in high school, if not earlier. This second option also entails the risk of unnecessarily turning the classroom into a forum for religious confrontation, rather than science education.

A. Educating Students Well In The Sciences At The Post-Secondary Level Is Critical To California's And America's Prosperity In The 21st Century

1. The Economic Importance Of Science And Technology Education

Students who are competent and proficient in science and mathematics are especially important in an economy that increasingly depends on science, engineering and technology to spur new ideas for innovation and economic competitiveness. The importance of the link between education, particularly science and technology, and California's and the United States' long-term economic well-being has been observed and documented by virtually every major American organization representing business, research and education, as

well as government agencies and Presidential commissions.³ Indeed, as recently as his national address on February 24, 2009, President Obama stressed the importance of science education in maintaining America's place as the world's economic leader. President Barack Obama, Address to the Joint Session of Congress (Feb. 24, 2009), *available at* http://www.whitehouse.gov/the_press_office/remarks-of-president-barack-obama-address-to-joint-session-of-congress/.

Science education exerts the most visible influence on the economy through its most rapidly changing offspring—innovation and new technology.⁴

³ A sampling of the published literature on the subject: National Center on Education and the Economy, *Tough Choices or Tough Times* (2008), *available at* <http://www.skillscommission.org/executive.htm>; President George W. Bush, *Competitiveness Initiative* (2006); National Science Board, *America's Pressing Challenge – Building a Stronger Foundation*, *available at* <http://www.nsf.gov/statistics/nsb0602/nsb0602.pdf> (2006); National Academies Committee on Science, Engineering and Public Policy, *Rising Above the Gathering Storm* (2006); Business-Higher Education Forum, *A Commitment to America's Future: Responding to the Crisis in Mathematics and Science Education* (2005), *available at* <http://lsc-net.terc.edu/do.cfm/11683>; National Innovation Initiative, Counsel of Competitiveness, *Innovate America: Thriving in a World of Challenge and Change* (2004); National Commission on Mathematics and Science Teaching for the 21st Century, *Before It's Too Late: A Report to the Nation* (2000), *available at* <http://www.ed.gov/inits/Math/glenn/index.html>; CCST, *California Report on the Environment for Science and Technology* (“CREST Report”) (1999), *available at* <http://www.ccst.us/publications/index.php>; National Commission on Excellence in Education, *A Nation at Risk: The Imperative for Educational Reform* (1983), *available at* <http://www.ed.gov/pubs/NatAtRisk/index.html>.

⁴ W. Popper and C. S. Wagner, *New Foundations for Growth: The U.S. Innovation System Today and Tomorrow*, (RAND Corporation, 2002). The authors state: “The transformation of the U.S. economy over the past 20 years has made it
(continued...)

See James Lewis, *Waiting for Sputnik: Basic Research and Strategic Competition* 5, 25 (2006). Innovation is the relentless driver behind the nation's standard of living, the source of U.S. economic leadership, and the foundation for our competitiveness in the global economy.⁵ See Bill Gates, Editorial, *How to Keep America Competitive*, Washington Post, Feb. 25, 2007, at B07. Economic studies conducted even before the information-technology revolution have shown that more than 50% of measured growth in U.S. income per capita is due to technological innovation.⁶ Robert Solow, Nobel laureate for economics, demonstrated that productivity depends on more than labor and capital. Intangible assets—research and development, or the acquisition of knowledge—are crucial

(continued...)

clear that innovations based on scientific and technological advances have become a major contributor to our national well being.”

⁵ One study argues that “there has been more material progress in the United States in the 20th century than there was in the entire world in all the previous centuries combined,” and most of the examples cited have their basis in scientific and engineering research. S. Moore and J. L. Simon., *The Greatest Century That Ever Was: 25 Miraculous Trends of the Last 100 Years*, Policy Analysis No. 364 (Cato Institute, December 15, 1999).

⁶ US Congress House of Representatives Committee on Science, *Unlocking Our Future: Toward a New National Science Policy* (1998), available at <http://www.access.gpo.gov/congress/house/science/cp105-b/science105b.pdf>. The report notes that “the growth of economies throughout the world since the industrial revolution began has been driven by continual technological innovation through the pursuit of scientific understanding and application of engineering solutions. *Id.* at 1.

for a civilization's progression.⁷ In today's society, "the knowledge density of modern economies has steadily increased, and the ability of a society to produce, select, adapt, and commercialize knowledge is critical for sustained economic growth and improved quality of life." *Rising Above the Gathering Storm, supra*, at 45.

2. University Science Has A Profound Effect On Statewide Economic Growth

University science and engineering tends to work on the frontier of knowledge and so is disproportionately the source of breakthroughs and new industries. As one American scholar recently explained, "[t]he tie between higher education and technology is vital Universities produce the bodies and the ideas that we need to remain competitive." *See* J. Lewis, *supra*, at 5. During the period that the new innovative knowledge is systemized and diffused, it is likely to be applied commercially near where it is discovered through "geographically localized knowledge". *See* CCST, *Critical Path Analysis of California's S&T Education System: Universities and Colleges in California* 75-77 (Feb. 2002), available at <http://www.ccst.us/publications/index.php>. Over the last decade, research has shown that the founding of new-technology high-tech firms by region is primarily impacted by geographic proximity to top quality science and

⁷ R. M. Solow, *Technical Change and the Aggregate Production Function*, 39 *The Review of Economics and Statistics* 310, 312-20 (1957).

technology university programs. *Id.* The best example of this phenomenon is California's science and technology base, which leads the nation in top quality scientific research departments and high-tech startups. *Id.* at 75.

3. Science And Technology Education Is One Of The Most Crucial Driving Forces Of California's Economy

Science- and technology-based industries constitute an extraordinarily large, high-wage component of California's economy—making California's economy the sixth largest in the world.⁸ *See* CCST, *CREST Report, supra*, at 7-9. Recent census statistics show that these high-tech sectors are much more prominent (and vital) to the California economy than they are nationwide. *See* CCST, *CPACSTES Report, supra*, at 32.

More importantly, these sectors provide a source of high-income jobs essential to supporting California's tax base by generating tax revenue for state and local governments. *See* CCST, *CREST Report, supra*, at 9. The most recent economic census data shows high-tech science and technology wages in California average over \$73,500 per worker, compared to an average payroll of approximately \$37,300 for all other private non-farm industries. *Id.* at 33. Social

⁸ California's share of total U.S. employment has hovered near 11% for the past two decades, while its share of U.S. science and technology employment has topped 18% over the same period. High-tech industries account for 5.6% of U.S. jobs, while it accounts for nearly 10% of California jobs. *See* CCST, *CPACSTES Report, supra*, at 32.

service benefit levels and total public expenditures on social services per capita in California are among the highest in the nation, as well as per capita California government expenditure levels. *See* CCST, *CREST Report, supra*, at 9. Therefore, continued growth in these science and technology industries is essential for retaining current levels of public services. *Id.* at 9.

Today more than ever, California's sustained growth in high-tech industry requires a highly skilled workforce. 41% of jobs in California's science and technology industries require a baccalaureate degree or higher. *See* CCST, *CPACSTES Report, supra*, at 32-34. For another 23% of those jobs, a baccalaureate degree or higher in a science and engineering field is preferred. *Id.* And jobs that require an associate's degree account for another 5%. *Id.* Even jobs with lesser degree essentials demand an understanding of scientific methods. *Id.* Despite the obvious need to fuel California's (and the nation's) high-tech workforce with highly educated and younger workers, mounting evidence indicates that California's post-secondary institutions are not producing the quality or quantity of science and engineering graduates that they once did.

4. Our Nation's Once Unchallenged Preeminence In Science And Technological Innovation Is Being Overtaken By Countries Throughout The World

a. Students In The United States Are Falling Behind Their Counterparts In Other Countries

For most of the 20th century, the American education system provided a substantial part of the talent and proficiency needed to sustain and improve our way of life. Today, however, as the U.S. economy becomes even more reliant on younger workers with greater knowledge and technological expertise, the domestic supply of qualified workers is not keeping up with the skill demands. And economists estimate that “trailing other developed countries on education measures may reduce U.S. economic growth by as much as a half percentage point a year.” *See Business Roundtable, Tapping America's Potential: The Education for Innovation Initiative 5-6 (July 2005), available at <http://www.businessroundtable.org/initiatives/education>.* Much of this problem can be traced to America's colleges and universities.

For decades, U.S. college students have been migrating away from hard science—towards business, law, and liberal arts degrees. In January 2006, General Electric CEO Jeffrey Immelt lamented in a speech that “[w]e had more sports-exercise majors graduate than electrical-engineers grads last year.” *See Rick Newman, Can America Keep Up?, U.S. News and World Report (March 27, 2006), available at <http://www.physicsforums.com/archive/index.php/t->*

116454.html. Recent studies tell a similar story. Long-term trends in degree-taking show a decline in U.S. student completion of natural science and engineering degrees relative to other countries, dropping from 3rd on rate of baccalaureate attainment to 14th from 1975 to 1999 among 19 countries. The proportion of bachelor's degrees in physics to total degrees awarded to American students was twice as high in the late 1950s as in 2004. *Rising Above the Gathering Storm, supra*, at 14-17. Throughout the 1990s, fewer than half of American undergraduate students who entered college intending to earn a science or engineering major completed a degree in one of those subjects. *Id.* at 98.

This shift away from the sciences at American colleges and universities has come at a time when the rest of the developed world is investing (and surpassing the United States) in post-secondary science and technology education.⁹ In South Korea, 38% of all undergraduates receive their degrees in natural sciences or engineering. In France, the figure is 47%, in China, 50%, and in Singapore, 67%. In the United States, the corresponding figure is 15%. *Rising*

⁹ The United States ranks 16th of 17 nations in the proportion of 24-year-olds who earn degrees in natural sciences or engineering as opposed to other majors and 20th of 24 nations when looking at all 24-year-olds. *Rising Above the Gathering Storm, supra*, at 98. See also Erik Hanushek, *The Seeds of Growth*, Education Next 6 (Hoover Institution, Sept. 22, 2002), available at <http://www.hoover.org/publications/ednext/3364966.html> (noting that U.S. students are not likely to complete more schooling than those in a significant number of other developed and developing countries).

Above the Gathering Storm, supra, at 16. Indeed, China graduates four times as many engineers as the United States. National Science Board, *Science and Engineering Indicators, 2004*, Appendix Table 2-34 (2004), available at <http://www.nsf.gov/statistics/seind04/>. And since the late 1980s, the European Union has produced more science and engineering Ph.Ds than the United States. *Id.* This alarming trend mirrors the situation facing California's colleges and universities.

b. University And College Students In California Are Falling Behind As Well

Over the last decade, California's science and technology workforce has become particularly worrisome as a gap between degree production and workforce demand now exists. California is underproducing baccalaureate science and engineering degrees—finding itself in the lowest quartile of states producing degrees per 1,000 in the 18-24 age range, and in the third quartile of bachelor's degrees in science and engineering disciplines conferred overall in the same group. *See CPACSTES Report, supra*, at 62-64. Furthermore, California now lags behind other states (i.e. Massachusetts, New York) in per capita production of science and engineering degrees and rate at which baccalaureate recipients pursue graduate degrees. *Id.* at 72.

More importantly, in California, attrition is significant from high school through the undergraduate system. Less than 3.3% of 9th grade students

enrolled go on to complete a baccalaureate in science and engineering. About half of the undergraduate students who enroll in science and engineering actually complete a baccalaureate in the same field. Science and engineering undergraduate students also have a higher attrition rate compared to other disciplines. *Id.* at 63. This shift away from the sciences has led to approximately 15,000 job vacancies (and counting) for graduates with a science and engineering degree in California. *Id.* at 71.

5. California And The United States Need *All Of Their Citizens To Be Scientifically Literate*

Over fifty years ago, the Supreme Court identified “education” as “the very foundation of good citizenship.” *Brown v. Bd. of Educ.*, 347 U.S. 483, 493 (1954). Today, that education must include a solid grounding in the sciences, even for those who pursue careers in fields other than science or technology. Indeed, “[n]o citizen of America can participate intelligently in his or her community or, indeed, conduct many mundane tasks, without being familiar with how science affects his daily life.” *Before It’s Too Late*, *supra*, at 14.

Moreover, “a scientifically literate population is vital to the democratic process.” National Science Board, *Failing Our Children: Implications of the Third Mathematical and Science Education Study* (1998), available at <http://www.nsf.gov/nsb/documents/1998/nsb98154/nsb98154.htm?org=NSF>. No matter what the substantive issue may be, “[t]o make informed decisions about

public policies, people need to know how scientific evidence supports those policies and whether that evidence was gathered using well-established scientific practice and principles.” *Science, Evolution, and Creationism, supra*, at 43.

Further, many of the key issues of the day are themselves directly science-related—including global warming, stem-cell research, and the use of DNA testing, each of which was the subject of at least one California ballot initiative since 2004. *See* California Proposition 10: Alternative Fuel Vehicles and Renewable Energy (2008), *available at* <http://voterguide.sos.ca.gov/past/2008/general/title-sum/prop10-title-sum.htm>; California Proposition 71: Stem Cell Research (2004), *available at* <http://vote2004.sos.ca.gov/propositions/prop71-title.htm>; California Proposition 69: DNA Samples (2004), *available at* <http://vote2004.sos.ca.gov/voterguide/propositions/prop69-title.htm>.

VI. CONCLUSION

The future prosperity of California and the United States depends on the reversal of the trends described above, through the increased production of university graduates who are well educated in the sciences. UC has determined that it can best contribute to these goals by setting standards that ensure that matriculating students are prepared for college science classes. That determination and the District Court's judgment should not be disturbed.

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CERTIFICATE OF COMPLIANCE

I certify pursuant to Federal Rule of Appellate Procedure 29(c)-(d) and 32(a)(7)(C) and Ninth Circuit Rule 32-1 that the attached *amicus curiae* brief is proportionately spaced, has a typeface of 14 points, and contains 6660 words.

s/ Salvatore Picariello _____
Salvatore Picariello

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