

A Tale of Two Years: 1983 and 2005

The Urgent Need to Improve
Science, Technology, Engineering and
Mathematics Education
in the 21st Century Economy



January 2006

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Summary

The purpose of this white paper is to elevate the level of public discussion and address the immediate urgent need for strategies to improve science, technology, engineering, and mathematics (STEM) education.

A Nation at Risk was issued in 1983 and pointed out, among other things, that the U.S. had been “committing an act of unthinking, unilateral educational disarmament.” Twenty-two years later, when *The World Is Flat* was published, Tom Friedman called the situation regarding STEM education “a quiet crisis.” The Arkansas 2005 benchmark exams show student proficiency in mathematics declines steadily from the third grade to the eighth grade. Nationally, Bill Gates declares that American high schools are obsolete.

It is within this context that the Arkansas Science & Technology Authority’s Board of Directors finds that: (1) STEM education is an essential building block for economic growth; (2) STEM education that exerts “maximum effort to accomplish minimum results” is inadequate; (3) time is running out – the state and nation cannot afford to wait another 22 years to improve STEM education; and (4) it is time to act.

Wishing to elevate the public discourse about STEM education and drawing on a variety of recommendations, including those from the report *Rising above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future*, the Board poses questions about what would happen if Arkansas were to provide the science, technology, engineering, and mathematics skills needed to ensure student success.

What would happen if Arkansas focused its action tightly on providing a supportive environment for STEM education, including a rich STEM curriculum, talented STEM teachers with content knowledge, 21st century tools and broadband access in the classroom, and communities and families that expect high academic performance as a prerequisite for economic success?

The Unheard Call to Action: Two Reports

The World Is Flat is a call to action for scientists and engineers. Tom Friedman’s chilling chapter seven – titled “The Quiet Crisis” – highlights what he calls the “dirty little secrets” about the numbers gap, the ambition gap, and the education gap in the United States. For many scientists and engineers, this quiet crisis – about science, technology, engineering, and mathematics (STEM) education – is no dirty little secret at all.

Routine evidence of sliding student performance, declining interest in science and engineering, and dropping numbers is so abundant that many have become desensitized, both to the evidence and the implications for the U.S. economy and national security.

American scientists and engineers, however, have failed to communicate, educate, or agitate to the extent necessary to generate the kind of response that American policy makers must make to improve STEM education and secure our nation from risk.

The World Is Flat follows by 22 years another report with similar warnings.

*A Nation at Risk*¹ was published in 1983, is particularly well written, and states:

If an unfriendly foreign power had attempted to impose on America the mediocre educational performance that exists today, we might well have viewed it as an act of war. As it stands, we have allowed this to happen to ourselves. We have even squandered the gains in student achievement made in the wake of the Sputnik challenge. Moreover, we have dismantled essential support systems which helped make those gains possible. We have, in effect, been committing an act of unthinking, unilateral educational disarmament.

The World Is Flat continues the painful assessment, contains many important insights, and has two points that scream out to be repeated here in the wake of, “We have, in effect, been committing an act of unthinking, unilateral educational disarmament.” First:²

“We looked at two things,” she continued. [She is Tracy Koon, Intel’s director of corporate affairs.] “We looked at the fact that in disciplines that were relevant to our industry, the number of U.S. students graduating at the master’s and Ph.D. levels was declining in absolute numbers and relative to other countries. In our K to twelve we were doing okay in the fourth grade, we were doing middle-of-the-road in the eighth grade, and by the twelfth grade we were hovering near the bottom in international tests related to math. So the longer kids were in school, the dumber they were getting ... You have teachers turning off kids because they were not trained. You know the old saw about the football coach teaching science – people who do not have the ability to make this accessible and gripping for kids.”

And second:³

... the people who understand these issues the best and are closest to them have the same message: Because it takes fifteen years to create a scientist or advanced engineer, starting from when that young man or woman first gets hooked on science and math in elementary school, we should be embarking on an all hands on deck, no holds barred, no budget too large crash program for science and engineering education immediately. The fact that we are not doing so is our quiet crisis. Scientists and engineers don’t grow on trees. They have to be educated through a long process, because, ladies and gentlemen, this really *is* rocket science.

The Current Situation

A Nation at Risk made a compelling argument for action in 1983, and many things have happened since, but there are few indications that improvement is in sight. To the contrary, Bill Gates told the nation’s governors that American high schools are obsolete, adding, "By obsolete, I don’t just mean that our high schools are broken, flawed and underfunded, though a case could be made for every one of those points. By obsolete I mean that our high schools, even when

¹ *A Nation At Risk*, April 1983. <http://www.ed.gov/pubs/NatAtRisk/risk.html>

² *The World Is Flat*, Thomas L. Friedman, 2005. [pp. 272-3]

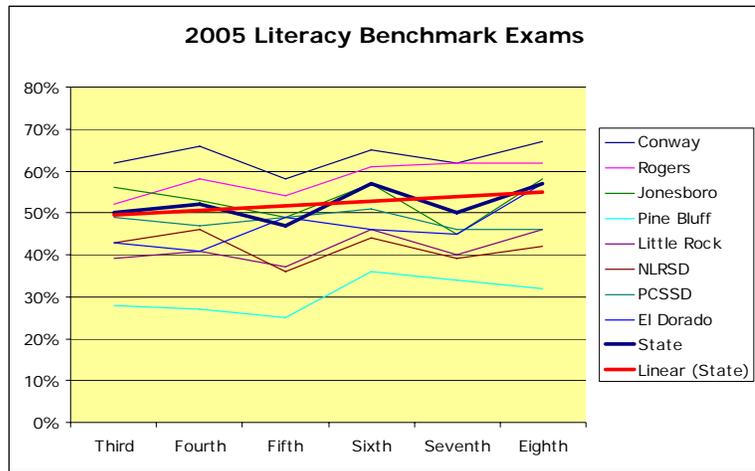
³ *The World Is Flat*, Thomas L. Friedman, 2005. [p. 275]

they're working exactly as designed, cannot teach our kids what they need to know today."⁴ Observations by corporate leaders – such as Bill Gates and the many business people cited in *The World Is Flat* – show how important the skills of scientists and engineers are to global business and the knowledge-based economy.

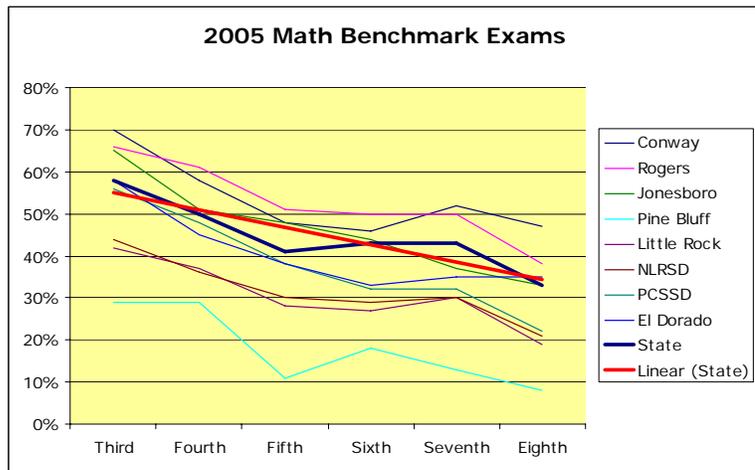
Student performance in the critical areas of science, technology, engineering and mathematics has not improved. One needs to look only as far as the local newspaper to find the disturbing reports.

Recently the *Arkansas Democrat-Gazette* reported on literacy and math benchmark exams that were taken by more than 205,000 students statewide.⁵ The benchmark exam is a snapshot of the proficiency levels in specific grades at a particular time. The story reported the percentage of students performing at or above the proficiency level for each grade from three through eight in the state as a whole and in eight school districts from locations around the state. A table of scores was published and a link to the education department's website (<http://arkedu.state.ar.us>) was given.

At the statewide level, student proficiency in literacy tended to improve gradually from third through eighth grade – from 50 percent to 57 percent – as shown in the chart titled 2005 Literacy Benchmark Exams. Six of the eight identified school districts showed the percentage of students performing at or above proficient improving from third to eighth grade. The two that showed decreases were one and three percentage points respectively.



The data for student proficiency in math show a much different picture. Statewide student proficiency in math dropped from 58 percent in the third grade to 33 percent in the eighth grade. These data are shown in the chart titled 2005 Math Benchmark Exams. Each of the eight school districts saw steady erosion of proficiency by grade level and in each case the proficiency dropped by more than 20 percentage points.



Two things are especially troubling about these numbers. First, the students seem relatively more proficient in math than literacy in the third grade, which suggests that students are interested. Second, the magnitude of the

⁴ "U.S. high schools are called obsolete," by Paul Barton, Sunday, February 27, 2005, *Arkansas Democrat-Gazette*, p. 1A.

⁵ "Exam results come in below state average," by Cynthia Howell, Sunday, October 9, 2005, *Arkansas Democrat-Gazette*, p.2B.

decline in math proficiency is stunning.

The Challenge

Current public discussion in Arkansas is focused largely on a twice-reopened 2002 Arkansas Supreme Court decision on the Lakeview school funding case, which found that the state, not local school districts, is constitutionally responsible for public education. This opened new territory for state officials and tightened the focus of attention at the state level on policy, funding, effectiveness, and facilities.

In the meantime, interest in science, technology, engineering, and math (STEM) education has grown because of its relevance to economic growth, but attention to this important part of the educational system has been overshadowed by the larger, more urgent challenge posed by the Supreme Court.

This is the perennial challenge for STEM education; it is easy to push it aside when the more urgent – not necessarily more important, but more urgent – educational issues arise. This is what Charles Hummel called “the tyranny of the urgent.” While urgent issues come and go, the important issue of STEM education remains largely overlooked.

The September 10, 2005 issue of the *Arkansas Democrat-Gazette*⁶ reported on testimony before state Supreme Court masters in the twice-closed and re-opened Lakeview school funding case. According to the article, one of the two masters, former Supreme Court Justice David Newbern, “likened education finance in Arkansas to a ‘Rube Goldberg machine,’ a description used for a complicated scheme for a seemingly simple objective.”

Reuben Goldberg was a graduate engineer and cartoonist who received a Pulitzer Prize in 1948. His legacy, however, is his collection of cartoons illustrating inventions – Rube Goldberg machines – that make simple tasks overly complicated. According to the Rube Goldberg website, “His cartoons were, as he said, symbols of man’s capacity for exerting maximum effort to accomplish minimum results.” This describes the situation in public education, where dedicated educators work hard to get minimum results.

ASTA Board Findings

The purpose of this white paper is to elevate the public discussion about this important issue and address the immediate, urgent need for a strategy to improve science, technology, engineering, and mathematics education. Despite emerging arguments to the contrary, the Board of the Arkansas Science & Technology Authority believes that we are in a global economic race to the top, and that Americans do not have 22 years – as there were between *A Nation at Risk* and *The World Is Flat* – to address STEM education issues.

The Board of the Arkansas Science & Technology Authority finds that:

- **STEM Education Supports Economic Growth.** The National Innovation Initiative, the Southern Innovation Summit, and Accelerate Arkansas – three different approaches at three different geographic levels – each identifies science, technology, engineering, and math education as an essential economic building block.
- **STEM Education Is Inadequate.** The public education system is not preparing its students for the careers in science, engineering, and technology needed to keep the state and region economically competitive and the nation secure from external threats.

⁶ “Masters grill legislators as they wrap up hearings in school-funding case,” by Seth Blomeley, Saturday, September 10, 2005, *Arkansas Democrat-Gazette*, p. 1A.

- Time Is Running Out. The opportunity for incremental change is gone, overtaken by global competition and an all out international race to the top.
- It Is Time to Act. Arkansas needs what Tom Friedman calls an immediate “all hands on deck, no holds barred, no budget too large crash program for science and engineering education.”

What Would Happen If . . .

The Board of Directors of the Arkansas Science & Technology Authority, wishing to elevate the public discourse about STEM education and drawing on a variety of recommendations, including those from the report *Rising above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future*,⁷ poses the following questions.

Supportive Educational Environment

- What if the state provided a supportive and effective educational environment for students, an environment in which students receive the skills needed to ensure success in higher education and the workforce?
- What would happen to the number of students in the STEM pipeline if the state restructured teaching elementary science and math so that the science and math specialist teachers rotated from class to class introducing every student at that excitable age to in-depth, fun, and exciting science and technology?
- What would happen to the state’s economy if the state established regional STEM specialty high schools? What kind of leaders would such schools create? Could regional STEM high schools test teaching materials; create a corps of exceptional math and science teachers; provide a training ground for K–8 teachers; collaborate with local STEM-related resources; and provide summer programs that introduce students to science and mathematics?
- What would happen if the state incorporated inquiry-based learning – such as the Environmental And Spatial Technology (EAST) initiative – into every school in Arkansas so that students could apply their education to real world issues?
- What would happen to the quality of education in Arkansas if the measures of teaching performance included student retention, graduation rates, and rates of students seeking higher education?

Curriculum

- What would happen to the Arkansas economy if the state included a rich STEM curriculum – perhaps incorporating STEM curriculum elements related to the Natural State’s ecology?
- What would happen to Arkansas’ image if it modeled its K–12 curriculum materials on world-class standards and included science, technology, pre-engineering, and math content in curriculum frameworks for all appropriate grades?
- What would happen if the state increased the number of students who take advanced placement science and mathematics courses?
- What would happen if more students were prepared to enter the science and engineering talent pipeline because science, technology, and pre-engineering was part of the curriculum?
- What would happen if the state created summer internships and research opportunities to provide valuable laboratory experience for both middle-school and high-school students?

⁷ *Rising above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future*, National Academy of Sciences, National Academy of Engineering, and Institute of Medicine of the National Academies. Executive Summary, Prepublication Copy (2005)

Teachers

- What would happen to the state's economy if talented STEM teachers were in every science, technology, pre-engineering, and mathematics classroom in the state?
- What if the state created incentive programs – or created and funded a bonus system – for STEM teachers whose students make significant progress on nationally standardized tests?
- What would happen if Arkansas required math and science teachers to have a degree in the field that they teach? What if the state created advanced-degree incentive programs for STEM teachers?
- What would happen if the state provided incentives (such as tuition reimbursement after the students take Arkansas teaching jobs) to recruit top students into the teaching profession.
- What would happen to the state's economy if STEM teachers were paid salaries commensurate with what they could earn in alternative career paths?

Scholarships

- What would happen to the state's economy if Arkansas provided new 4-year competitive undergraduate scholarships – scholarships that would be difficult to get, but easy to keep – each year for physical-sciences, life sciences, engineering, and mathematics bachelor's degrees to keep the best high school graduates in the state?
- What if the state funded new graduate fellowships each year to keep the best science and engineering graduates in the state?
- What if the state funded post graduate fellowships to keep the best science and engineering researchers in the state long enough to find a knowledge-based job?

Broadband Access

- What would happen to the state's economy if the supportive and effective STEM educational environment was enabled by 21st century tools and broadband access in the classroom?
- What would happen to the state's economy if the supportive and effective STEM educational environment was enabled by 21st century tools and broadband access in every student's home?

Communities and Families

- What would happen to the state's economy if communities and families were more engaged in STEM education as a building block of the knowledge-based economy and planned their futures around the local opportunities made possible by science and technology?
- What if communities and families expected high academic performance from their students?
- What would happen to the state's economy if communities viewed technology-oriented entrepreneurship as a building block of the knowledge-based economy and encouraged STEM students to be innovative and think entrepreneurially?
- What if every family valued education as central to the children's and family's success and every family took advantage of libraries, museums, parks, and other interpretive centers in order to better understand the role of science and technology in their lives? What if pre-school children with their natural curiosity were exposed to the excitement of science and technology by their families?

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- What if communities and families – as well as schools – made role models of female and minority scientists and engineers to complement existing stereotypes?
- What if local media outlets – newspapers and radio stations – gave better coverage to science, engineering, and technology related to local schools, colleges, and businesses?

Why ASTA? Why Now?

The Arkansas Science & Technology Authority has the mission of bringing the benefits of science and advanced technology to the people and the state of Arkansas. The mission is carried out through programs and activities that foster research, technology development, entrepreneurship, technology transfer, manufacturing extension, and support of education at all levels. The Board has released this white paper to elevate the public discussion about science, technology, engineering, and mathematics education as a building block of economic growth. It has taken unanimous action now because the Board believes that time is running out – that the state and nation do not have another 22 years to consider improvements to STEM education – and that the time to act is *now*.

Approved Unanimously
January 20, 2006 by the
Board of Directors of the

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