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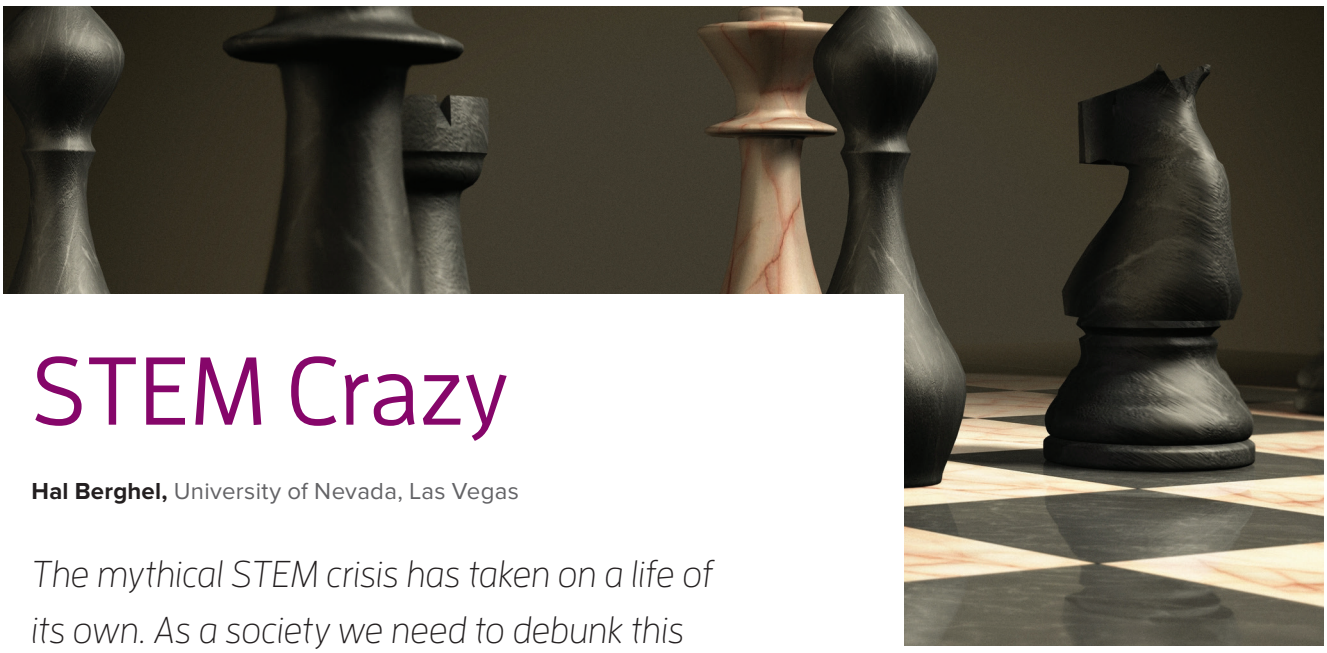

STEM Crazy

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The mythical STEM crisis has taken on a life of its own. As a society we need to debunk this myth before it adds another giant neoliberal heap to the national debt.

One definition of pornography is the "depiction in a sensational manner so as to arouse a quick intense emotional reaction" (Merriam-Webster's Collegiate Dictionary, 11th Edition; www.m-w.com). This definition fits the mythical "STEM crisis" perfectly. In fact, it fits all mythical crises perfectly. In his attack on the student left during the 1960s, Edward Teller, the hawkish Cold Warrior physicist said that "... student demonstrations and radical administrations at MIT and Stanford had wiped out military R&D, leaving the United States short of scientists ready and able to build the next generation of nuclear weapons," as quoted in *Merchants of Doubt*.[1] Maybe. But during that same period, those same administrations and students contributed to the computing industry advances that created our current quality of life. Although we've given up a few thousand neutron bombs, we gained the semiconductor industry, personal computers, the Internet, cell phones, smartphones, fiber optics, Teflon, the iPad, and so much more.

Teller and fellow fearmongers used such arguments to justify overturning the National Intelligence Estimates, which showed that the US held superior weaponry over the Soviet Union. The effort culminated in Team B (see *Merchants of Doubt*, p. 28).[1] Team B's mantra—resurrected 30 years later when Defense Secretary Donald Rumsfeld attempted to explain why no weapons of mass destruction were found in Iraq—was derived from a C.S. Lewis argument used to explain friendship as substantive love: "The very lack of evidence is thus treated as evidence, the absence of smoke proves that the fire is very carefully hidden."[2]

In Rumsfeld's mind during the Iraq War (or second Gulf War) in 2003, Lewis's argument took on a more literal, aphoristic quality as it shifted from substantive love to the politicization of substantified invisible weapons: "absence of evidence is not evidence of absence." The fact that the CIA and other intelligence agencies couldn't find evidence of any Iraqi military threat meant the Iraqis were devilishly clever at concealment.

History (not to mention the mass media) repeats itself with the alleged STEM crisis: there is an absence of evidence that such a crisis exists. However, those who stand to gain from it have taken the Rumsfeldian view that we'll be better off pretending that it does exist. As with the second Gulf War, the mainstream media is avoiding any serious investigative effort to get to the truth. The question of whether the STEM crisis is another example of an illogical argument being used to justify a questionable proposition that serves special interests is never considered.

TESTING FOR NEOLIBERAL POSTURE

Are you ready for the STEM crisis? Answer the following questions and retain a running total based on the number of the answer, so if you select answer 2, you earn 2 points, and so on.

1. A Wall Street executive is asked to comment on the level of government regulation in that industry. The response will most likely be: (1) this regulation is necessary for the safety of the investors; (2) the regulation is necessary, on balance, and healthy for the industry; or (3) current regulation is excessive and hurts the industry.
2. A president of a modern research university is asked to comment on the level of federal funding for research universities. The response will most likely be: (1) federal funding is excessive and unlikely to be in the long-term public interest; (2) federal funding initiatives are misguided and lack focus; or (3) federal funding is insufficient to support the ever-expanding missions required of modern universities.
3. The secretary of defense is asked to comment on the adequacy of the defense budget. The response will most likely be: (1) the current budget is rife with waste; (2) funding levels are more than adequate; or (3) the current funding levels are dangerously low and likely to put the country's security at risk.
4. The head of the National Science Foundation (NSF) is asked to comment on the current NSF budget. The response will most likely be: (1) current federal support is consistent with the current needs of the scientific community; (2) our greatest challenge at the moment is to more efficiently use the budget we already have; or (3) the demands on the scientific community have never been greater, and significantly greater resources are required if science is to satisfy these demands.
5. The CEO of a major community hospital is asked to evaluate the current level of government support. The response will most likely be: (1) we can get by with what we have; (2) the community would be better served if this facility were closed and the funding directed to other, more efficient hospitals; or (3) we cannot deliver the level of care expected of us by the community with the meager budget we have, so it must be increased for the sake of community health.
6. The president of a local sports franchise has threatened to move the team if it doesn't get a new stadium soon. When

ABSENCE OF EVIDENCE RELOADED

Misguided rhetoric promotes all manner of new STEM projects and programs. Since I last wrote about this in "STEM, Revisited" in this column last March,[3] I regret to report that very little has changed in terms of government policy and industry recruiting efforts. To be clear, my claim isn't that STEM jobs aren't important or that STEM education isn't useful. My claim is that there's no empirical evidence to support the thesis that either there is a lack of STEM college graduates or a shortage of candidates with STEM expertise in the workforce. We need to wrap our heads around that fact.

Using spin to influence public policy is as old as public policy itself. The first major use of spin to influence education in my generation occurred when the Soviet Union launched *Sputnik* in 1957, which set off an arms race, a space race, and an academic race—all focused on besting Soviet capabilities in missile and space technology. The mass media missed the real scoop, because the US was far ahead of the Soviets in almost all categories, as many critical observers knew at the time. We now know that US superiority in these areas was suspected as early as the Truman administration in the 1940s. The rational observers at the time felt that the threats claimed in the National Security Council paper NSC-68 were vastly inflated.[4] NSC-68, though largely bogus, was resurrected in desperation after North Korea invaded South Korea, and remained the core of US policy long after Soviet supremacy was disproved by the CIA's U-2 flights over Russia in the late 1950s. The "Red Scare" described in NSC-68 was challenged at the time it was written as spurious and alarmist for exactly the right reasons, as history has shown.

There's a close parallel between the manufactured STEM crisis and the manufactured Red Scare: both are rooted in political motivations and derive support from special interests seeking to benefit from them. One author has traced the origin of the Red Scare to a specific date, 5 March 1948, when Army chief of intelligence lieutenant general Stephen Chamberlin convinced general Lucius Clay, US commander in Germany, to send a scare letter to the White House claiming that the Soviet Union intended to attack Western Europe. Chamberlin argued that a threat of imminent attack from the Soviets was necessary to "galvanize American public opinion to support increased defense expenditures."[5]

As Michael Teitelbaum describes in his book *Falling Behind? Boom, Bust & the Global Race for Scientific Talent*,[6] a similar argument was used by Elmer Hutchisson a mere 10 years later.

asked to comment on the share of the cost that should be borne by the franchise, the response will most likely be: (1) we should pay for all of it because we'll be profiting from it; (2) we'll share the costs of the new stadium with the city 50–50 and in return will make the city a co-owner of the franchise; or (3) the team shouldn't have to pay anything—this is the city's investment in their future and the fans should be grateful to have this great franchise.

7. The president of the local Chamber of Commerce is asked where the funds will come from to host the upcoming invitation-only business roundtable. The response will most likely be: (1) I'll cover the expenses from donations to a barbecue I'm hosting in my mother's back yard, (2) the local Hyatt will cover all the expenses out of love, or (3) it won't cost the taxpayer anything because we're going to use the capital improvement fund to cover the cost of the banquet and the Sting concert immediately thereafter. It's all about jobs!
8. The chairman of the board of a regional electric company is asked to comment on how net-metering pricing should work for solar rooftop customers. The response will most likely be: (1) power companies should buy all wholesale power at the same price regardless of the source; (2) net metering is essential for the protection of the environment; or (3) we're all for net metering as long as the customer pays a connection fee that covers our operating costs.
9. A university president is asked to comment on the indirect rate (the overhead that's added to the direct costs of every grant—usually around 50 percent) that's paid to the university by funding agencies. The response will most likely be: (1) it's way more than we need—we don't spend anywhere near 50 percent of the direct expenses to keep the offices and labs open; (2) I think it's fair—it covers our infrastructure expenses and gives the administration significant discretionary income; or (3) the current indirect rate is way too low and doesn't begin to cover all of the in-kind and infrastructure expenses that the university provides to the researcher.
10. A prisoner is asked to comment on his involvement in the robbery for which he has been arrested but for which there is only weak, circumstantial evidence. The response will most likely be: (1) I did it and I realize the error of my ways; (2) no need to Mirandize me, just tell me what you want to know; or (3) I didn't do it, and I don't know what you're talking about.

Add up your scores. If your total is 30, you're a neoliberal rock star! If your score is less than 30, you're delusional or hopelessly naive—try a career in politics or public relations.

As executive director of the American Institute of Physics, Hutchisson saw the launch of *Sputnik* as "an almost unprecedented opportunity to take advantage of the present public questioning concerning the quality of science instruction in our schools" and "the opportunity of influencing public opinion greatly" to convince Congress and President Eisenhower to pass the National Defense Education Act in 1958.[6]

The so-called STEM crisis seems to have originated in much the same way—motivated to sway political support to reduce labor costs. The technology industry's scare tactics are less about growing the skills of the workforce than they are about improving its own bottom line.[6,7] Teitelbaum specifically links the STEM crisis spin to four vested interests: employers, universities, government granting agencies, and immigration law attorneys, all of which exclusively focus on the supply side of the equation to the exclusion of the demand, a practice he argues is unwise, wasteful, and ineffective.[8] But it goes beyond that. More powerful forces—business interests and lobbyists—are at work, keeping the "scare" in the public eye for purposes of labor arbitraging.[9] Without this selfish and narrow-minded interest, it's hard to otherwise account for the huge support and vigor behind the movement to flood the STEM labor market with H-1B visa holders. Politicians find such lobbying simply too tempting to resist: after all, who wouldn't want to educate and recruit smart people? Labor economics issues are never raised.

The critique by Robert Charette in *IEEE Spectrum* is a well-referenced and cogent statement of the arguments debunking the STEM crisis.[10] A review of the accompanying online comments shows that the majority of respondents—*Spectrum* readers and—presumably IEEE members—approached the discussion from the free market and labor economics viewpoints. No surprise there. However, it's very surprising that no one challenged Charette's thesis that the STEM crisis is a myth! And yet we continue to see the STEM shortage mantra repeated in all influential circles—including IEEE publications. What will it take to convince those who should know better that not only does this STEM crisis emperor have no clothes, but he's also covered with lesions?

Let's add a scholarly analysis to the mix. Hal Salzman and his colleagues' study, "Guestworkers in the High-Skill US Labor Market,"[11] concludes that "... the IT labor market, guestworker flows, and the STEM education pipeline finds consistent and clear trends suggesting that the United States

has more than a sufficient supply of workers available to work in STEM occupations."

These three sources—Teitelbaum, Charette, and Salzman et al.—are noteworthy not only because of their solid scholarship, but more importantly because they provide extensive documentation in support of their conclusions. Of course, lack of evidence doesn't diminish the ideological fervor. So, as we might predict, academic, government, and business interests must also weigh in—if not with scholarship, then with hand waving and polemic.

HAND-WAVING AND POLEMIC

Before reading this section, take the "Testing for Neoliberal Posture" quiz in the sidebar. If your score is less than 30, skip this section.

In a recent report by the Coalition for Reform of Undergraduate STEM Education,[12] the authors comment about research debunking the STEM crisis. Here's what this report has to say: "While some recent reports have called into question the so-called US 'STEM crisis,' framing the discussion purely in terms of STEM majors or STEM jobs overlooks the need for a STEM-literate society." The Coalition's report references Charette and Salzman et al., but not Teitelbaum. This is some weapons-grade baroque logic. No one advocated for less lucidity in curricula—whether we're talking about STEM, social sciences, art, or Esperanto, for that matter. The STEM myth criticism under review is epistemic, not motivational.

Drawn out, the argument goes something like this: P1) there are too few STEM graduates to satisfy the demands of business; P2) prima facie we should support policies that satisfy the demands of business (the neoliberal creed); C) therefore, we need to add more STEM graduates.

But, as I've explained, the available evidence indicates that the first premise is false, hence the argument is unsound. The unsoundness of the argument should be the starting point of the public debate, not whether believing falsehoods can serve a greater corporate or educational good. This report is nothing more than an illogical polemic and a black mark on the academic organizations that endorsed it.

Let's look at this from some other perspectives. In April 2013, the US Government Accountability Office (GAO) investigated the 209 federally funded STEM projects and programs spanning 13 agencies and representing more than US$3 billion in expenditures.[13] It found that "most agencies did not use outcomes measures in a way that is clearly reflected in their performance planning documents, ... [and] a majority of programs did not conduct comprehensive evaluations since our prior review in 2005 and the time of our survey in 2011 to assess effectiveness, and the evaluations the GAO reviewed did not always align with program objectives."

> There's no evidence to support either thesis that there's a STEM crisis in education or the workforce.

The GAO's report describes how recommendations it made in a January 2012 report included "provide guidance on program evaluation" to determine whether metrics can identify whether STEM programs have been successful, and "develop monitoring framework" to determine whether projects are satisfying intended goals. As of the April 2013 GAO report, neither of these recommendations had been followed. The GAO also faults these STEM programs and projects for failing to systematically disseminate results "in a fashion that facilitated knowledge sharing between both practitioners and researchers." Given that the programs were neither monitored nor evaluated properly, this might be a good thing.

It's incumbent on all scientists and engineers to get informed about the motivation behind this so-called crisis. By some estimates, the federal government has spent $40 billion thus far on STEM education programs and activities without having established any evidence of need.[14] Federal programs are essentially zero-sum, so the operative question here shouldn't be whether the $40 billion provided anything of value, but whether the money could have been more effectively used elsewhere for greater public benefit.

FOLLOW THE MONEY

Over 30 years ago, Congress considered changing the tax laws to provide economic incentives for computer manufacturers to donate computers to schools. These laws enabled the companies to write off up to 200 percent of the basis (or cost) from their tax bill. I wrote at the time that this wasn't charity at all, but lucrative product dumping that enabled the computing industry to unload unneeded inventory.[15] I said that if one really wanted to understand the point of the legislation, they needed to follow the money trail. The same holds true for the manufactured STEM crisis.

We can, of course, discount the business whitepapers and reports, where neither pretense of scholarship nor objectivity is to be found. Businesses are looking to increase profits, and one way to do that is by enlarging the labor pool to drive down costs. Nothing surprising there.

It's also a little difficult to take the government reports seriously. They are driven by policy, not common sense or fiscal responsibility. If the

White House or Congress champions a cause, no matter how ill conceived, there will be countless government white papers to support it. The only partial exception comes from the GAO—an agency tasked with ensuring that government behavior holds shy of a level of outrageousness that might offend the senses and shake the soul. As a consequence, the GAO's frequent lament is that agencies both underassess and underreport their activities, with the result being that it's almost impossible to determine whether anything of enduring importance was accomplished. Although government reports are more scholarly than those from the business community, they're still largely biased, uncritical, and incurious.

That leaves the heavy lifting to academic research and scholarship. If one takes the time to look, scholarship favors the thesis that the STEM crisis is a myth! That's what makes the Coalition for Reform of Undergraduate STEM Education report so disturbing. This report is endorsed by leaders of several scientific associations, although it isn't a scholarly report as such.

Why would an academic organization spin the facts? The answer can be found by following the money. The most rigorous STEM crisis defense comes from the 2007 report from the National Academies entitled "Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future" (www.nap.edu/download.php?record_id=11463#). The report's endorsers are almost exclusively industry and academic leaders who will be the beneficiaries of federal largess. Industry wants the labor pool to increase, and academic administrators want increases in federal support for their institutions. These groups, along with the Coalition's supporters, are economically incentivized to encourage federal funding for STEM, not to determine whether this is the best use of federal funds. This parochial attitude produces what Teitelbaum calls the "alarm/boom/bust cycles" of federal programs."[16] This isn't surprising—it's predictable. The STEM crisis is a myth, but neoliberals and self-serving special interests aren't about to let any myths and/or crises go to waste. By following the money, we can see that this is just another example of special interests attempting wealth redistribution for the benefit of corporate interests; it's short-sighted capitalism at its best.

The mythical STEM crisis needs to be exposed for what it is—an attempt by special interests to attract federal funding or cheap labor via H-1B visas on the pretense that there's a national emergency.

The mythical STEM crisis needs to be exposed for what it is—an attempt by special interests to attract federal funding or cheap labor via H-1B visas on the pretense that there's a national emergency. I've followed the literature on this myth for several years and have yet to find a single scholarly article with evidence to support it. None. Nada. Zip. The STEM crisis argument is as bogus as the claims that there's no global warming and smoking tobacco is harmless. Unfortunately, these myths are always exposed too late, and, in all cases, the environment, the uncritical, and the taxpayers are always the worse for wear.

Quality scholarship, as such and in general, is easily spotted by certain characteristics: virtually unlimited curiosity, minimal reliance on intuition, the quality of its references, objectivity, the commitment to truth, and an aversion to polemic. The challenge for STEM crisis believers is how to build support for their claims on the basis of such scholarship, rather than on polemic and propaganda. Remember that absence of evidence is itself evidence.

REFERENCES

1. N. Oreskes and E.M. Conway, *Merchants of Doubt*, Bloomsbury Press, 2010.
2. C.S. Lewis, *The Four Loves*, Harcourt Brace, 1960, p. 60; https://books.google.com/books?id=0qoftMnQ1rAC&pg=PT72&lpg=PT72&ots=gBK-KXnJvn&focus=viewport&dq=The+very+lack+of+evidence+is+thus+treated+as+evidence,+the+absence+of+smoke+proves+that+the+fire+is+very+carefully+hidden.
3. H. Berghel, "STEM, Revisited," *Computer*, vol. 47, no. 3, 2014, pp. 70–73.
4. "A Report to the National Security Council," report NSC-68, US Department of State, 7 Apr. 1950; www.trumanlibrary.org/whistlestop/study_collections/coldwar/documents/pdf/10-1.pdf.
5. C. Simpson, *Blowback: America's Recruitment of Nazis and Its Effects on the Cold War*, Collier Books, 1988.
6. M.S. Teitelbaum, *Falling Behind? Boom, Bust, and the Global Race for Scientific Talent*, Princeton Univ. Press, 2014.
7. R.N. Charette, "Exposing the Roots of the Perpetual 'STEM Crisis'," *IEEE Spectrum*, 12 May 2014; http://spectrum.ieee.org/riskfactor/at-work/tech-careers/exposing-the-roots-of-the-perpetual-stem-crisis-.
8. M.S. Teitelbaum, "The Current Model of STEM Graduation Education and Postdocs," presentation to the Office of Science and Technology Policy, National Institutes of Health, 5 Nov. 2012; http://rbm.nih.gov/stem/Teitelbaum.pdf.
9. "Greenspan: Let More Skilled Immigrants In," *Boston Globe*, 14 Mar. 2007; www.boston.com/business

/globe/articles/2007/03/14/greenspan_let_more_skilled_immigrants_in.
10. R.N. Charette, "The STEM Crisis Is a Myth," *IEEE Spectrum*, 30 Aug. 2013; http://spectrum.ieee.org/at-work/education/the-stem-crisis-is-a-myth.
11. H. Salzman, D. Kuehn, and B.L. Lowell, "Guestworkers in the High-Skill U.S. Labor Market," Economic Policy Institute Briefing Paper No. 359, 24 Apr. 2013; www.epi.org/publication/bp359-guestworkers-high-skill-labor-market-analysis.
12. C.L. Fry, ed., *Achieving Systemic Change—A Sourcebook for Advancing and Funding Undergraduate STEM Education*, Assoc. of American College and Universities, 30 Oct. 2014.
13. *Science, Technology, Engineering, and Mathematics Education: Governmentwide Strategy Needed to Better Manage Overlapping Programs*, report GAO-13-529T, Government Accountability Office, 10 Apr. 2013; www.gao.gov/assets/660/653661.pdf.
14. R.N. Charette, "STEM Graduates Not Workforce Ready? Employers Should Look in the Mirror as to Why," *Source*, 2015; www.advanc-ed.org/source/stem-graduates-not-workforce-ready-employers-should-look-mirror-why.
15. H. Berghel, "Tax Incentives for Computer Donors Is a Bad Idea," *Comm. ACM*, vol. 27, no. 3, 1984, pp. 188–194.
16. M.S. Teitelbaum, "The Myth of the Science and Engineering Shortage," *The Atlantic*, 19 Mar. 2014; www.theatlantic.com/education/archive/2014/03/the-myth-of-the-science-and-engineering-shortage/284359.

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