The lost STEM

American decline in "techno-innovation"

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There is a STEM (Science, Technology, Engineering and Math) education gap in public schools developing, likely a response to, 'saturation overload' in media and technology, and a lack of diversity in STEM outreach. Students in American schools are slipping behind in STEM education, leaving our brightest minds unchallenged, or even worse, uninspired to create, develop or invent our nations next source of income, or better yet, our national pride.

We live in a time where technology is everywhere, and our economic wealth today, is partly because of our success at being an innovation-nation in technology and systems development. Since President Dwight D. Eisenhower signed the National Aeronautics and Space Act in 1958 we have seen a great rise in access to education especially in STEM subjects for all United States Citizens. However, in the last two decades, there has been a downward trend in the number of students graduating with STEM degrees, as well as proficiency in STEM subjects for students in public schools. Similar to the drake equation which evaluates the possibilities of life in the universe; the reasons why STEM is loosing ground is the United States is an equally complex equation.

Decline of techno-innovation

According to Dr. Mel Schiavelli, "Innovation begins with the talent, knowledge and creative thinking of a workforce. Highquality STEM education and learning environments that prize innovation and imagination produce graduates who will germinate new inventions, develop new products, and create new solutions to many of our world's most pressing problems."

However, innovation is apparently in great jeapordy in the United States. Once a leader in innovative technology research and development, now America has lost her lead on technology as we compete with countries like China, Korea, India and Tiwan for exports in technology and services for these new mediums.

> In broader terms, the US share of global exports has fallen in the past 20 years from 30% to 17%, while the share for emerging countries in Asia grew from 7% to 27%. The United States now has a negative trade balance even for high-technology products. That deficit raises concern about our competitive ability in important areas of technology. (Gathering Storm)

In addition statistics show that patent application in the US are not rising as quickly as our international competitors. (Image 1) The graph below illustrates that the fastest growing economies are filing a greater percentage of patents. Coincidentally the United States is now the lead importer of technology, versus the lead exporter from a few years back. This is a complete role reversal from twenty-five years ago. Is this indicative of our failure to integrate STEM fully into our American educational system? How did we fail to inspire our youth with inventive behavior? Is it our short attention span, that which has allowed us to become distracted, especially by media?

Alarmingly there is current data that suggests children and youth are consuming technology and media at alarming rates. We have shifted from an inventive developmental producer of technology to a media driven, technology consumer. Our youth are no longer excited about images of Apollo, or landing on the moon, their imaginations go further. Why have these images become mundane, while images from You Tube become the next fad? Is it a lack of interactive connectivity and stimulation in STEM education, which fails to inspire our youth?

However a recent study by UCLA researchers -- Dr. Gary Small, Teena D. Moody, Ph.D., and Susan Y. Bookheimer, Ph.D, which will soon appear in the American Journal of Geriatric Psychiatry, is reporting that using Internet search functions fires brain neurons. The study suggests that web surfers with experience registered a two-fold increase in brain activation, which could suggest why it is also so addicting and or interesting.

Described by the research team, "Mental stimulation similar to the stimulation that occurs in individuals who frequently use the Internet may affect the efficiency of cognitive processing and alter the way the brain encodes new information." Small explains, "Internet searches require the brain to retain important information in working memory and to comprehend the displayed graphics and words, thus having to fire more brain neurons."

Understanding why youth in America are attracted to Internet technology is critical for STEM education to be successful. Today, teachers must compete with over stimulated media and technology savvy youth.

Today's, youthful imaginations take them further than Apollo and flutter images on a black and white screen. The techno-media revolution can drive that vision and excitement, through its endless plethora of sources. Youth trends are not something to be dismissed, they are the leading consumers in our nation, and they are our future makers and shakers. But, if they only know how to consume, they how will they support our future American economy? We need to make sure that our teens use technology wisely, to further their education, and hopefully stimulate inventive behavior.

Lenn Millbower explains in his article, Can Google make you smarter? How the Internet is also a useful tool, when used wisely. "The Internet make reams of knowledge available. And, although you have to sift the information carefully for truth, anything you need to find out -- anywhere in the world -- is likely to be available at the type of a few words." So how do we get our youth to use technology wisely, and responsibly? Current trends for technology and media use, show them steadily increasing, with numbers of teens using social networking sites as almost 50% (Image 2).

However according to Schiavelli, "seeing real-life examples motivates, too. Many young innovators have fostered a new kind of "cool" and can serve as role models. Facebook developer Mark Zuckerberg invented the social-networking site at age 19. Bill Gates was 19 when he started the first microcomputer software company. Napster file-sharing software was developed by 19-year-old Shawn Fanning. Apple was founded by 21-year-old Steve Jobs and 25-year-old Steve Wozniak." Locally we have entrepreneurs like Nathan Seidle of SparkFun Electronics, a local DIY electronics enterprise located in Gun Barrel Technology Center.

"Majoring in a science or technology discipline does not guarantee a Porsche in the future, but it also does not limit successful careers to so-called techno-geeks," according to Dr. Schiavelli. The stereotypes of the techno-geek are changing, and because of this we would expect to see more participation from non-traditional STEM learners, but somehow the social stigmas still affect students decisions to focus on STEM. Not to mention issues with capitalism, marketing, corporate mindset, and our consumer attitudes. Could all these issues stack up to a lack of techno-ethics? Are we missing our education in the social sciences, specifically ethics?

Why STEM Education is Important

Dr. Schiavelli suggests, "Engaging and rigorous undergraduate STEM education provides the foundation for the STEM workforce, for advanced study, for well-prepared K-12 teachers, and for an educated 21st century citizenry."

What I think is important about this statement is the term "21st Century Citizenery". What does it take to be a well educated, and productive citizen in the 21st Century, and what are our moral and ethical obligations to learning and teaching STEM as a part of critical societal development fostering an inventive workforce? Because today, it takes a well educated citizen to participate and support our national security and pride.

Currently, there are just a few pieces of legislation to support STEM education nationwide, with even less dollars committed to the proposed projects. Infact, over the last several years, EPO (Educational Public Outreach) funding has slowly been disappearing from the NASA budget. Former NASA adminstrator Mike Griffin was quoted in an interview on Star Stryder explaining why he feels the NASA budget is already spending too much on education.

"Let me remind you that NASA is not the department of education. NASA spends $15million each year on education – that's enough money for one more discovery mission, and we cant do that mission because of the education we do." However this is ironic considering they face a diminished pool of STEM qualified cantidates to fill positions for future NASA missions.

Dr. Schiavelli suggests in his essay Innovation stems from scientifically educated workforce. "STEM is now, and will increasingly be, the universal languages of the global marketplace. The nations that invest heavily in STEM education, research and the development of a skilled workforce will enjoy leadership

positions. American students, however, are falling behind in the essential subjects of math and science, putting our position in the global economy at risk."

According to the TAP Report (Tapping America's Potential), students who graduate with STEM degrees have greater opportunities for future employment. "The Bureau of Labor Statistics projects that employment in science and engineering occupations will grow 70 percent faster than the overall growth for all occupations." and "STEM graduates on average enjoy better employment prospects and higher starting salaries than graduates in non-STEM fields." (TAP Report) However, the table below (Image 3) illustrates that current statistics for STEM Bachelor degree production is not within the standards set out by the TAP Foundation.

Current Legislation and STEM Initiatives

NASA will continue to pursue three major education goals according to their document 2006 and Beyond. First, "Strengthening NASA and the Nation's future workforce. " Second, "Attracting and retaining students in science, technology, engineering and mathematics, or STEM, disciplines." And third, "Engaging Americans in NASA's missions."

According to the NASA Education Communication Strategy document, the investment in education, especially early on is critical to creating the type of technologically savvy and STEM proficient workforce.

> "To achieve the Vision, the Agency requires a skilled and diverse workforce with sufficient depth and breadth. Our education investments are an important component to ensuring an appropriate workforce for the Nation's aeronautics, Earth and space science, and space operations activities." (NASA Education Communication Strategy)

However it is ironic that since this docuemt was published, actual funding for Education Public Outreach and Education within NASA has actually decreased. In addition, none of the funds from the recent American Recovery Act were allocated to Education within NASA's budget. The shortcomming is that the YK10 budget does not represent their current goal for education.

Although NASA has implimented an educational framework management tool they call the NASA Education Communication Strategy. This mission outlines critical areas of education and activities for K-12 and College level programs. The pyramid, programmatic look at the education portfolio supports the agencies education goals. (Image 6)

In response to recent data, several national and state level STEM education policies have been enactd. However the most creative inititive, which reaches to attract non-traditional STEM education participants is Kentucky Act 177, which provides an alternative route to STEM teaching certification for veterans.

Building diversity into STEM and EPO

According to Minatiya Dawkins of the American Council on Education, "Building awareness about STEM careers among non-traditional learners and underrepresented groups and providing them with multiple pathways to education and training for STEM-related professions are equally important. Not only do we have to create an environment that encourages these students to say, we have to entise them to come, by supporting them as diverse individuals with changing needs."

According to Wendy Pan, "Single parent family households have become a common occurrence in the United States, and the number of these types of households has been on the rise for the last several decades. Currently in the United States, according to single parent family statistics, there are over 13 million single parents." And "Nearly 85 percent of these households are headed by a female, while the remaining households are headed by a male."

This could suggest an entire demographic missed, a demographic, which would greatly benefit from STEM education, allowing them to better provide for their children and families with skills that will help their employability for decades to come.

Dr Susan Niebur reports, "only one of NASA's planetary science flight missions in the past 30 years

has been led by a women scientist as Principal Investigator," in her paper Women in Mission Leadership. According to Schiavelli, "NASA's motto is simple: "For the benefit of all." We should adopt a similar view of STEM education." So in additon to seeking a diverse group of STEM students, we also need to encourage them to continue studing STEM degrees through mentor programs.

Dr. Fran Bagenal suspects, "the most important factor is asking qualified women to apply. So… are you a qualified woman, e.g. less than 10 years out from PhD, couple publications per year, some significant first-author papers—and a moderately thick skin? Apply, apply, apply! You have nothing to lose."

Interesting, considering the TAP (image 7) report suggested that, "57 percent of the women reported having a faculty mentor—a difference approaching significance." And "women were more likely to report having a mentor in electrical engineering and physics." This could suggest that one of the most important aspect to keeping women and non-traditional students in a STEM track could simply be mentoring.

STEM-A (Science, Technology, Engineering and Math through Art)
STEM+ART=MATTERS

Why choose to use Art as a form of teaching STEM? According to David Warlick, "the creative arts are the language of the 21st Century." As many students today use technology and media as a source for almost all their stimulating interactions, it is logical for educators to look for solution in teaching methods using technology and social networking which students are accustomed to.

Art curicullium has the ability to teach ethics along with STEM basics, allowing for development in "21st Century Citizenry." In addition, use of inventive behavior is encouraged, while techniques are allowed to be developed through practice of creative exploration. The integreation of STEM and 'art' allows for the students who may not have been interested in a STEM track, an opportunity to explore an alternative way of approaching STEM education.

We have to move past the social stigmas which place "white males", "geeks," and the "socially isolated" as our only genuises or our "key science role leaders". We need to diversify our beliefs and our STEM workforce. We need to start thinking of ourselves as human, with a variety of capibilities, not limited to our ethnicity, sex, religion, or social and parental status.

The YK10 budget for NASA, includes only 7%, 126.1 million dollars, of the total 18 billion dollar proposed budget toward education. Is this amount enough to quell the gap in STEM education? Recently, Presidnet Obama addressed issues of STEM education in his address to the public in a document called, A new era of responsibility.

> To give our children a fair shot to thrive in a global, information-age economy, we will equip thousands of schools, community colleges, and universities with 21st Century classrooms, labs, and libraries. We'll provide new technology and new training for teachers so that students in Chicago and Boston can compete with kids in Beijing for the high-tech, high-wage jobs of the future. We will invest in innovation, and open the doors of college to millions of students. We will pursue new reforms—lifting standards in our schools and recruiting, training, and rewarding a new generation of teachers. And in an era of skyrocketing college tuitions, we will make sure that the doors of college remain open to children from all walks of life. (Barack Obama)

As the presidents mission sounds great, we will see if he backs up his words with legislation, just as Eisenhower did in 1958. The facts show that education of our nations children, our future entroponures and inventors, has fallen behind our international competitors. We have the largest national debt in American history, and it's parcially because we consume more technology than any other country. We are short-changing our future, by not funding the education of our youth and non-traditional learners. The deficite in STEM education is a longterm ripple effect, which will greatly influence American economics in the near future. Addressing this issue is key for the future of NASA as well as American national security and pride.

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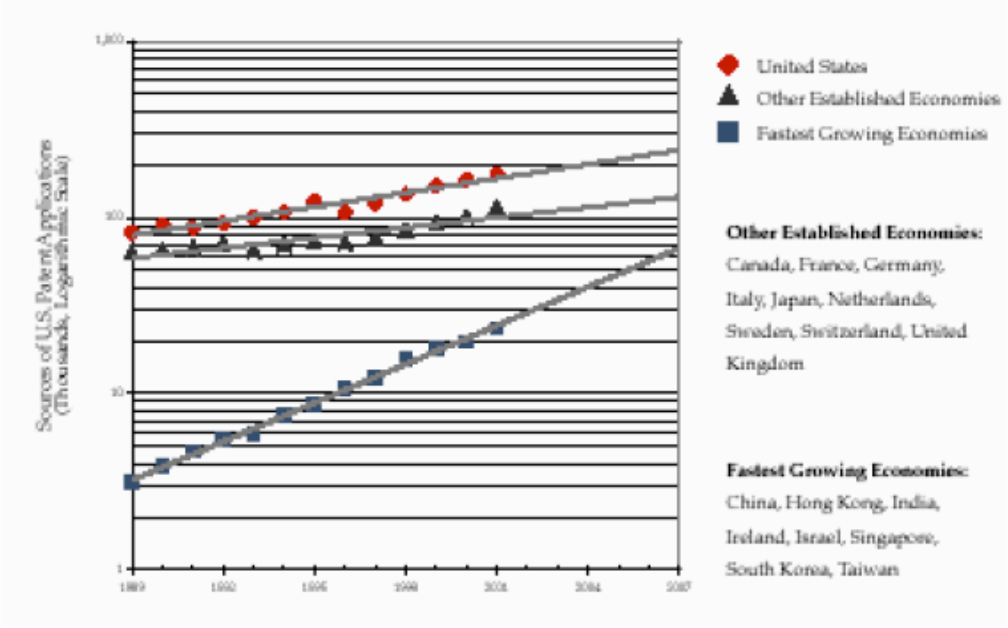
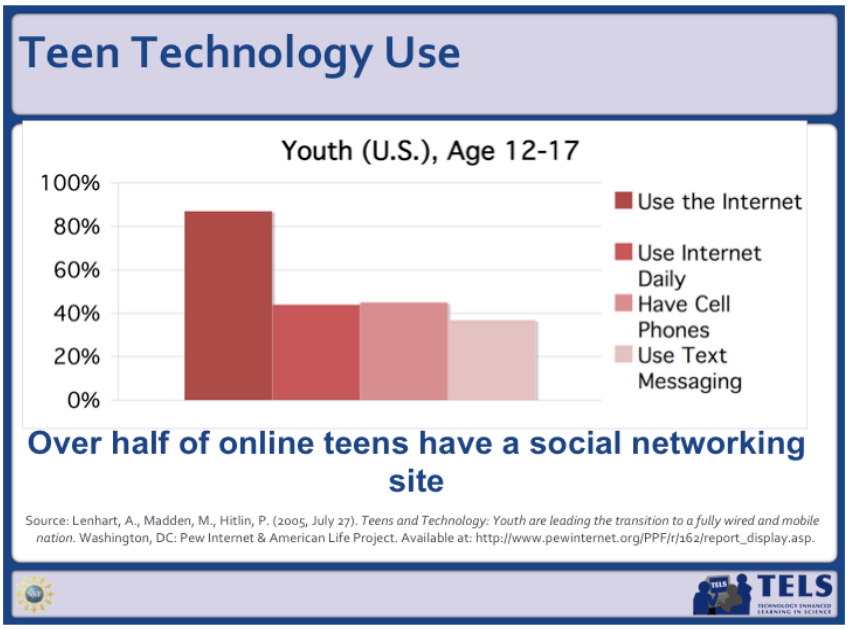
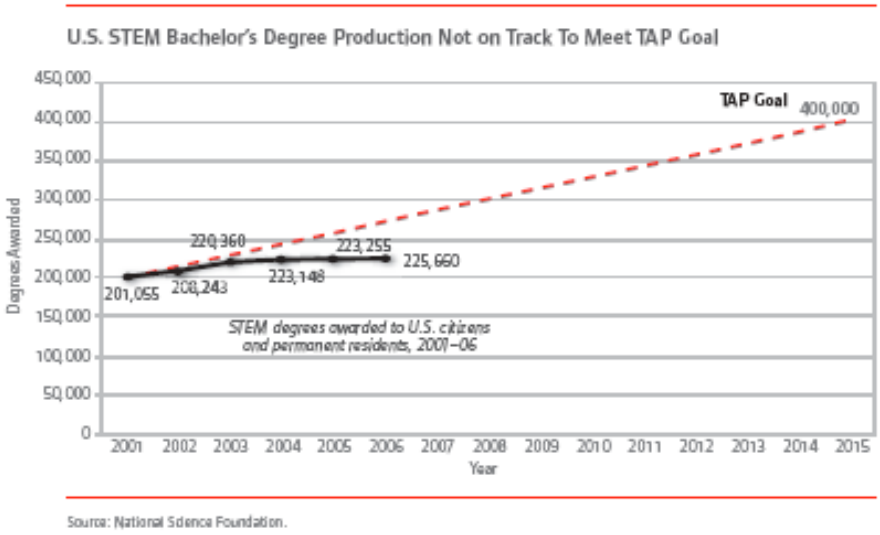
Images and Tables



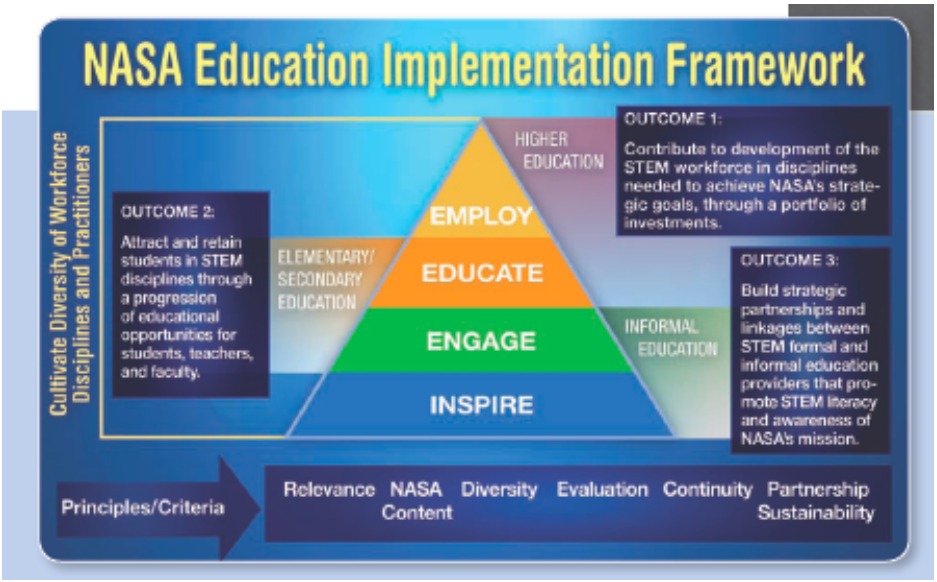
(Image 1) US patent applications. Source: Task Force on the Future of American Innovation based on data from National Science Foundation. Science and
Engineering Indicators 2004, Appendix Table 6-11. Arlington: APS Office and Public Affairs.



(Image 2) Shows teen use of technology and social networking.



(Image 3) U.S. STEM Bachelor Degree Production vs TAP Goal.



(Image 6) NASA Education Strategy.

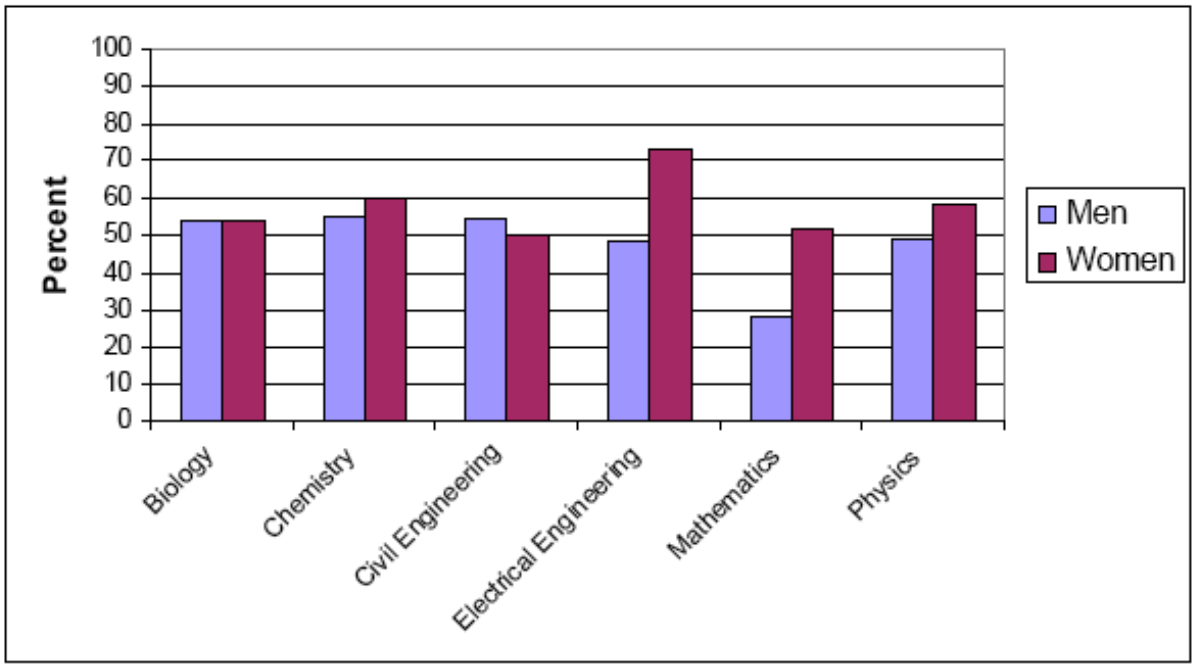


FIGURE 4-6 Percent of faculty responding that they had a mentor, by gender and field.

(Image 7) % of faculty by gender and field whom received mentoring during their academic career.