STEM
Challenges and Opportunities

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Overview

- STEM: Crisis? Myth? Challenge? Opportunity?
- The REAL **Crisis**
- Job Projections 2006-2018 and beyond
- Why Study STEM? Computing?
- Computing Careers
- What can WE do?

STEM – CRISIS or MYTH?

- A 2012 report by President Obama's Council of Advisors on Science and Technology stated that over the next decade, <u>1 million additional STEM graduates</u> will be needed.

- At the same time there are also reports suggesting just the opposite—that <u>there are more STEM workers than suitable jobs.</u>

- Do we have a **<u>crisis</u>** or is this shortage a **<u>myth</u>**?

- <u>http://spectrum.ieee.org/at-work/education/the-stem-crisis-is-a-myth</u>

STEM – Crisis or Myth?

Scientists and Engineers

- Stress the need to significantly expand the number of native-born students graduating with degrees in science, technology, engineering and mathematics fields to meet the needs of business and maintain a technological edge (a New Sputnik moment).

Economists and Demographers

- Cite job market data and flat wages for scientists and other technologists, and have challenged the notion of an undersupply.

http://www.insidehighered.com/news/2011/10/20/study-analyzes-science-work-force-through-different-lens#ixzz2gQkHOk00

STEM – Crisis or Myth?

All Occupations

JOB

Number of Unemployed

Overall, unemployed people outnumbered job postings by 3.6 to one

STEM Occupations

JOB   JOB

Number of Unemployed

In the STEM occupations, job postings outnumbered unemployed people by 1.9 to one

STEM – Crisis or Myth?

- **But who are these STEM workers?**

- Someone with a college degree in a STEM field?

- Someone whose job requires the use of STEM skills?

- Someone who manages STEM workers?

- What industries and jobs are considered STEM?

- There seems to be great inconsistencies in the way we "count" STEM workers and what fields are included in these statistics. (NSF counts healthcare, psychologists and social scientists, but the Department of Commerce does not.)

Some STEM Statistics

- In 2010, there were 7.6 million STEM workers in the US, representing about 1 in 18 workers.

- STEM occupations are projected to grow by 17.0 percent from 2008 to 2018, compared to 9.8 percent growth for non-STEM occupations.

- STEM workers command higher wages, earning 26 percent more than their non- STEM counterparts.

- More than two-thirds of STEM workers have at least a college degree, compared to less than one-third of non-STEM workers.

- http://www.esa.doc.gov/sites/default/files/reports/documents/stemfinalyjuly14_1.pdf

Figure 1. Recent and Projected Growth in STEM and Non-STEM Employment
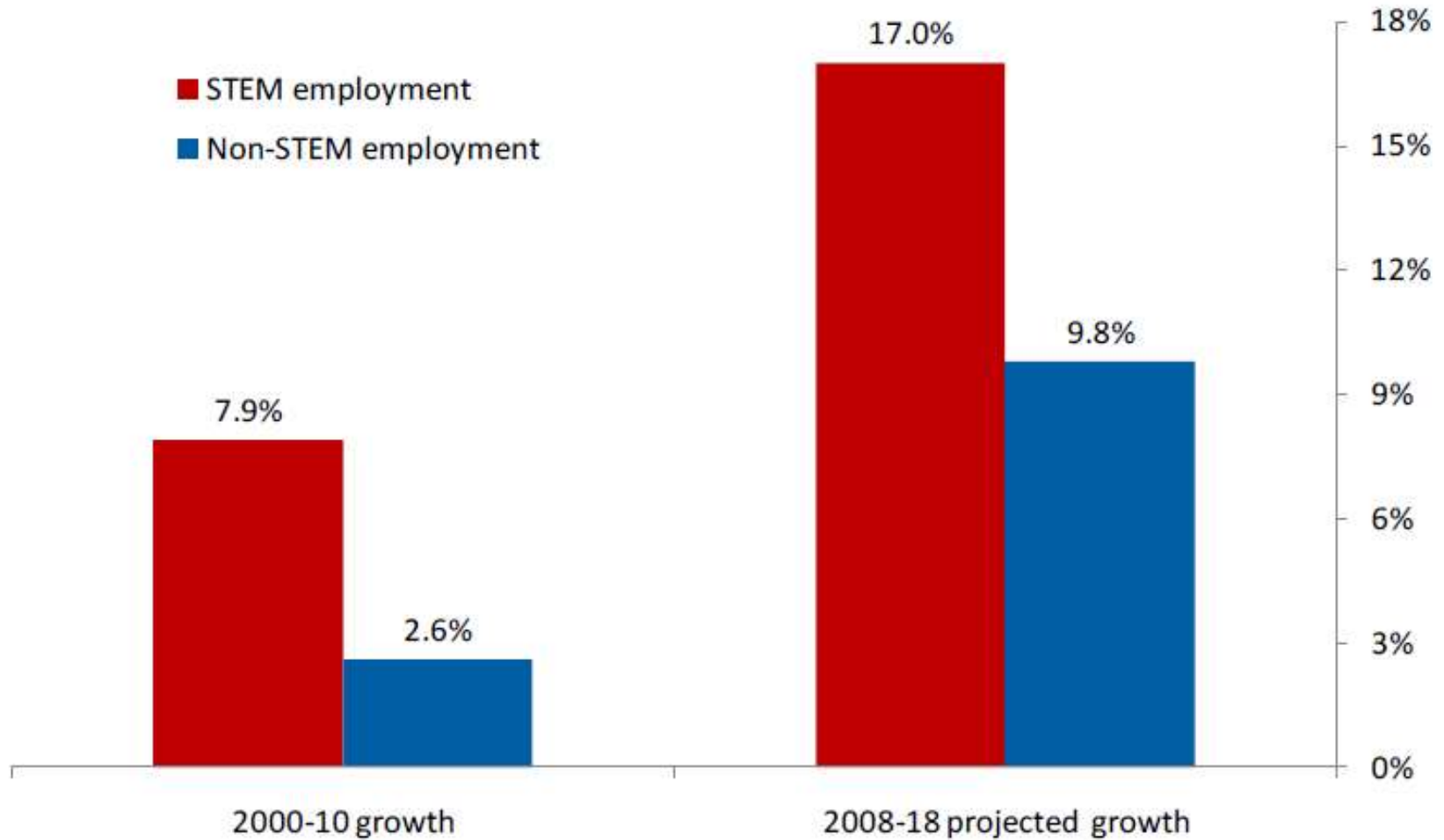
Source: ESA calculations using Current Population Survey public-use microdata and estimates from the Employment Projections Program of the Bureau of Labor Statistics.

STEM – Crisis, Myth or Opportunity?

- In spite of the seemingly conflicting claims of a shortage and a surplus of STEM workers, most would agree that there is a very real STEM crisis—just not the one everyone's been talking about.

- **The real STEM crisis is one of literacy**: the fact that today's students are not receiving a solid grounding in science, math, computing and engineering.

- A literate nation not only reads. It computes, investigates and innovates.

- http://changetheequation.org/why-stem

Falling Behind….

- In 2009, 34% of 8th graders were proficient or better in math

- US Students ranked behind 12 industrialized nations in science and 17 in math. (only 4 industrialized nations performed lower on math)

- In 2001, only 45% of US High School graduates were ready for college math and only 30% were ready for science.

- http://changetheequation.org/why-stem

Remember when computers looked like this?

Apple 1
1976

Or When

- Windows were objects you washed…

- Desktops were places for writing…

- Laptops were places for your pets and children to sit…

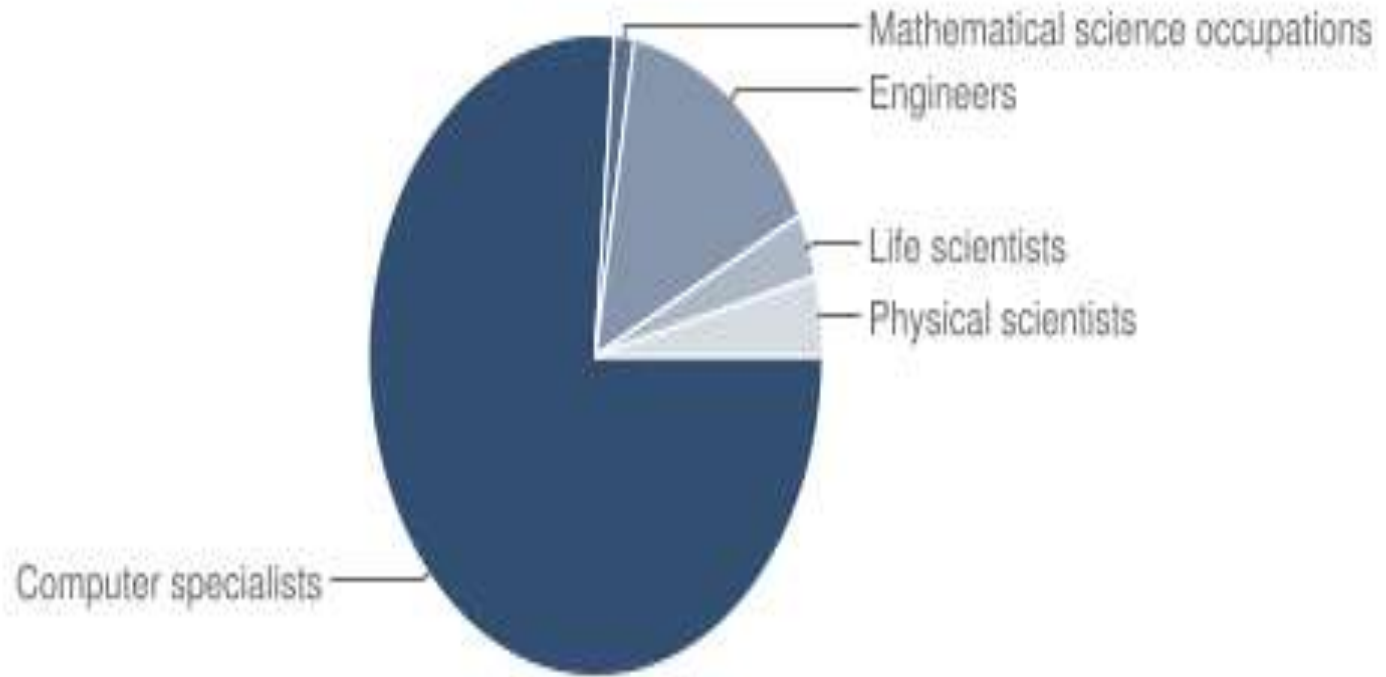# Neither do our students

21ˢᵗ Century Students

- Are digital
- Connected
- Always "on"

- Their world is

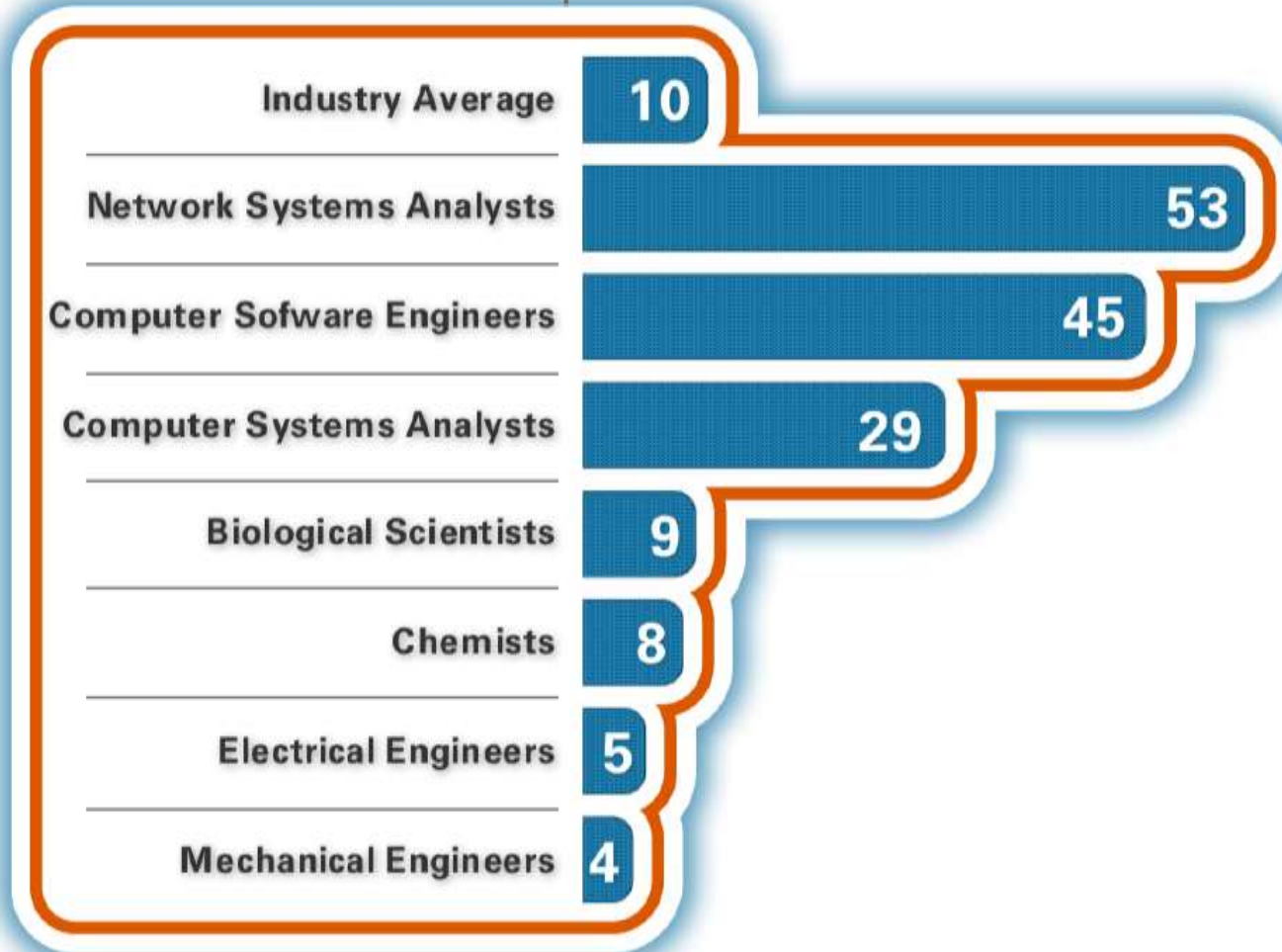**But is their education preparing them for this digital world?**

STEM Job Projections

New Jobs 2006-2016

- Mathematical science occupations
- Engineers
- Life scientists
- Physical scientists
- Computer specialists

FASTEST GROWING OCCUPATIONS

Projected Percent Change,
STEM Occupations 2006-2016

Occupation	Percent Change
Industry Average	10
Network Systems Analysts	53
Computer Sofware Engineers	45
Computer Systems Analysts	29
Biological Scientists	9
Chemists	8
Electrical Engineers	5
Mechanical Engineers	4

Source: Bureau of Labor Statistics, Monthly Labor Review, November 2007

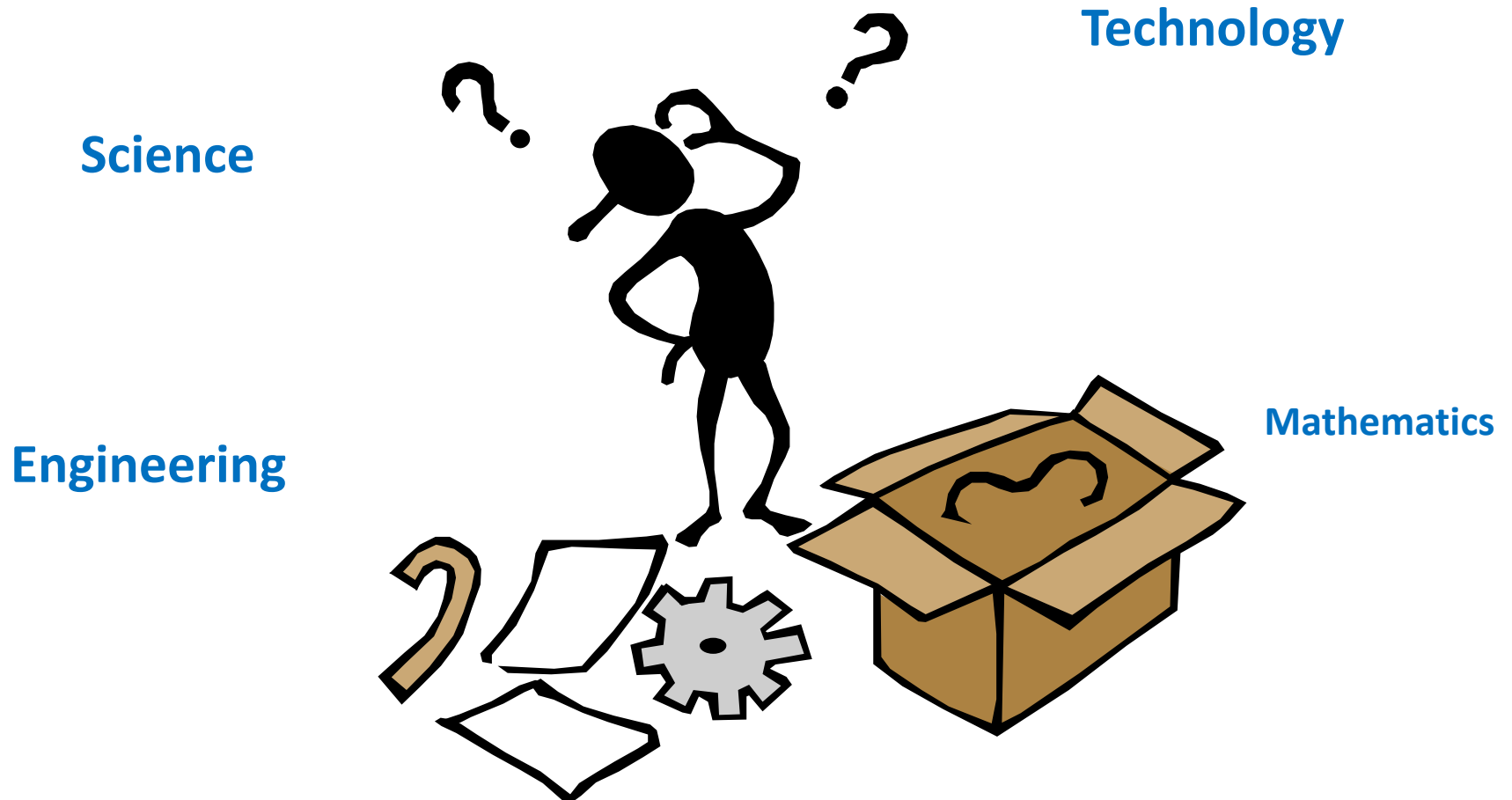**Annual STEM Job Openings vs College Graduates Through 2018**

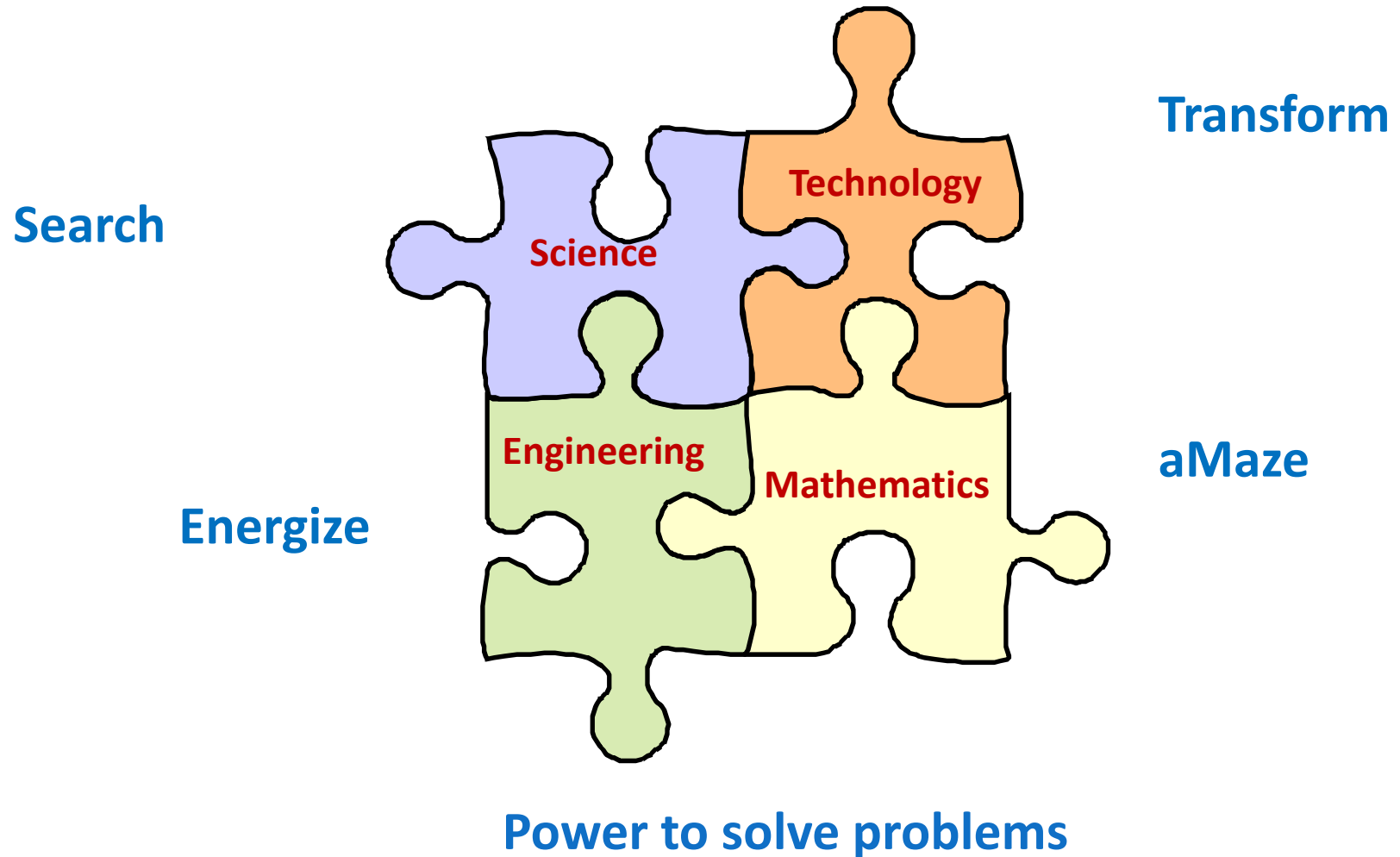☐ Job Openings ☐ Bachelors Awarded
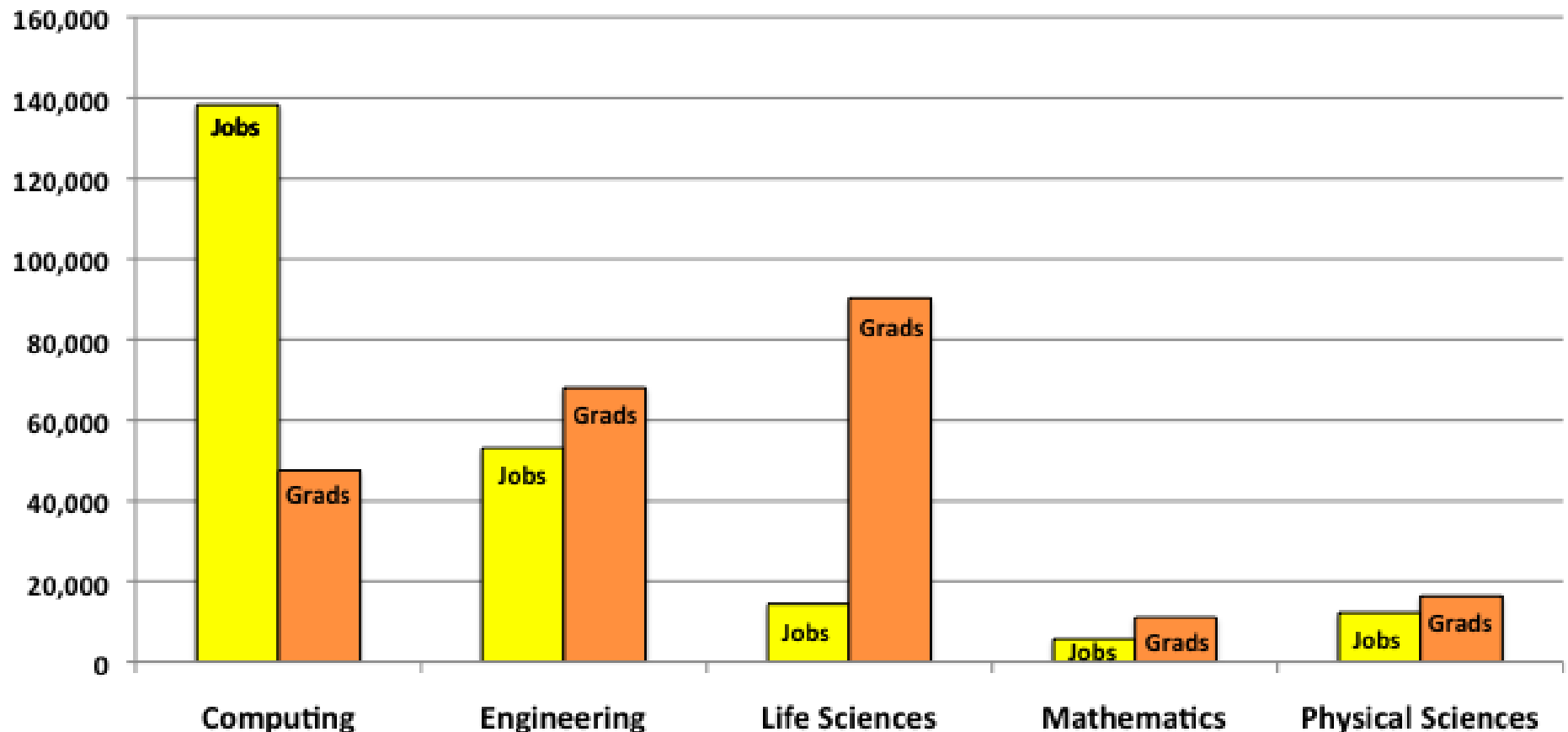
Data Sources: *US-BLS Employment Projections, 2008-2018* (http://www.bls.gov/emp/ep_table_102.pdf),
National Science Foundation Division of Science Resource Statistics (http://www.nsf.gov/statistitcs/nsf08321/tables/tab5.xls), and
National Center for Education Statistics (http://nces.ed.gov/programs/digest/d08/tables/dt08_286.asp).

What is STEM??????

- **To many it's a puzzle!**

Technology

Science

Engineering

Mathematics

STEM IS POWER!!!!!

Transform

Search

Science

Technology

Engineering

Mathematics

Energize

aMaze

Power to solve problems
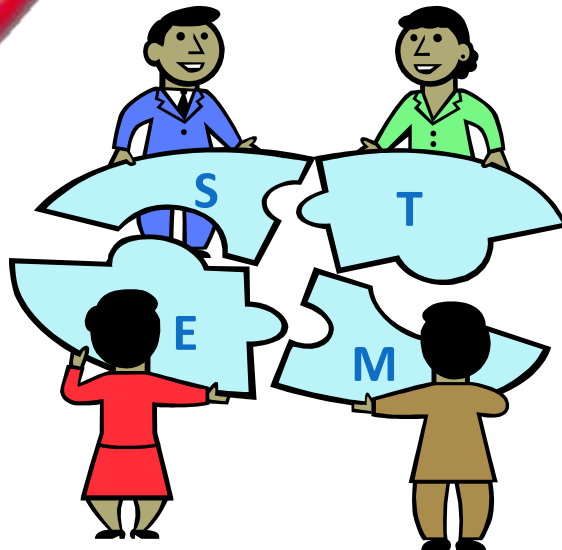
STEM Gives Us "Superpowers"

To use for good
and not for evil!

To construct our world....

Too Young to make a difference??

- Some young Scientists:
  - It's your chance to change the world

    (Google Science Fair)

Today's Young Scientists and Engineers

- Meet **Jack Andraka** –
  - Jack is a scientist and innovator.
  - He created a simple test for identifying pancreatic, lung and ovarian cancer which is:
    - 68 times faster than what is currently available.
    - 26,000 times less expensive. That's not a typo!
    - potentially almost 100% accurate.
- What is most amazing is that Jack is only 15!

More Young Innovators

Adrian Cheng-28 Invented a high speed imaging technique for the Brain.

Laura Deming-18 Working in biotechnology on a cure for aging

Christine Fleming -29 Professor at Columbia University who invented an optical imaging device for studying the heart

Vipul Goyal -27 Microsoft – researching location based cryptography for security

http://www.forbes.com/special-report/2012/30-under-30/30-under-30_science.html

More Young Innovators

John Murray -28 Invented Mathematical models to simulate how the brain remembers

Isaac Kinde -29 At Johns Hopkins-working to improve the accuracy of DNA sequencing in detecting cancer
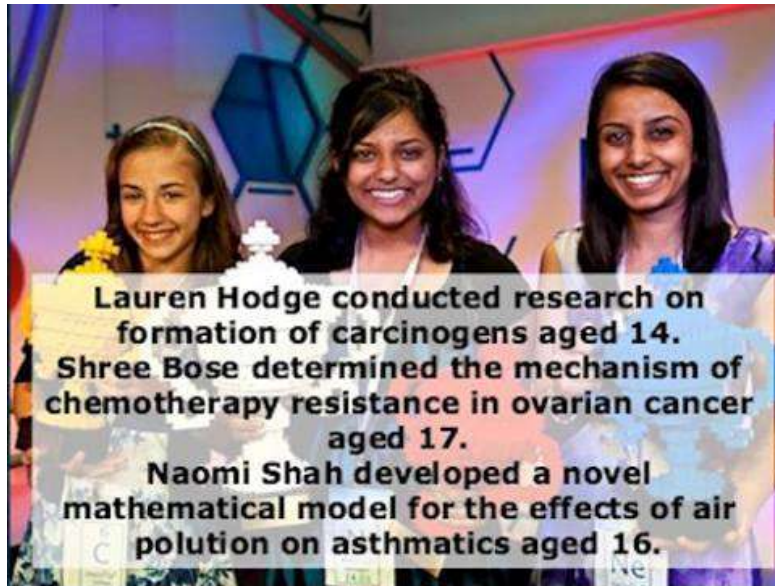
Katie Stack-26 Works with the NASA Mars Curiosity Rover to study the rock layers to learn where and if water existed on Mars

Daniella Witten-28 is developing machine learning programs for use in cancer therapy, understanding genomes, shopping and predicting elections

Still More Young Innovators

Lauren Hodge conducted research on formation of carcinogens aged 14. Shree Bose determined the mechanism of chemotherapy resistance in ovarian cancer aged 17. Naomi Shah developed a novel mathematical model for the effects of air polution on asthmatics aged 16.

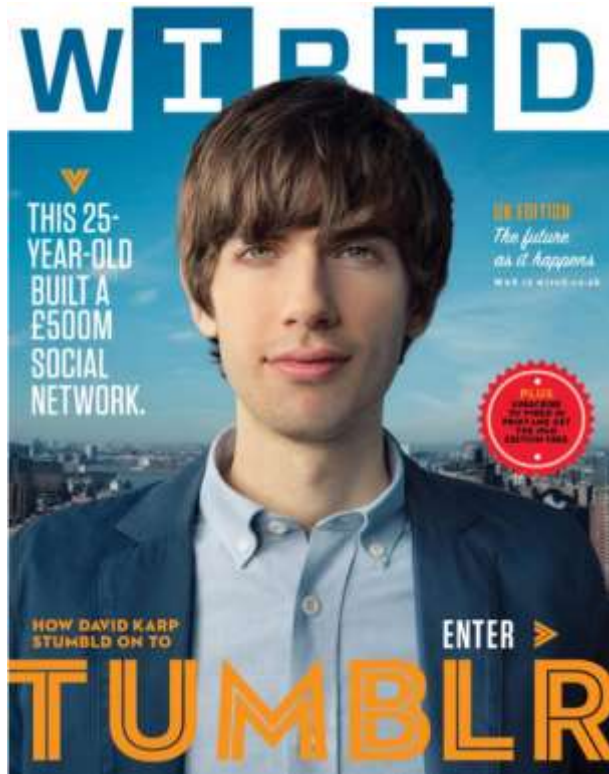At age 18, Brittany Wenger developed a computer algorithm for diagnosing leukemia.
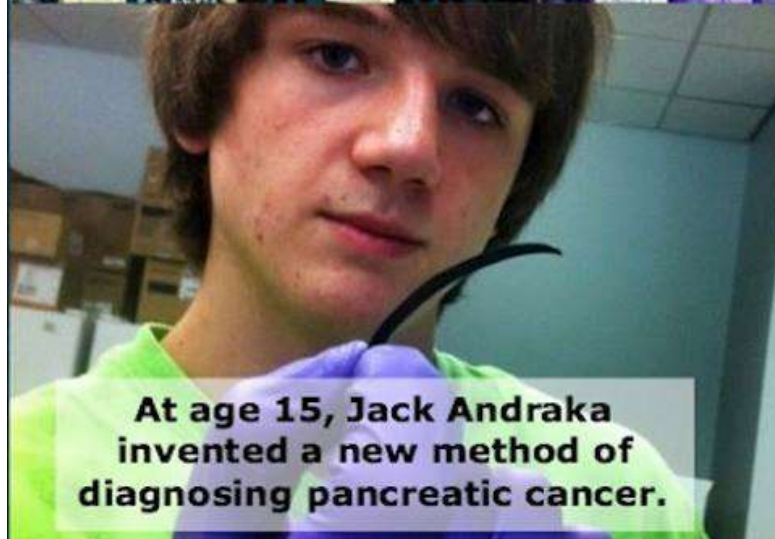
At age 15, Jack Andraka invented a new method of diagnosing pancreatic cancer.

At age 18, Eesha Khare developed a super-capacitor that could charge a phone in 20 seconds.

Recently- Young Innovators in the News

David Karp –founder of the $1.1 Billion Tumblr Empire

Marissa Meyer- CEO of Yahoo Fortune's 14th most powerful business woman

…and two of the most well known young inventors…

Steve Jobs (18) and Steve Wozniak with their design for the Apple 1 and 2

Our 21ˢᵗ Century Students

- **Totally digital**
- **Connected**
- **Always "on"**
- **Very creative**

  their world is

**How can they use their education to prepare for and make a difference in this digital world?**

How can we change our world? (Put the pieces together)

- **If you can dream it, you can do it!**

- Encourage students to:
  - **Get involved in STEM**
  - **Consider a STEM career**
  - **Think, reason, explore, imagine**
  - **Participate in Science and Engineering Fairs**
  - **Work cooperatively or with a mentor**
  - **Look for an internship or scholarship**
  - **Investigate positions in industry**
 - **Use their STEM Power for good…**

STEM and Technology Related Careers

- **Fastest growing professional occupations**
  - **By 2016 there will be 1.4 million computer related jobs and by 2018 more than 800,000 high-end computing jobs will be created**
- **Rank as some of the best jobs in America**
- **Offer intellectual excitement**
- **Provide the opportunity to change the world…**
- **Have the highest starting salaries of any entry level bachelor's degree starting from $53,100**
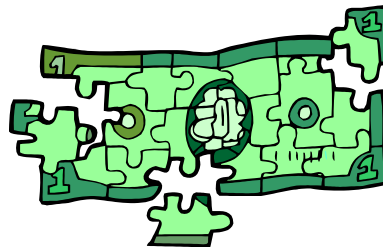
Why Study STEM?

- **STEM is an area of <u>National Need</u>**

- **Provides critical 21st Century Skills**

- **Leads to rewarding careers**

- **Teaches innovative design, critical thinking and problem solving**

- **Improves our world**
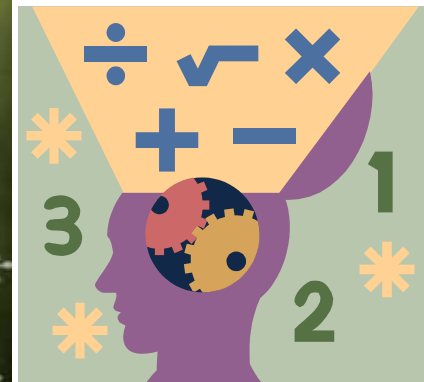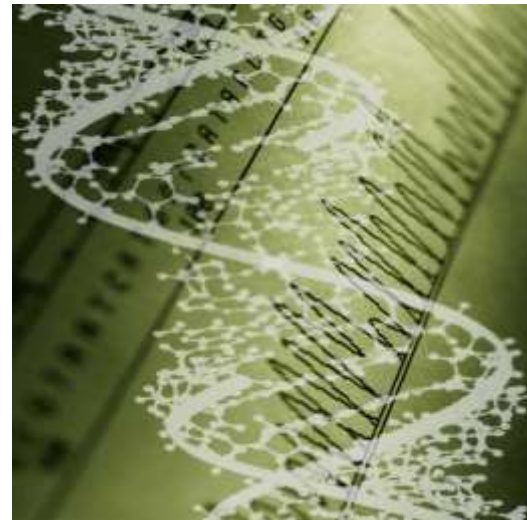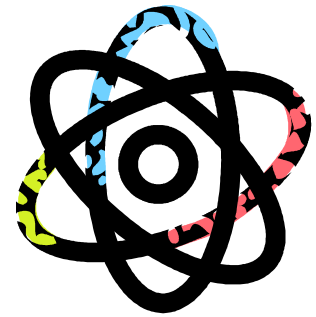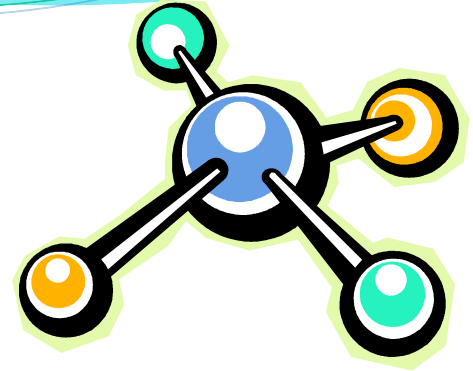
Job Predictions

In 5 years there will be jobs that we have not even thought of today and a great demand for all STEM areas:

Science and engineering workforce projections, 2010-2020
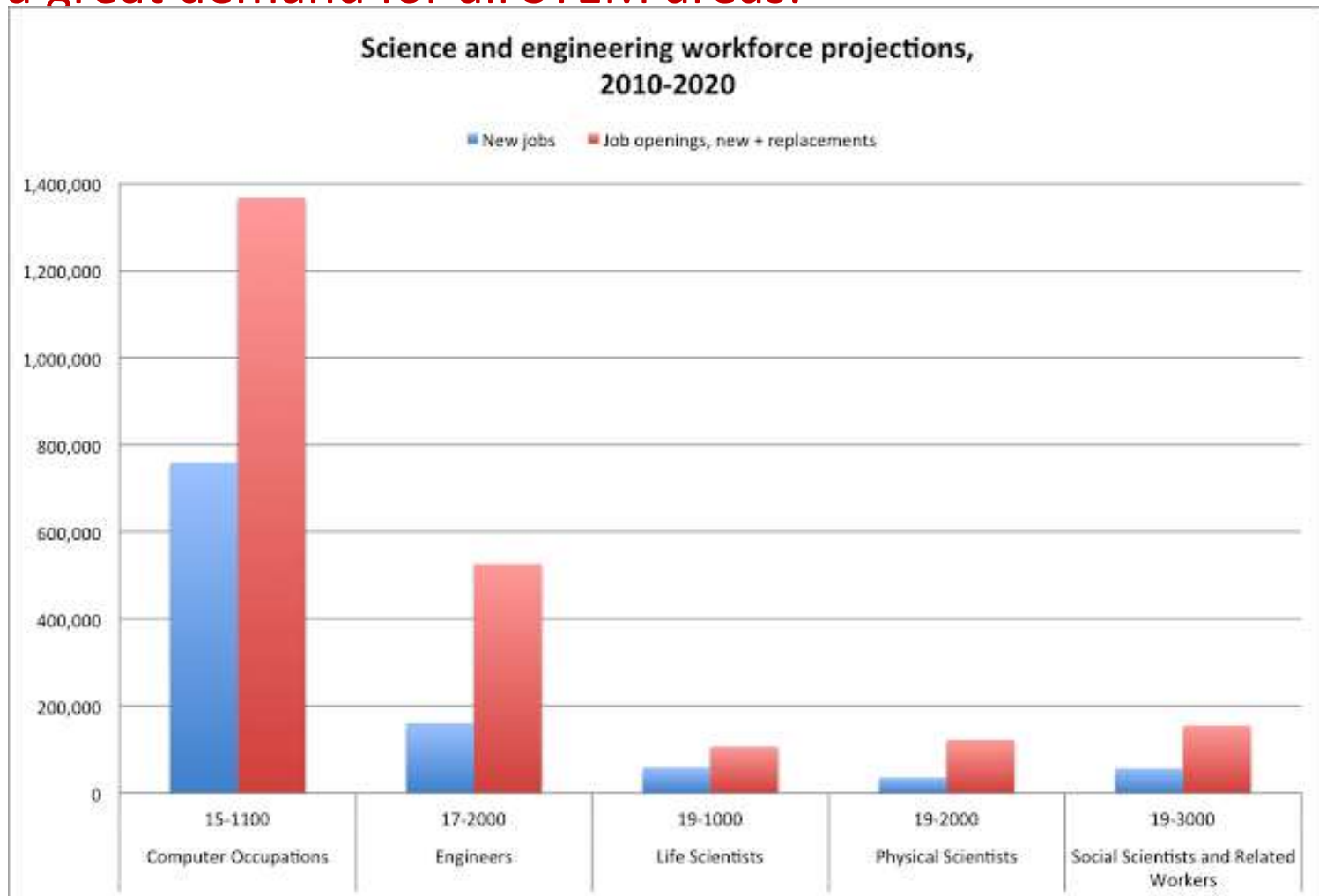
Some STEM Career Fields

Actuarial Science
Chemistry
Mathematics
Applied Mathematics
Statistics
Computer Science
Computational Science
Biological Sciences
Biochemistry
Robotics
Computer Engineering
Electrical Engineering
Electronics
Mechanical Engineering
Industrial Engineering
Information Science
Civil Engineering
Aerospace Engineering
Chemical Engineering

Astrophysics
Astronomy
Medicine
Optics
Physics
Psychology
Nanotechnology
Nuclear Physics
Mathematical Biology
Operations Research
Neurobiology
Biomechanics
Bioinformatics
Acoustical Engineering
Geographic Information Systems
Atmospheric Sciences
Educational/Instructional technology
Cyber Security
Health Sciences

- And many others….. The list goes on….

Top 30 Innovations of Last 30 Years

The list is as follows, in order of importance:

1. **Internet, broadband, WWW (browser and html)**
2. **PC/laptop computers**
3. **Mobile phones**
4. **E-mail**
5. **DNA testing and sequencing/Human genome mapping**
6. **Magnetic Resonance Imaging (MRI)**
7. **Microprocessors**
8. **Fiber optics**
9. **Office software (spreadsheets, word processors)**
10. **Non-invasive laser/robotic surgery (laparoscopy)**
11. **Open source software and services (e.g., Linux, Wikipedia)**
12. **Light emitting diodes**
13. **Liquid crystal display (LCD)**
14. **GPS systems**
15. **Online shopping/ecommerce/auctions (e.g., eBay)**
16. **Media file compression (jpeg, mpeg, mp3)**
17. **Microfinance**
18. **Photovoltaic Solar Energy**
19. **Large scale wind turbines**
20. **Social networking via the Internet**
21. **Graphic user interface (GUI)**
22. **Digital photography/videography**
23. **RFID and applications (e.g., EZ Pass)**
24. **Genetically modified plants**
25. **Bio fuels**
26. **Bar codes and scanners**
27. **ATMs**
28. **Stents**
29. **SRAM flash memory**
30. **Anti retroviral treatment for AIDS**

http://knowledge.wharton.upenn.edu/article.cfm?articleid=2163

Some Computer Related Careers

- Programmer
- Software Engineer
- Network Administrator
- Computer Engineer
- Database Manager
- Website Designer
- Computer Forensics
- Robotics Designer
- Bioinformatics Specialist
- Computational Mathematician
- Cryptographer
- Computer Teacher

- Animator (Pixar, Disney)
- Graphics Designer
- Business Analyst
- Artificial Intelligence
- Security Specialist
- Game programmer
- Cognitive Scientist
- IT Support Technician
- Medical Informatics
- Media Specialist
- E-commerce Specialist
- ?????????????????????

Why Study Computing?

- **Provides critical 21ˢᵗ Century Skills**

- **Leads to rewarding careers**

- **Teaches innovative design, computational and critical thinking and problem solving**

- **By providing students with a strong background in elementary and high school, computing contributes to student success in the 21ˢᵗ Century, and strengthens the workforce.**

- **Computing has the power to transform our world**

- **Computing helps people….**

Why Study Computing?

- Computing is an integral part of US culture and is reshaping how people interact

- Computer science is transforming industry, creating new fields of commerce and driving innovation

- Computer science underpins the IT sector of the economy and contributes significantly to the U.S. economic output

- Computer science is critical for national security and for meeting the challenges that a modern society faces.

(Computer Science Education Act 0f 2011- S.1614)

Crisis? … or Opportunity???

- Greater **demand** for computer scientists yet fewer graduates
- Computer Science in NY (and 34 other states) is considered an elective and not part of the "core" curriculum
- Bureau of Labor Statistics expects computer jobs to remain in high demand
- According to the U.S. Government Accountability Office (GAO):
  - employment in the computer sciences and math fields increased by 78% over the most recent tracking period
  - while employment increased by only 17% in non-science and tech fields.

Why the Crisis?

Running on Empty: *The Failure to Teach K–12 Computer Science in the Digital Age*
(http://csta.acm.org/runningonempty/fullreport.pdf)

Secondary schools offering AP Computer Science courses: change from 2005 baseline

	2005	2007	2009
% change	Baseline	-20%	-35%

Secondary schools offering introductory (or pre-AP) Computer Science courses

	2005	2007	2009
Yes	40%	34%	23%
% change	Baseline	-6%	-17%

Higher Education – experiencing declining enrollments in Computer Science
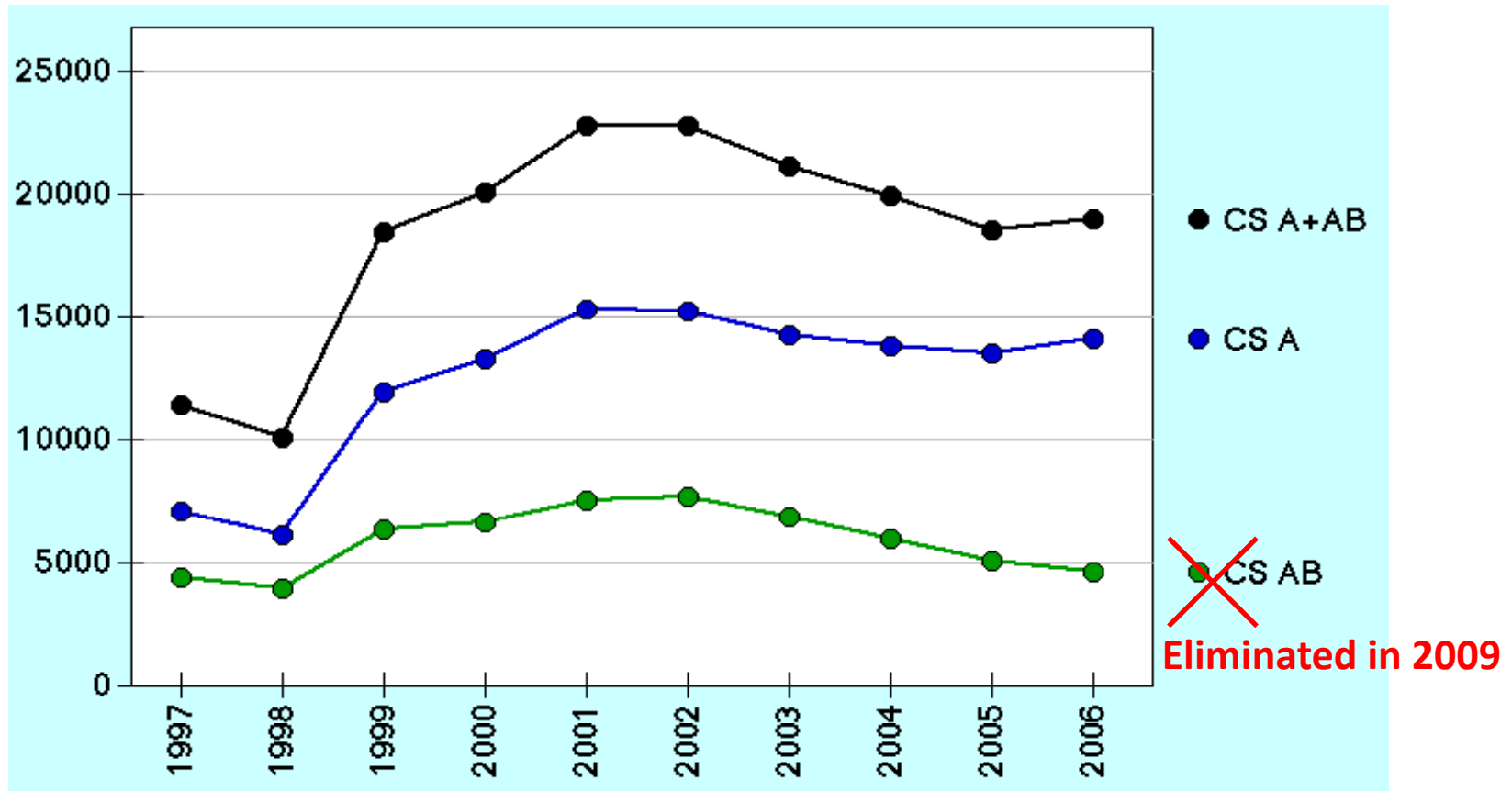**2002-2005** 70% decline in enrollment, some recent improvement

AP Computer Science
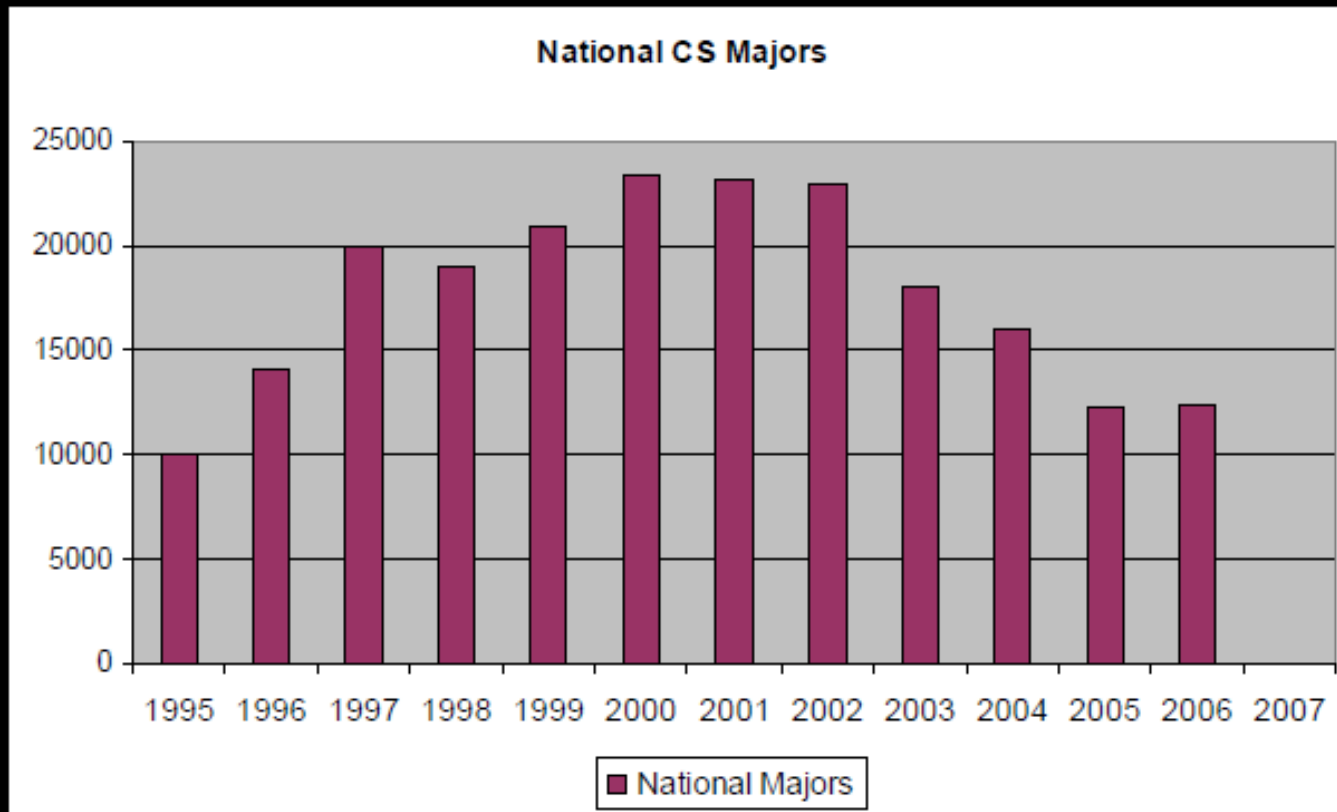## Had Relatively Small Enrollment
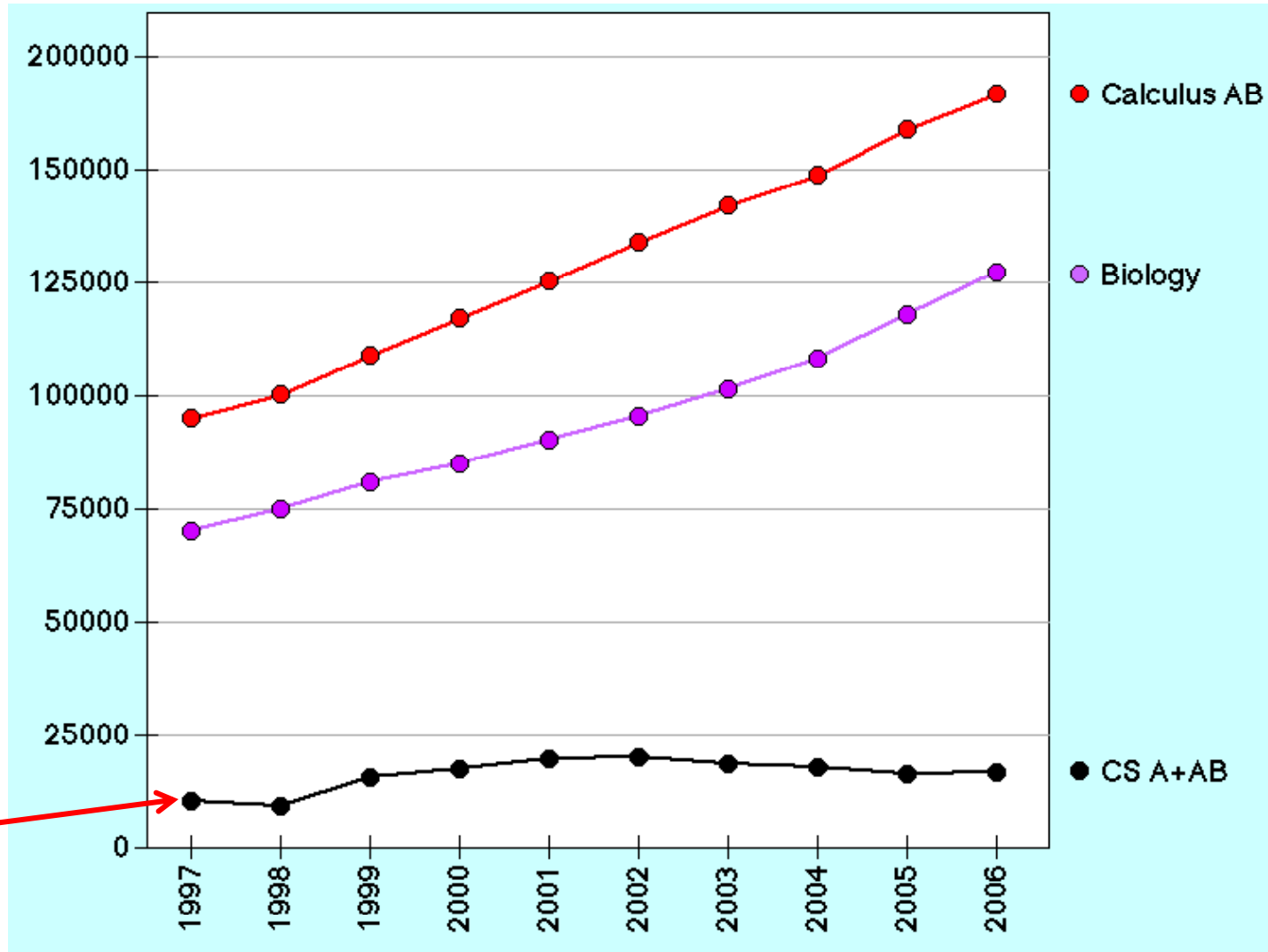
AP CS is Losing Ground

- The Computer Science exam is the Advanced Placement exam that has shown a consistent decline in student numbers in recent years.

Salary Comparisons

Degrees	Salary Range
Associate's Degree	$36,699 - $63,626
Bachelor's Degree	$41,779 - $78,497
Master of Business Administration (MBA)	$57,433 - $109,315
Doctorate (PhD)	$62,363 - $115,642
Bachelor of Science (BS /BSc), Computer Science (CS)	$57,218 - $97,656
Average starting salary for BS in Engineering	$75,000

CODE.org

- Click on the following link and check out the video presentation

http://code.org/stats

Building An Operating System For Computer Science Education

- A recent study of students' perceptions and attitudes toward computer science education focused on the process by which students make course selections as they relate to elective or advanced CS, math, and science courses.

- They observed why students choose or avoid STEM courses;

- Why they choose of avoid CS courses;

- They present 5 challenges

http://cemse.uchicago.edu/computerscience/OS4CS/

Why Don't Students Choose STEM?

- **Student interests, attitudes, and achievement play a major role.**
  - Students who did not choose to study science exhibited a narrow and stereotypical view of science, science careers, and scientists (Cleaves, 2005).
- **Parents' education, plans for students, and expectations may influence students' course choices.**
  - In a study of recent high school graduates, over half of students surveyed (58%) report relying on their family for guidance in identifying and achieving their goals after graduation.

Why Don't Students Choose STEM?

- **College preparedness and career prospects affect choices of study.**

  - 44% or recent high school graduates surveyed report that they wish they had taken different courses during high school. 40% wish they had taken more math, and 33% wish they had taken more science courses. Students also wished that they had taken courses with more writing skills and research emphasis.

    (The College Board, 2011.)

- **Gender differences**.

  - Women were more likely to be influenced by their aptitude in a subject, while men gave higher ratings to the influence of level of pay in the field, potential for career advancement, and potential job opportunities (Malgwi, Howe, and Burnaby, 2005).

Why Don't Students Choose CS

- **Students don't think that CS is interesting.**

- **Students lack awareness of CS.**

- **Students don't see themselves as computer scientists.**

- **Students lack an understanding of what CS is.**

- **Students do not see CS as relevant to the real world or to their lives. CS students see the field as engaging, creative, and relevant.**

- **Female teenagers have a perception of CS as a male-dominated field, that is difficult and programming oriented.**

Common CS Misconceptions

- Computing = Programming
- Computer Science = Computer Literacy
- Computer Science is not a scientific discipline
- Computing is a solitary field practices by "geeks"
- Computing is a male field
- There are no jobs in this field
- All computing jobs are outsourced

The New Educational Imperative: Improving High School Computer Science Education, Final Report of the CSTA Curriculum Improvement Task Force, February 2005

Why Do Students Choose CS?

- **Teachers have a positive influence on students' decision to study CS.**

- **Students are interested in and curious about computers.**

- **They see computers as being relevant to their lives.**

- **They want to make a difference in the world.**

5 Challenges to Education

1. There is no shared understanding of what computer science is

2. More comprehensive, quality instructional resources are needed

3. Computer Science is not prioritized in schools

4. There is a need for more, well prepared Computer Science Teachers

5. Computer Science teachers are isolated

Opportunities
What can WE do?

- Begin a dialog

- Encourage students

- Inform parents, guidance counselors

- Provide assistance and resources for teachers and administrators

- Involve universities/colleges

- Collaborate with Industry Partners

Opportunities
What can WE do?

- Support new Curriculum Standards and **Computer Science Education Act (2011)**, to make computing part of the core

- Offer Computer Science courses as part of the core and integrate technology into other courses

- Promote and provide internships

- Offer summer computing camps/workshops…

What's next????

- [Google glass](#)

- [Self driving cars](#)

- [The Future????](#)
- [Computers of the Future???????](#)
- [Surface](#)
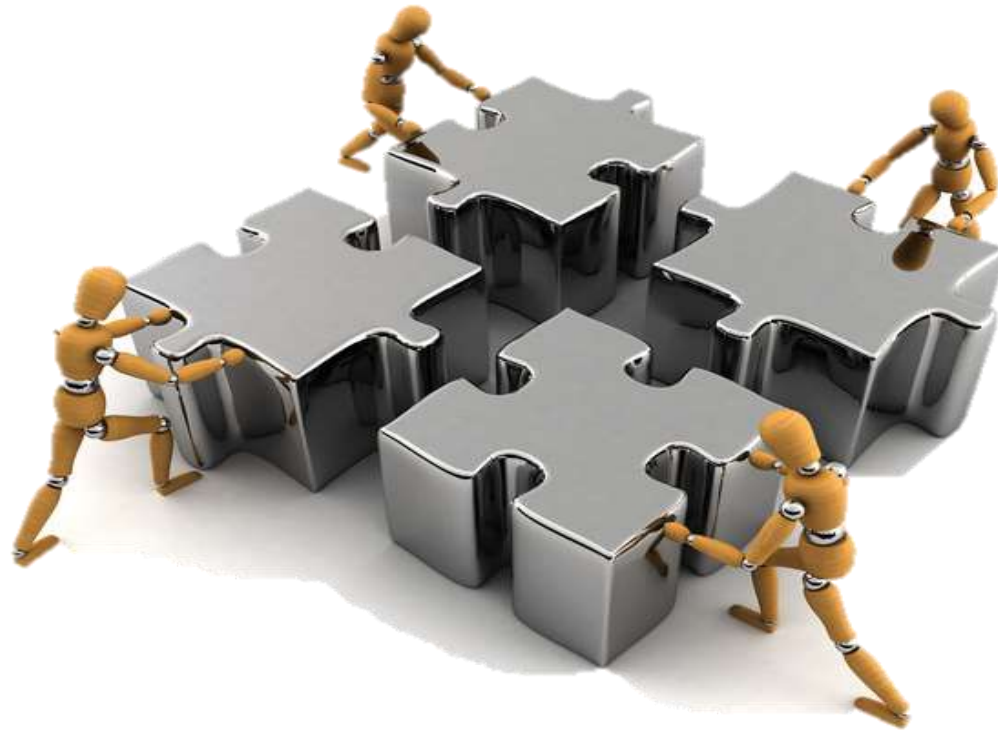
STEM is our Future – aim high!

If we can DREAM it……   **We can Do it.**

Working together…. We can create a better future!

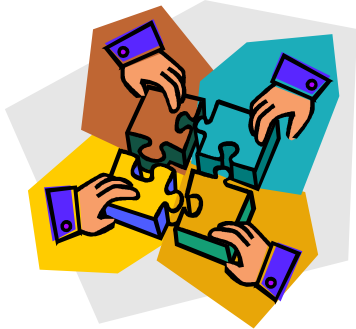# Working together … we CAN build and change our world.

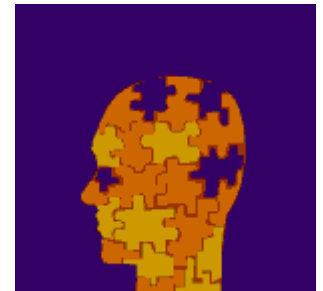# How can WE begin this dialog?

- Communicate?

- Collaborate?

- Empower ?

- Inspire?

- Any suggestions, ideas, questions?

Thank you!

Questions?

Additional Resources

- LI STEM HUB http://www.listemhub.org/

- Code.org http://www.code.org/

- Code Academy http://www.codecademy.com/learn

- Connect To Tech http://www.connecttotech.org/

- Coder Dojo LI http://www.coderdojoli.org/

- More Prodigies

  - Santiago Gonzales (14) - coder
    https://www.youtube.com/watch?v=DBXZWB_dNsw

  - Thomas Suarez – 12 year old app developer
    http://www.ted.com/talks/thomas_suarez_a_12_year_old_app_developer.html

CSTA

- Free membership and Resources
- http://csta.acm.org/
- Materials for CS Ed Week – Dec
- http://csta.acm.org/Advocacy_Outreach/sub/CSEdWeek.html
- Video - http://csta.acm.org/Advocacy_Outreach/Other/Med-4H.mov
- ACM K-12 Curriculum
- http://csta.acm.org/Curriculum/sub/ACMK12CSModel.html
- **LI Chapter of CSTA:** Ron Martorelli - linycsta@gmail.com
  https://sites.google.com/site/linycsta/

More Resources

- **CSTA**
- http://csta.acm.org/Resources/sub/BrochuresPostersVideos.html
- **Careers**
- **Engineering (it's more than robotics…)**
  - Explore engineering
    http://tryengineering.org/explore.php
  - Games in Engineering   http://tryengineering.org/play.php
    http://spark.ieee.org/
  - **Discover Engineering** http://www.discoverengineering.org/
- **Computing**
  http://www.trycomputing.org/work/computing-careers
- **Resources**
  http://www.trycomputing.org/resources

More Stem Resources

- STEM: Good Jobs Now and For the Future

  http://www.esa.doc.gov/sites/default/files/reports/documents/stemfinalyjuly14_1.pdf

- STEM Crisis is a MYTH – IEEE Spectrum Tech Alert

http://spectrum.ieee.org/at-work/education/the-stem-crisis-is-a-myth

- From STEM to STEAM: A Carnival Ride into Engineering

http://spectrum.ieee.org/tech-talk/at-work/education/from-stem-to-steam-a-carnival-ride-into-engineering

- Change the Equation – connection between CS and Jobs

http://changetheequation.org/blog/computer-science-spotlight

http://changetheequation.org/why-stem

- Building an Operating System for Computer Science Education

http://cemse.uchicago.edu/computerscience/OS4CS/

STEM Standards

- Common core – NY

- http://www.p12.nysed.gov/ciai/common_core_standards

- Frameworks in Math

http://www.parcconline.org/parcc-model-content-frameworks

Miscellaneous Resources

- What's it Worth? Degree Statistics (Georgetown)

http://www9.georgetown.edu/grad/gppi/hpi/cew/pdfs/whatsitworth-complete.pdf

NY Hall of Science- Science Career Ladder

http://changetheequation.org/featured-programs/science-career-ladder

STEMworks Database- Programs and funding

http://changetheequation.org/improving-philanthropy/stemworks