Why Producing Engineers is Challenging

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Today’s Talk

- Status
- What we know
- Issues
- What is being done
- What should be done
Status - Education performance of 4th grade 8th grade and 15 year olds

Among 34 OECD countries (Organization for Economic Co-operation and Development)

- PISA results 2012 (Program for International Student Assessment)- Math, Reading and Science
  - USA ranked 17th of 34 countries in reading, 21st in science, 26th in math, which doesn't look good. Did not improve since 2006
  - “A picture of educational stagnation” "An absolute wake-up call for America," – Arne Duncan – U.S. Education Secretary
    - Source: OCED.org, The Economist Dec 7th 2013, Page 62
- Capital in the 21st century - Thomas Piketty — the French economist
  - This is the first-ever comprehensive survey of the skills in literacy, numeracy and technology.
  - In numeracy and technological proficiency, young Americans who are on the cusp of entering the workforce — ages 16 to 24 — rank last.
    - Source: America’s educational failings – F. Zakaria, Wash Post May 1st 2014
- Silver lining- As per PISA, American students perform above average in problem-solving, creativity, novelty, and critical thinking.
What we know

On a relative scale: From the previous references

- “The biggest force behind falling American rankings is not that the United States is doing things much worse but that other countries have caught up and are doing better.”
- “The U.S. system of education and training is inadequate in the new global environment.”
  - F. Zakaria, Wash Post May 1st 2014

- PISA test shows that
  - American students perform above average in problem-solving, creativity, novelty, and critical thinking.
  - Poor in math, reading, and science

On an absolute scale: We are very good in setting standards and generating ideas but poor with implementation

- Lack of sufficient depth, budget, quality, and rigor
- Countries that do better than USA balance breadth and depth in STEM education. US K-12 ed is more breadth than depth.
  - We must balance teaching of fundamental concepts and problem solving skill development
Several research articles out of College of Education, news reports, including my own research supported my NSF point to these factors:

- K 12 Education – Science neglected for many years
  - Quality of Teacher – particularly elementary school
    - Not prepared to teach different subjects if the same instructor is teaching all subjects
    - Low pay does not attract the well qualified
    - Technology alone will not solve the problem but will make them more effective
  - STEM Engagement time at school is less than many OECD countries particularly in science
    - Lacks rigor in implementation
    - Science was not tested until recently
  - Hands on learning is fun but the real issue is that the science behind the experiment is not often discussed (*know vs know how*)
    - Lack of teacher content-knowledge
    - Lack of time (disciplinary/student behavioral issues at some schools)
Issues (continued)

K 12 – University Education

- Problem solving approach to learning is not emphasized enough
- Individual subjects are still being taught like silos without much attention to their integration for problem solving

Education policies

- Where should fed and state spend their money?
- Do we have the loop complete? Industry needs education design
  - More important – how often is the above loop visited?
- Common Core – yes or no? No science in common core. States are in the process of adopting Next Gen science standards.
  - More important – how to implement for different factions of the student population with problem solving skills as a focus?
- Assessment and rewarding mechanism

Distractions – ever increasing

- Are parents doing enough to moderate the time spent on distractions?
- How involved are we in our children's education?
What is being done

- Change the Equation (CTEq) pins its hopes on
  - Common Core and its equivalent and the Next Gen Science Standards
- In Virginia – VISTA (Virginia Initiative for Science Teaching and Achievement) innovates science education in Virginia and beyond by promoting hands-on, problem based learning
- Industry/Govt Agencies have increasingly shown more involvement in K-12 Education
  - Fund-raising for scholarships
  - Volunteering in classrooms, science fairs
- Online Delivery of STEM, Ex: Khan Academy, MOOCs, teachengineering.org
What should be done (several stakeholders)

- Math, English Language Arts, Science, and **Coding**
  - We know what should be taught – **the question is how to implement it**
    - Emphasize problem-based learning – skill development through K-16
    - Discuss fundamental science behind hands-on activity
    - More engagement **time** with STEM subjects in schools, **rigor** in implementation
    - Start early – early childhood and elementary school education

- Resources
  - Data: Connection between industry/govt needs and education design must be often visited
  - $$$: Intensive teacher training on content-knowledge and on the use of problem-based learning (style of instruction), recruit **qualified** teachers with higher pay
  - Parents - Know the facts and get involved, onus cannot be only on teachers, question and participate in the implementation phase
  - More university- and industry/govt-school division partnerships
  - Several moving parts- need a systems thinking approach with **particular attention to implementation in the coming years**
    - Aligning instruction, curriculum, standards and assessment.