

Pre-Engineering, the STEM Workforce, and Virginia Tech Online Courses for Teachers



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This presentation covers a proposed model for pre-engineering courses for teachers, and why they are needed

Background and motivation



Proposed online courses, including a local industry and academic mentoring component



***Accessible and affordable for
Virginia's teachers***

***Facilitating economic development
and STEM workforce in Virginia***

Pre-engineering curriculum is by and large unavailable in the 403 secondary schools in Virginia

According to the Virginia DOE Technical Education Specialist*, there are approximately 95 high schools that offer engineering/pre-engineering courses



However, some classes in Virginia have “engineering” in the title but do not actually include real engineering content

Massachusetts requires engineering content in Pre K-12 curriculum**, and New Jersey is pursuing similar frameworks

Research (Besterfield-Sacre [1998]) shows that without exposure to engineering in a positive classroom environment, many talented students are unmotivated and/or unprepared to choose engineering as a viable career path

*Conversation with Lynn Basham, Nov 13, 2008

** Massachusetts Department of Education www.doe.mass.edu

Virginia concerns in STEM education mirror national concerns

Many students never make it into the STEM pipeline, because of inadequate preparation in math and science, or limited teacher resources and background in the K-12 systems.

The low engagement with STEM-related learning is particularly acute among minority, female, and lower-income students, who comprise a growing proportion of the total college-going public.

This information came from a report prepared for the U.S. Department of Labor, Employment and Training Administration by Jobs for the Future. The STEM Workforce Challenge: the Role of the Public Workforce System in a National Solution for a Competitive Science, Technology, Engineering, and Mathematics (STEM) Workforce April 2007



The STEM workforce is decreasing in Virginia and nationally

A large segment of the existing STEM workforce is approaching retirement age with the rest of the baby boomers.

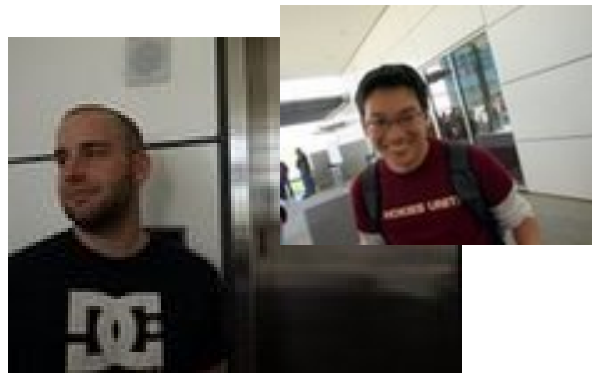
Women appear to be choosing non-STEM employment opportunities with increasing frequency.



STEM workforce needs can not be met by reliance on immigrants, or the traditional population

The reliance on immigrants for meeting employer demand for skilled STEM workers has become increasingly problematic. This is partly due to tighter visa policies, increasing demands for STEM workforce across the globe, and also concerns about national security.

The majority of the current STEM workforce, White, non-Hispanic men, is shrinking.



Therefore, there is more urgency on recruitment and training of historically underrepresented students

These challenges translate to an increased need to focus on underrepresented groups, males and female students from ethnic minority populations and White females.

There is also a need to understand and target the decreasing interest of White males.



There is an increased need to improve accessibility to all students

These challenges; however, were consistent with the outcomes of a recent robotics recruitment visit to rural Eastern Montgomery High School in Shawsville, VA and rural Auburn High School in Riner, VA.

The visit resulted in little to no interest in the robotics program.



Addressing the challenges accompanying underrepresented groups requires an understanding of the influencing factors, the social constructs

Social Constructs

(Unwritten rules that guide interpersonal interaction)

- Low perceptions of efficacy in STEM disciplines
- Elitist representations of STEM disciplines in society
- Stereotypical representations of certain cultures (defined roles)
- Lack of access to preparatory learning experiences and opportunities



One program that seems to be making headway with some of these social constructs is the Robotics Program in Montgomery County



The Robotics program is:

- A yearlong experiential course with the FIRST[®] competition integrated within it.
- The students are allowed to take it as sophomores continuing throughout their senior year in high school.
- It is a hands-on/minds-on authentic program in its 10th year, and has been experiencing consistent outcomes each year.
- Sponsored by VT School of Education with additional support from VT College of Engineering
- VT students are mentors and meet weekly with HS students
- An NSF grant was just obtained to research factors influencing the outcomes particularly with female students.



Learning outcomes for the robotics program have been consistent throughout the years

- 90%+ retention rate of students over 3 years
- Enrollment of female students increased from 5 to 38% with 90% retention rate over 9 year period
- Students prepared for the requirements of STEM majors and careers
- Students motivated and excited about STEM disciplines
- Students choosing to remain in the program throughout high school, did not originally intend to do so (Mastery Experiences)



Achieving outcomes such as the ones described requires teachers skilled in the content and processes associated with pre-engineering

A successful K-12 pre-engineering education initiative would require a pool of teachers having the skills necessary to facilitate learning experiences that provide students with the background for being successful in these disciplines.

The structure and outcomes of the robotics collaborative led to the conceptualization of the following pre-engineering courses for teachers...

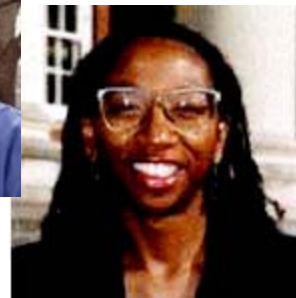


The proposed project includes the development of two online pre-engineering courses

Two on-line courses will be developed by faculty and graduate students from VT School of Education, VT College of Engineering, Norfolk State University, and James Madison University

Courses will be housed within VT School of Education and operated through VT Enterprise Fund including 40% price tuition discount for VA teachers

- *sustainable through VT online course structure*
- ***accessible and affordable for Virginia's teachers***



Pre-engineering courses for teachers will be developed by *both* science education and engineering faculty

Courses are designed to:

- engage teachers in learning experiences that develop their understanding and application of relevant math and science content in engineering contexts
- engage teachers in learning experiences that positively influence their efficacy beliefs related to STEM content
- engage teachers in learning experiences that develop their understanding of the social constructs that influence student's learning in STEM
- engage teachers in learning experiences that enhance their capacity to facilitate student-centered learning environments
- include rigorous pre-engineering content and challenges



To develop teacher competency, a conceptual framework requiring the application of content has been developed

Content	Application	Extension
Math and Science Concepts	Engineering Problem Solving/Exploratory Learning	Relevant Applications
Social Constructs	Case Study Methodology	Instructional Applications
Student Centered Instruction	Collaborative and Solo planning	Experiential learning activities



The project also includes mentoring by local industry and academic partners

Provides “on-the-ground” support for teachers throughout the Commonwealth to enhance online course

Mentors are from industry and higher education, and come to VT for 1-2 day workshop training

Mentors meet with teachers to facilitate hands-on activities during online course, and visit teacher’s classrooms after the course(s)



The mentoring component creates a community for pre - engineering education, and a pipeline to STEM workforce

Letters of support already obtained from
Micron, AREVA, Northrup-Grumman,
BWX, etc



Letters of interest from teachers,
administrators and county supervisors



Letter of support from the state CTE
director, Elizabeth Russell



www.micron.com; www.northropgrumman.com; www.areva.com; www.babcock.com; www.doe.virginia.gov



Pre-Engineering courses and mentor partnerships will facilitate pre-engineering in K-12 curriculum in Virginia

On-line courses can count for re-certification points for math, science, and tech education teachers

Courses will be designed to help teachers add engineering to their topical areas, and in the context of SOLS

First step towards required innovative pre-engineering curriculum, and add-on endorsement for teachers in Virginia

Will facilitate increase in STEM workforce in Virginia



In conclusion, pre-engineering courses for teachers are a critical step toward improving accessibility for STEM opportunities to *all* students in Virginia

Research shows that if students do not understand what engineering is, they will not choose to pursue it (Besterfield-Sacre [1998]) – major implications for STEM workforce!

Two online pre-engineering courses developed by science education and engineering educators across the state are proposed (funding needed)

Courses include an industry-based mentoring program including Micron, AREVA, Northrup-Grumman, etc.

Courses are ***affordable and accessible*** to all Virginia educators

First step to innovative K-12 pre-engineering curriculum, and add-on endorsement for all teachers in the Commonwealth of Virginia

