

Taking an Innovative Approach to Fulfilling a Need for STEM Innovators

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Gone Missing -- STEM Graduates

Industry leaders, the science research community, and governments have raised concerns about the need to produce more scientific innovators in order to advance the global economy and achieve a better quality of life for more people.

It is estimated that the US must generate approximately one million *more* university graduates in STEM fields over the next decade than we are currently on track to produce (President's Council of Advisors on Science and Technology, February 2012)

In addition to declining enrollments, universities are experiencing significant attrition of STEM majors in college (60% of students who enter university with the goal of majoring in STEM do not graduate with a STEM degree).

The majority of individuals receiving engineering PhDs and science and technology postdocs are educated outside the US, as are a third of U.S. Nobel laureates in science, a quarter of our engineering workforce, and 38% of our scientists. This profile extends downward into the secondary school years with “46% of the members of the US physics team and 65% of the top U.S. scores in the mathematics Olympiad [being] children of immigrants” (National Research Council, 2007 p. 49).

Studies of Talented Young People in Science, Music and Art

- Longitudinal study of Westinghouse Science Talent Search Winners
- Qualitative study at three U.S. conservatories of music.
- Beginning exploration of art institutes in the U.S. and France.

Some Study Results: Beyond Intensive Preparation in Content and Skills

In order to be a successful innovator, you need:

- The ability to persist through good and bad times
- Strategic risk taking skills
- Social and communication skills
- Creative problem finding

These skills are part of the curriculum in the arts, but not part of the curriculum for career preparation in STEM. Rather, they are learned by chance in the course of conducting research or developing products.

Comparing the Development of Performers and “Producers”

- See next slide

	Performers	Producers
Similarities	Must master the content within the domain	
	Need guided and deliberate practice and/or study	
	Must have commitment and motivation	
	Domain values are inculcated by mentors	
	Psychosocial variables limit or enhance success	
Differences	What you need to practice is more clearly defined—results of practice seen more easily	Tasks are more diffuse, long term, and multi-component
	Judgments of experts are trusted throughout the process	Judgments for selection in academic disciplines, at least at the pre collegiate level, are not trusted, and objective tests serve as a stand-in
		Judgments of experts are trusted in fields such as composition, playwriting, and visual arts
	Physical abilities are important—you do not have them forever, which constrains the arc of talent development	Physical abilities do not serve as central constraints to the arc of talent development
	Greater winnowing and fewer opportunities over time	Room for a greater number of producers, particularly in domains designated to target societal need
	More current focus on psychosocial-skills training	Little current focus on psychosocial-skills training
	The outcome of excellence and creativity is clearer—better sense of knowing the path and where you are going	Outcome of excellence is clear only in some areas—e.g., academic publications, grants, awards
	Domain is appreciated more widely by the public	Domain is mainly appreciated by insiders

What if Science and Engineering Were a Larger Component of Arts Education?

- Do they need formal advanced mathematics for all components of STEM?
- What if science were taught as design, problem solving and building in high school?
- What if technical high schools' status was restored?
- What are some domains of science that have direct applications to the arts that already have representation in art schools?
- New thinking in engineering education is serving as a potential link between institutions.

What if Undergraduate Science and Engineering Education Were More Like Music Conservatory or Art School?

- Audition for admission.
- Selection of institution based on reputation of teachers.
- An individualized relationship with advisor who picked you from audition.
- Focus on identifying strengths and weaknesses, and capitalizing on strengths
- Regular opportunities for public display of work.
- Practical knowledge on how to handle oneself in new situations.
- Lots of exposure to experiences designed to hone judgment and scientific taste.