Integrative STEM Education Defined

by Mark Sanders

I n the late 1990s, NSF began using the term "SMET" (which later became "STEM") to refer to "science" *or* "mathematics" *or* "engineering" *or* "technology," with no implication of interdisciplinary connections among those fields. After all, they had each been taught in complete isolation from one another for more than a century. The first interdisciplinary STEM education projects emerged in the early 1990s, and were described by adjectives and narratives, not by "STEM." For example, the Technology/Science/Mathematics Integration Project (funded by NSF, 1991-1996) used "integration" in the project title and the project described its integration of STEM content and practice in considerable detail in each of its project-related publications, such as the *Technology, Science, Mathematics Connection Activities* (LaPorte & Sanders, 1996).

The fear that America was losing its global competitive edge, described in 2005 in Thomas Friedman's *The World Is Flat*, helped fuel STEMmania (Sanders 2008), a frenzy of *STEM education* rhetoric and funding, with the vast majority of dollars going to traditional (silo) math and science education. Though the integration of T/E concepts and practices with S/M education was exceedingly rare at that time, a groundswell of educators and the media began to suggest that calling it *STEM education* somehow made it integrated in one way or another; a practice that hopelessly confused the meaning of *STEM education*.

In 2005, Virginia Tech launched its STEM Education Graduate Program (Sanders & Wells, 2005) grounded in the core idea of situating S, T, E, and M teaching and learning in the context of technological/engineering design activity (Sanders, 2006, 2008). But, by 2008, the term "STEM education" had become so misused/ambiguous that we at Virginia Tech renamed our program "Integrative STEM Education" (Sanders, 2008) and published the following operational definition:

> *Integrative STEM education* refers to technological/engineering design-based learning approaches that intentionally integrate the concepts and practices of science and/or mathematics education with the concepts and practices of technology and/or engineering education. Integrative STEM education may be enhanced through further integration with other school subjects, such as language arts, social studies, art, etc. (Sanders & Wells, 2010).

Note that this definition (intentionally) excludes pedagogical approaches that do not situate the teaching and learning of STEM concepts and practices in the context of technological/engineering design-based activity. Furthermore, only technologies that are integral to designing/making/engineering constitute the T/E in this definition. For example, using instructional technologies to teach S/M concepts does not constitute *integrative STEM* instruction. Similarly, the common practice of using *STEM education* to refer to integrated S/M (sans T/E) is no more valid than using *STEM education* to refer to integrated T/E (sans S/M) (which to my knowledge has not been done). Moreover, *integrative STEM education*:

- is appropriate for all K-PhD students;
- is not intended to supplant S, T, E, & M instruction that is more effectively taught in nonintegrative ways;
- may be implemented by one or more S, T, E, or M teachers in one or more classrooms/class periods;
- may be implemented during and/or after the normal school day; and
- should be thoughtfully and effectively articulated across multiple school grades/bands (Sanders, 2012).

In operationally defining *integrative STEM education* in this way, we hope to avoid the gross confusion/ambiguity associated with *STEM education*. Those who wish to use *integrative STEM education* to describe instruction must be certain that instruction is grounded in the context of technological/engineering design activity.

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Resources

American Society for Engineering Education (ASEE)
ASEE is a nonprofit organization of individuals and institutions committed to furthering education in engineering and engineering technology.
www.asee.org

International Technology and Engineering Educators Association (ITEEA)
ITEEA is an international organization for technology, innovation, design, and engineering educators. Its mission is to promote technological literacy for all by supporting the teaching of technology.
www.iteea.org

NASA Education
In 2012 and beyond, NASA will continue to pursue three major education goals: strengthening NASA and the nation's future workforce; attracting and retaining students in science, technology, engineering, and mathematics, or STEM, disciplines; and engaging Americans in NASA's mission.
www.nasa.gov/offices/education/about/index.html

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