

Integrative STEM Education: A More Robust Explanation

by Mark Sanders

In the late 1990s, NSF began using the “STEM” acronym to refer to “science *or* technology *or* engineering *or* mathematics” *with no implication of interdisciplinary connections among those fields*. After all, each had been taught in complete isolation from one another since the late 1800s. The first interdisciplinary STEM education projects emerged in the early 1990s and were described by adjectives and narratives, rather than by the “STEM” acronym. For example, the *Technology/Science/Mathematics Integration Project* (funded by NSF from 1991-1996) used “integration” in the project title and described its curricular integration of STEM content and practices in considerable detail in each of its many 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 book titled *The World Is Flat*, helped fuel “STEMmania” (Sanders, 2009), a frenzy of “STEM education” rhetoric and funding, most of which was directed to conventional (silo) math and science education. Though the integration of T/E concepts and practices with S/M instruction was *exceedingly* rare at that time, a groundswell of educators and the mass-media increasingly used the term “STEM education” to imply that some sort of integrated S, T, E, M instruction was underway, when in actuality, T/E concepts and practices were almost never integrated in K-12 classrooms in that era. Regrettably, this practice quickly began to shroud the phrase “STEM education” in dire ambiguity.

In 2005, we at Virginia Tech launched a unique STEM Education Graduate Program, *grounded in the core idea of situating S, T, E, & M teaching and learning in the context of technological/engineering design activity* (Sanders, 2006, 2009). But, by 2009, the term “STEM education” had become so ambiguous that we at Virginia Tech renamed our graduate program “Integrative STEM Education” (Sanders, 2009) and published the following original operational definition of integrative STEM education on our program Web site to ameliorate “STEM education” ambiguity dilemma that remains to this day.

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 (clearly and very 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 the *doing of designing/making/engineering* constitute the T/E component in this definition. For example, simply employing instructional technologies to teach S/M concepts *does not constitute the T/E component essential to integrative STEM instruction*. Similarly, the common practice of integrating only S/M instruction *does not constitute integrative STEM Education*, just as the common practice of integrating only T/E instruction does not constitute integrative STEM education.

Moreover, *integrative STEM education*:

- is appropriate and desirable for *all* PK-PhD students;
- is not intended to supplant “silo” (isolated) S, T, E, or M instruction that has been shown to be more effectively taught via non-integrative methods; 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 the phrase “STEM education.” Those who wish to use “integrative STEM education” to describe instruction must be certain that said instruction is clearly grounded in the context of technological/engineering design activity in accordance with the definition and related information above.

References

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