STEM education is an intentional, metadisciplinary approach to teaching and learning, in which students uncover and acquire a cohesive set of concepts, competencies, and dispositions of science, technology, engineering, and mathematics that they transfer and apply in both academic and real-world contexts, in order to be globally competitive in the 21st Century. (Rider-Bertrand 2007)

STEM: A Metadiscipline

The current educational climate is one of standards and accountability. "The demands for teachers to cover the standards and for students to perform well on standardized measures are overwhelming" (Drake & Burns, 2004, p. 2). Now, more than ever, students are faced with an immense amount of information that they must filter, process, and store. A student's ability to do this depends greatly upon his or her ability to make connections (Humphreys, 2005). One method that is recommended by a number of educators, authors, and reformers, including those involved in STEM education, is to address the vast number of standards-based requirements through the use of integrative approaches. While it may seem counter-intuitive in an era of "back-to-basics," indeed, curricular integration is proposed by the U.S. Department of Education, the American Association for the Advancement of Science, the Accreditation Board for Engineering and Technology, and the National Council of Teachers of Mathematics (Humphreys, 2005). Furthermore, in a meta-analysis of 30 studies that included substantive data, Hartzler (2000, as cited in Drake and Burns, 2004, p. 28) concluded that students who learned in integrative programs consistently outperformed students in traditional programs on standardized assessments.

Drake and Burns (2004) present three different integrative approaches—multidisciplinary, interdisciplinary, and transdisciplinary, and suggest that they all fit on an integration continuum. Multidisciplinary integration would be on one end, as it involves the organization of curriculum and instruction from two or more disciplines around a theme. Interdisciplinary integration would be more centrally located, as it involves the organization of curriculum and instruction around common learnings across disciplines. Finally, transdisciplinary integration would be on the other end of the continuum, as it involves the organization around student questions, where concepts and skills are developed through a real-life context. The fundamental difference between each approach is the level of separation of the disciplines (Drake & Burns, 2004). Any of the three integrative approaches could serve as a means to help students make connections within and among disciplines, and Drake and Burns (2004) point out that "no one approach seems preferable."

Ideally, STEM education should be more than interdisciplinary or multidisciplinary, even more than transdisciplinary. It should be metadisciplinary, or reflective of something that is coherent, comprehensive, and greater than the sum of its parts. When curriculum and instruction is interdisciplinary, multidisciplinary, or transdisciplinary, it is a combination of elements of the traditional disciplines, either in whole or part. Whether the integrating element is a theme, common learnings, or a real-life context, all three of the integration methods espoused by Drake and Burns (2004) reflect the combination of something that has already been compartmentalized into
disciplines. On the other hand, metadisciplinary refers to "a larger curricular focus that transcends or supersedes traditional boundaries to create a truly holistic, systemic, integrative worldview uncluttered by familiar limits and barriers" (Werth, 2003, p. 36).

"At the heart of liberal education lies the idea that learning should be greater than the sum of its parts" (Huber & Hutchings, 2005), and STEM education is no exception. But, if the integration of the parts is the focus of the curriculum design and instructional delivery, the sum may or may not be greater. It is not enough to integrate the disciplines of science, technology, engineering, and mathematics around a theme, common learnings, or a real-life context. If students are to develop awareness of "complex interdependencies and [be] able to synthesize learning from a wide array of sources, to learn from experience, and to make productive connections between theory and practice (Huber & Hutchings, 2005)," educators must be intentional. Huber and Hutchings (2005) suggest that intentional learning is a skill necessary for lifelong learning. Accordingly, what is necessary to assure intentional learning in STEM education is an intentional approach that is holistic in the most Aristotelian sense.

REFERENCES


