EDUCATION WEEK

Bringing STEM Into Focus

By Jean Moon & Susan Rundell Singer

What do we intend when using the acronym STEM? It literally stands for science, technology, engineering, and mathematics, but what does it mean? Arguably, attempts to provide a meaningful response to these questions have not stuck. It is not for lack of trying, however. State education agencies, national membership organizations, advocacy groups, and state policymakers have been seeking definitions for STEM for quite some time, and with good reason. Today, not only do we have numerous definitions of STEM, but we also have branded numerous entities to be STEM councils, STEM schools, STEM networks, and STEM curricular outcomes. Despite the well-intended branding, understanding of the brand itself remains elusive. It is a conundrum.

While the STEM-definition conundrum can cause confusion, there is reason for optimism. It is our belief that some important conceptual ground has been gained on this conundrum, and it is ground worthy of exploration.

Several recent reports, including the National Research Council's "**A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas**," offer a vision for science and science education with significant implications, if not clues, for the "what is STEM?" question. For example, the K-12 framework effectively turns attention away from a content-specific definition of STEM to a more epistemic one—the sources, strategies, or practices from which science and, by extension, STEM knowledge comes and, in turn, is shared. It may well be that this long-standing inability to come up with an appropriate definition for STEM is an outgrowth of framing STEM as a fixed entity, an "it" instead of an assemblage of practices and processes that transcend disciplinary lines and from which knowledge and learning of a particular kind emerges.

Re-visioning school science around science and engineering practices, such as model-building, data analysis, and evidence-based reasoning, is a transformative step, a step found in the NRC report, which is critical to STEM learners and teachers, both K-12 and postsecondary. It puts forward the message that knowledge-building practices found under the STEM umbrella are practices frequently held in common by STEM professionals across the disciplines as they investigate, model, communicate, and explain the natural and designed world.

In addition to shared science and engineering practices, the NRC framework introduces us to crosscutting concepts (major ideas that cut across discipline lines) such as scale, proportion, and quantity or the use of patterns. Likewise, disciplinary core ideas (ideas with major explanatory power across science and engineering disciplines) are introduced. Together with shared practices, these three dimensions of the NRC framework—practices, crosscutting concepts, and disciplinary core ideas—reflect the realities of contemporary science and engineering, inclusive of mathematics, where concepts and practices, often very dependent on technologies, create productive bridges across STEM disciplines. Such bridges make interdisciplinary collaboration possible and, most importantly, provide a set of strategies and tools unique to the process of STEM learning and teaching.

Lest some believe this is setting up another false dichotomy in science or mathematics education between content and process, let us quickly add a strong evidentiary note: Epistemic practices and the learning and knowledge produced through such practices as building models, arguing from evidence, and communicating findings increase the likelihood that students will learn the ideas of science or engineering and mathematics at a deeper, more enduring level than otherwise would be the case. Research evidence consistently supports this assertion. Simply put, the centrality of the "means" by which STEM knowledge is learned, produced, shared, and revised allows us to grasp what constitutes STEM, what it is, and what it brings to the teaching and learning process.

Messages in other recent reports are also nudging us toward a new, clearer vision of STEM, and helping set learning priorities in these subjects. When we look at these messages as a whole, a clarity about the reality of STEM as a field of shared knowledge and practices moves us beyond STEM as an acronym or a branding mechanism or a theoretical dimension. Weaving meaningful connections across STEM learning is beginning to echo across all levels of education. For example, learning to build models as a form of explanation and evidence-gathering can be found in the life science education fields, the scientific competencies for premedical and medical students, as well as the common-core mathematics standards. Whether by coincidence or via an implicit, shared vision, numerous thoughtful STEM communities have converged on a means of understanding STEM, creating the beginnings of an implementable infrastructure, a field of unique knowledge, practices, and expertise. We believe, as well, that a potential for more meaningful alignment between education and workforce is emerging in parallel with a clearer vision of what constitutes STEM as a field of knowledge and practices.

Collectively, these advances give us a clearer, more mature understanding of what constitutes STEM work. Continuing to mine these efforts for common threads is one way to unpack the essential elements characterizing STEM.

This is a unique moment in time. It is defined by synergistic shifts in the framing of K-12 and undergraduate STEM subjects supported by a rich research base on how students learn. It is fueled as well by a groundswell of collective interest, if not will, to re-vision what STEM education "is."

Moving STEM from a conundrum and a loose affiliation of disciplines to a powerful domain for structuring K-16 learning based upon a coherent set of shared practices and crosscutting concepts appears to be within our collective reach. This is a moment to build on the assembled wisdom now being conveyed. Work focused on K-12 in addition to postsecondary education offers complementary visions that have significant meaning for clarifying the STEM question. Much more work remains to be done, however. While the pieces of the puzzle, the outlines, are now more understandable, the next critical step is to organize the efforts, conversations, and scholarship needed to deepen and clarify these outlines, bringing STEM as a unique entity into a sharper, more meaningful, and enduring focus.

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