Book Review
A Call-for-Action for Improving STEM Education

Review by Torrey Trust
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Employers in STEM fields claim that they often hire international students because U.S. students lack STEM literacy, which is defined as "the knowledge and understanding of scientific and mathematical concepts and processes required for personal decision making, participation in civic and cultural affairs, and economic productivity" (National Research Council, 2011, p. 5). According to the National Assessment of Educational Progress, only 35% of 8th grade students are proficient in mathematics, and there are significant gaps in scores between White students and other subgroups (e.g., African American, Hispanic, and low-income; U.S. Department of Education, 2011). The results of international assessments, such as the Trends in International Mathematics and Science Study and the Program for International Student Assessment, show that U.S. students lag behind those of other countries in math and science (Gonzales et al., 2008).

This poor performance on international tests and the notion that U.S. students are ill-prepared for "the demands of today's economy and the economy of the future" (National Research Council, 2011, p. 3) are central to the desire of the Committee on Highly Successful Schools or Programs for K-12 STEM Education's to examine the conditions, strategies, and contexts that have the potential to improve STEM education. The Committee's analysis is presented in the book, *Successful*

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K-12 STEM Education: Identifying Effective Approaches in Science, Technology, Engineering, and Mathematics (2011). The book contains an exploration of the various criteria for identifying effective STEM schools and programs, with the goal of providing recommendations to administrators and policymakers about how to improve K-12 STEM education (National Research Council, 2011).

Based on an examination of background papers, research, and examples of effective STEM schools and programs, the Committee developed a list of three criteria to explore: STEM outcomes, STEM-focused school types, and instructional and organizational practices. The Committee found that STEM-focused K-12 schools have not been studied enough to warrant claims of success. Additionally, they noted that research on STEM outcomes is often limited to the use of students' achievement on standardized tests as the sole measure of success. Because instructional and organizational practices have been rigorously researched and found to be associated with better student outcomes, the Committee determined that these practices are the most useful criteria for identifying effective STEM schools and programs.

An emerging theme from the book was the lack of effective research on STEM education. Each of the research examples presented in the book had one or more limitations that affected whether a plausible claim could be made about the cause of results. This lack of rigorous research appeared to limit the Committee's ability to make substantiated claims about long-term STEM outcomes and STEM-focused school types. While the Committee found the research on STEM practices to be stronger than the research on the other two criteria for identifying effective STEM schools and programs, they argued that studies on STEM practices often focus on isolated, decontextualized variables without reference to authentic classroom learning. The Committee detailed the need for researchers to weave a narrative of the studies on STEM education to determine which practices might improve students' learning experiences.

The book concludes with four recommendations for schools, districts, and policymakers related to instructional and organizational practices within K-12 settings: (a) provide teachers with more time and resources to incorporate high quality science education into their classrooms; (b) develop rigorous, in-depth standards that are aligned across the curriculum; (c) improve STEM assessments to provide a more well rounded picture of students' knowledge; and (d) provide support to teachers and school leaders to help them create educational contexts that enhance student learning.

The book is a call-to-action for teachers, administrators, and policymakers to improve instructional practices related to STEM education in

U.S. schools. The committee believes that high quality STEM instruction is the exception in schools and that a transformation of instructional and organizational practices is needed to make high quality STEM instruction the norm in U.S. schools. The implications for teachers of this call-to-action concern a number of areas. Teachers will be encouraged to cover fewer science topics in greater depth, actively engage students with authentic learning experiences, and draw on students' interests and experiences to improve their conceptual understanding of the topics addressed.

Teachers will not, however, be left on their own to make these changes. The Committee noted that teachers would have the *Conceptual Framework for New Science Education Standards* (National Research Council, 2012) and the *Common Core State Standards for Mathematics* (National Governors Association Center for Best Practices, Council of Chief State School Officers, 2010) as guides for improving STEM education in K-12 schools. These guides will help teachers to incorporate more in-depth science and math content knowledge and practices into their instruction. Teachers' efforts to provide high quality STEM instruction will also be supported by the new national, state, and local assessments. According to Pellegrino (2013), these assessments are currently undergoing significant transformations as a means to incorporate students' reasoning, application of content knowledge, and understanding of core concepts as measures of proficiency (Pellegrino, 2013). Ideally, these new standards and assessments will support K-12 teachers in their efforts to improve STEM instruction.

The main limitation of the book was its lack of descriptive details about the research studies that support the Committee's claims and recommendations. For example, when explaining why the Committee chose each of the selection criteria, the authors did not reference any studies or literature. Instead the Committee stated, "We examined criteria related to STEM-focused schools because those schools are often viewed as the most effective route to improving STEM education" (p. 6). Too often, the Committee summarized their ideas and analyses without providing sufficient detail, and thereby evidence, to support their claims.

Regardless of these limitations, the book plays an important role in bringing STEM instruction to the forefront of the national conversation on improving education. The Committee believes that a transformation is needed in U.S. K-12 schools to provide high quality, effective STEM instruction. Additionally, the Committee advocates for more rigorous research on STEM education as a means to identify and evaluate the effectiveness of STEM schools, programs, outcomes, and practices. Ideally, this push for broader and richer research and improved practices in STEM education will lead to more effective learning experiences for

students and will ultimately help the U.S. to achieve its three goals for STEM education: (a) increasing the number of students who pursue advanced degrees in STEM fields, (b) increasing the number of students who are trained to work in STEM careers, and (c) improving STEM literacy for all K-12 students (National Research Council, 2011).

I recommend this book for administrators and policymakers who are looking for guidance for improving STEM education and for researchers who are studying STEM education. While this book is not specifically geared toward teachers, it does provide modest insights into how teachers can improve STEM education in their classrooms.

Reviewed Book

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