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Integration in K–12 STEM Education: Status, Prospects, and an Agenda for Research

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Integration in K–12 STEM Education: Status, Prospects, and an Agenda for Research[1]

Education for K-12 students in science, technology, engineering, and mathematics (STEM) has received increasing attention over the past decade with calls both for greater emphasis on these fields and for improvements in the quality of curricula and instruction.[1,2,3,4,5,6,7] In response, numerous new instructional materials, programs, and specialized schools are emerging. While most of these initiatives address one or more of the STEM subjects separately, particularly mathematics and science, there are increasing efforts to create connections between and among the subjects, including sometimes the T and E. For example, the recently published *Next Generation Science Standards* (NGSS),[8] modeled on *A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas*,[9] has focused attention on how science concepts and practices can be integrated with those from engineering.

Advocates of more integrated approaches to K-12 STEM education argue that teaching STEM in a more connected manner, especially in the context of real-world issues, can make the STEM subjects more relevant to students and teachers. This in turn can enhance motivation for learning and improve student interest, achievement, and persistence. And these outcomes, advocates assert, will help address calls for greater workplace and college readiness as well as increase the number of students who consider a career in a STEM-related field.

Despite the rise in interest in providing students with learning experiences that foster connection-making across the STEM disciplines, there is little research on how best to do so or on what factors make integration more likely to increase student learning, interest, retention, achievement, or other valued outcomes. Indeed, there is considerable confusion about just what integrated STEM education is and how, if at all, it is different from STEM education that is not integrated.

This paper summarizes the findings and presents the recommendations from a recently completed study of integrated K-12 STEM education. The study, carried out under the auspices of the National Academy of Engineering and National Research Council, identified and characterized existing approaches to integrated STEM education, both in formal and after-/out-of-school settings; reviewed the evidence for the impact of integrated approaches on various student outcomes; and determined a set of priority research questions to advance understanding of integrated STEM education. The project was funded by the S.D. Bechtel, Jr. Foundation and Stephen Bechtel Fund, the National Science Foundation, the Samueli Foundation, and PTC, Inc.

Methodology

The study was overseen by a committee of 15 people with expertise across all four STEM disciplines and backgrounds in a range of relevant areas, including classroom teaching, curriculum development, teacher education, research in education and the learning sciences,

[1] This article is adapted from the report, *STEM Integration in K-12 Education: Status, Prospects and an Agenda for Research* (National Academies Press, 2014).

school leadership, higher education, state STEM education reform, and business. The committee met five times over an 18-month period, held three information-gathering sessions, and commissioned topical papers relevant to its work.

The committee worked with outside consultant David Heil & Associates, Inc.(DHA), which conducted reviews of the research literature related to integrated STEM education in both formal and after- and out-of-school settings (e.g., robotics competitions, science and technology centers). The literature review began with a search using the major multidisciplinary search engines such as Scopus, Web of Science, and INSPEC and was designed to capture a broad range of studies. The search used combinations of the following terms: integrated curriculum; integrated education; integrative; cross-disciplinary; interdisciplinary; multidisciplinary; project-based; K–12 education; unified studies curriculum; STEM; STEM education; integrated STEM education; science, mathematics, technology, and engineering education; inquiry-based instruction and learning; constructivism; cognitive development; cognition; learning; achievement; informal education; non-formal education; mentor; out-of-school; after school; enrichment; and extracurricular.

Overall, multiple searches in the formal education, informal education, and cognitive areas uncovered over 500 reference citations. The abstracts of these articles were reviewed to glean more information about content and relevance. Papers were initially included if the program described or studied integrated at least two STEM subjects. Four other criteria were also considered:

- Does the integration include engineering as one of the integrated subjects?
- Does the article provide empirical evidence regarding the impact of the program or a review of research on integrated curriculum?
- Do the authors present information or insights that are likely to contribute to addressing the committee's charge?
- Is the focus of the article on K–12 education and/or informal education programs?

Articles were more likely to be considered if they met more of the criteria. This initial search of the literature was supplemented by searches using key authors suggested by the committee or identified in articles as search terms. The literature review was complemented by expert-authored commissioned papers on social cognition, embodied cognition, the development of interest and identity, and assessment.

In addition, with guidance from the committee, DHA identified a large sample of programs, projects, schools, and other initiatives that claimed or appeared to be engaged in integrated STEM education. Of 213 possible programs or initiatives, 55 were dropped because they did not appear to be integrated, no current information was available, or they did not have any evidence of impact. The remaining 158 programs were formal education programs (98), informal education programs (46), and programs that combined formal and informal elements in some way (14). From this group and taking account of time and budget constraints, 28 (14 formal and 14 informal) were selected to be reviewed in greater detail. The final selection (Appendix) was based on a combination of expert judgment, the information available for each program, the responsiveness of program developers or practitioners to inquiries, evidence of integration, and some evidence of program impacts. In addition, programs were selected to represent different types and scales of integration. Formal education programs were identified as activities, modules, full curriculum, school-wide programs, or teacher preparation/professional development. Informal program categories included curriculum, professional development, after-school, camps, community events, competitions, exhibit/on-site drop-in programs, mentoring/internships, and media (e.g., television, websites).

The committee's understanding of integrated STEM education and how to make its report useful to readers was further informed by interviews conducted with 30 stakeholders in education, policymaking, and industry.

Defining integrated STEM education

Developing a precise definition of integrated STEM education proved to be a challenge for the committee because of the multiple ways such integration can occur. It may include different combinations of the STEM disciplines, emphasize one discipline more than another, be presented in a formal or informal setting, and involve a range of pedagogical strategies. For example, one model[10] suggests that "integrative" STEM education must include technological or engineering design as a basis for creating connections to concepts and practices from mathematics or science (or both). This approach emphasizes the importance of bridging the learning experiences, habits of mind, and analytic practices of the design sciences (engineering and technology) with those of the natural sciences (science and mathematics) (e.g., Ref. 38).

In educational practice and in research, the term "integrated" is used loosely and is typically not carefully distinguished from related terms such as connected, unified, interdisciplinary, multidisciplinary, cross-disciplinary, or transdisciplinary. Defining integrated STEM education is further complicated by the fact that connections can be reflected at more than one level at the same time: in the student's thinking or behavior, in the teacher's instruction, in the curriculum, between and among teachers themselves, or in larger units of the education system, such as the organization of an entire school.

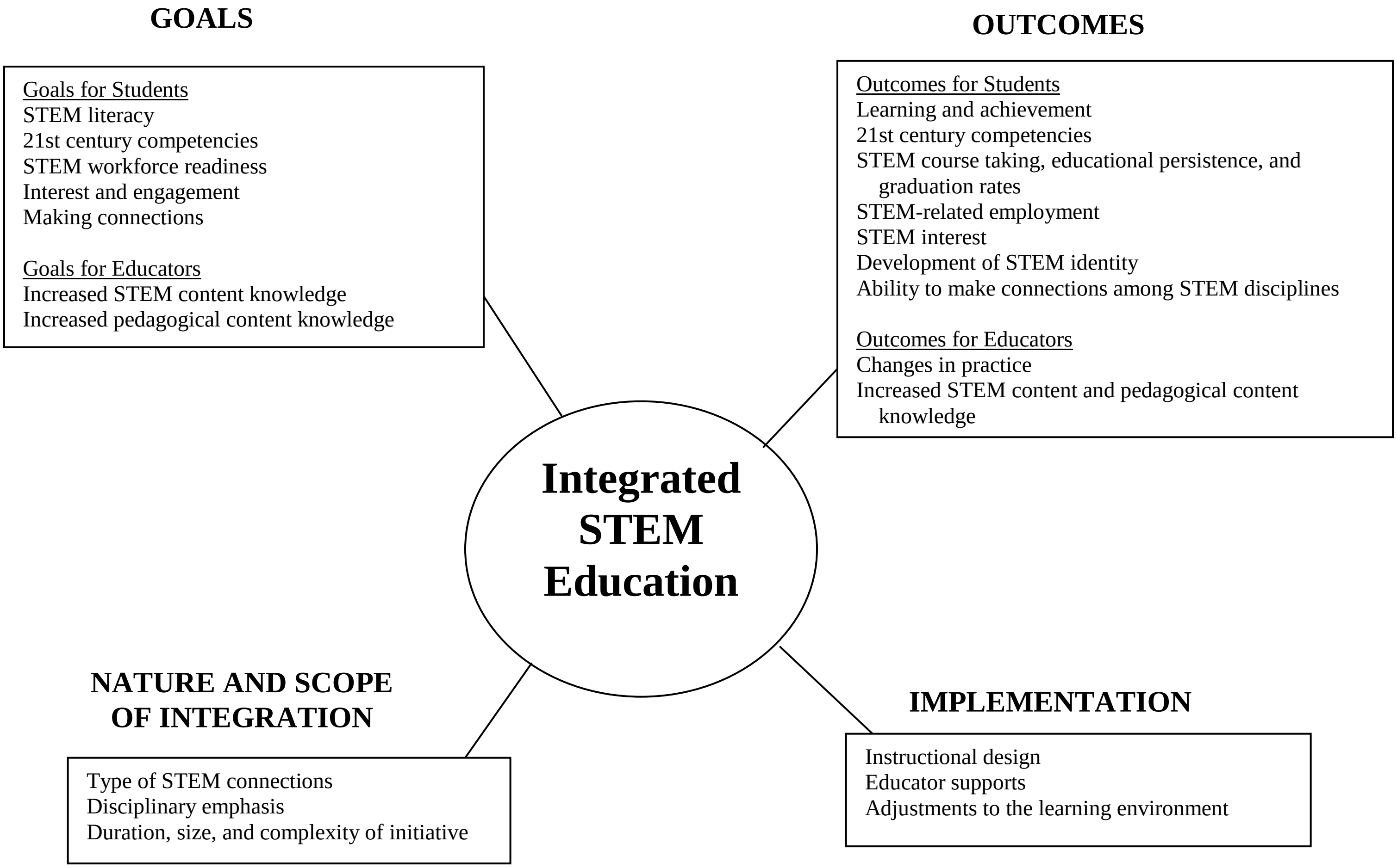
The multidimensional nature of integrated STEM education led the committee to develop a descriptive framework, rather than a strict definition, to characterize existing approaches to integrated STEM.

Framework

Far from being a single, well-defined experience, the committee determined that integrated STEM education includes a range of different experiences that involve some degree of connection. The experiences may occur in one or several class periods, throughout a curriculum, be reflected in the organization of a single course or an entire school, or be encompassed in an out-of-school activity. Each variant of integrated STEM education suggests different planning approaches, resource needs, implementation challenges, and outcomes.

To make sense of this confusing landscape, the committee developed a descriptive framework. The framework is meant to provide a common perspective and vocabulary for researchers, practitioners, and others to identify, discuss, and investigate specific integrated STEM initiatives within the K-12 education system of the United States. While there are potentially a very large number of variables that could be incorporated into such a framework, the committee chose to focus on four high-level features: goals, outcomes, nature of integration, and implementation. Each feature has a number of subcomponents (Figure 1).

FIGURE 1 Descriptive Framework Showing General Features and Subcomponents of Integrated STEM Education



Findings from the research: learning and achievement

Research on the impact of integrated experiences on students' achievement, disciplinary knowledge, problem-solving ability, and ability to make connections between domains is not extensive, and concerns related to both the design of studies and the reporting of results hamper the ability to make strong claims about the effectiveness of integrated approaches. Nonetheless, preliminary conclusions can be drawn from the well-designed studies. The findings suggest that integration can lead to superior improvements in conceptual learning in the disciplines, but that the effects differ depending on the nature of the integration, the outcomes measured, and the students' prior knowledge and experience.

The most well-studied integrated STEM education pairing is that of mathematics and science,[11,12,13,14,15] but the number of studies that report the effects of integration on student learning in these two subjects separately is small. Moreover, the studies often are not explicit about the theory guiding how learning in the two subjects is coordinated and developed. Hurley's[14] meta-analysis of 31 studies compared integrated mathematics and science instruction to a nonintegrated control group and reported mathematics and/or science achievement measures. She found positive effects of integration on scores in both math (effect size [ES] = .27) and science (ES = .37), which is consistent with other meta-analyses[16] that report small to medium positive effects of integration, although the effects varied both by subject and by the year the study was conducted. The lowest overall effect size for math achievement (ES = .07) was observed in the 10 most recent studies reviewed (1980s–1990s) and was lower than the effect for science achievement in all time periods.

In contrast, Lehrer and Schauble[17] found enhanced development of scientific concepts known to be challenging to students in the elementary grades when the students use mathematics as a resource for representing and modeling natural systems. These more carefully articulated studies of the use of mathematical systems as tools for learning about natural systems suggest that effect sizes may depend on details of the instructional approach that are obscured by simple characterizations of the temporal sequence of integration. Other studies[18,19,20,21,22,23] suggest that the nature of the mathematical tools and systems of representation available to students determine the depth and breadth of learning about core ideas in science because mathematical forms correspond to forms of understanding natural systems.

Design-based approaches, a hallmark of engineering education, have received particular attention for their potential as a rich context for integrated STEM. The effect of engineering on learning in science and mathematics was examined in the report *Engineering in K–12 Education: Understanding the Status and Improving the Prospects*.[24] The authoring committee found preliminary but promising evidence of a positive impact of engineering on learning in science and mathematics.

More recently, two published empirical studies of Project Lead the Way (PLTW), a major program in engineering education for middle and high schools, showed mixed results when state achievement test scores were the basis of comparison. In schools serving a high proportion of low-income families, all students showed significant overall gains in mathematics and science achievement scores between 8th and 10th grade regardless of their course enrollment. However, students enrolled in one or more PLTW engineering classes showed statistically less improvement in mathematics scores and a statistically insignificant difference in science achievement scores over that period, compared with a control group.[25] In schools serving predominantly affluent families, PLTW students exhibited small gains in mathematics achievement but no improvement in science achievement compared with students in a control sample.[26]

The results of these two studies provide additional evidence that enhancing math achievement through integration with other disciplines is difficult to do, and it is likely that students need additional support in place to see how specific mathematics concepts and skills are integrated with the engineering activities in order to exhibit substantial gains in mathematics achievement. These studies also fail to show substantially larger gains for students participating in project-based engineering courses, underscoring the inconsistency in current research on integrated STEM instruction.

Other research[27,28,29,30,31] has demonstrated the effectiveness of learning science concepts through design in some but not all situations. This approach can be effective if concepts are introduced when students engage with the design activity[32,33] or when design failure provokes conceptual change as students redesign an artifact to meet a goal.[34] In addition, participant structures such as research groups[34] and design sharing sessions (pin up sessions)[35] can provide conversational forums for clarifying and elaborating relations between designed artifacts and scientific concepts. Other studies reveal that students may not spontaneously make connections between the devices being designed and the related scientific concepts[36,37,38] and that they tend to focus on aesthetic or ergonomic aspects of design.[36,30] Furthermore, the scientific knowledge gained through design may be highly contextualized, unless the activities are developed to support transfer of knowledge from one context to another, for example by using designs that highlight similar concepts across contexts .[33, 39]

A small number of studies have examined the degree to which understanding of engineering and technology may improve as a result of integrated STEM experiences. One, a pilot study conducted as part of a large-scale curriculum intervention[41] in New Jersey, found learning gains in elementary, middle, and high school students.

Looking across studies, the integration of STEM concepts and practices has the promise to lead to increased conceptual learning within the disciplines. However, the positive impact on learning appears to differ for science and mathematics with less evidence of a positive impact on mathematics outcomes, based on current assessments for those subject areas, which might not fully capture integrated learning in STEM. For both science and mathematics, the impact on learning and achievement depends on the approach to integration and the kinds of supports that are embedded in the experience and provided through instruction. Integrated STEM education also shows promise of supporting knowledge gains in engineering and technology. Given the small number of studies, generally small sample sizes, and use of pre/post study designs, however, these potentially promising findings must be interpreted cautiously.

Findings from the research: interest and identity

There are indications that integrated STEM experiences can support interest development, but research studies vary considerably in quality and often do not take into account the different phases of interest development, limiting what can be concluded from this work. Integrated STEM education experiences may provide opportunities for students to engage in STEM in ways that potentially transform their identities with respect to the STEM subjects. This effect may be particularly strong for populations that have historically struggled in STEM classes and that are historically underrepresented in STEM programs in higher education and STEM professions. However, there are a limited number of studies on identity in the context of integrated STEM education, and most of these are qualitative in nature. In addition, outcomes focused on interest and identity are more commonly measured in after- and out-of-school settings than in the context of formal classrooms.

Findings from the research: cognition and learning

In addition to reviewing research related to outcomes, the committee examined research from cognitive psychology, the learning sciences, and educational psychology—as well as from studies focused specifically on integrated STEM education—for clues about factors that may help explain the potential benefits and challenges posed by integration.

From the perspective of what is currently known about cognition and learning, integration may be effective because basic qualities of cognition favor connected concepts over unconnected concepts so they are better organized for future retrieval and meaning making.[42] It is these connected knowledge structures that can support learners' ability to transfer understanding and competencies to new or unfamiliar situations. In addition, being able to represent the same concept within and across disciplines in multiple ways—for example visually, in physical form, and in writing—can facilitate learning, research shows.[43] But integration can also impede learning because it can place excessive demands on resource-limited cognitive processes, such as attention and working memory.[44,45,46]

While fundamental to all learning experiences, social and cultural experiences such as those which require students to work with each other and actively engage in discussion, joint decision making, and collaborative problem solving may be particularly important in integrated learning. Some social processes can support learning through deliberate efforts to convey knowledge and strategies to children. Techniques such as scaffolding[47] and peer collaboration can help students be successful with challenging tasks and move beyond their current state of knowledge.

One hallmark of integrated approaches, though not unique to them, is the use of real-world situations or problems. While these contexts can bring STEM fields alive for students and have the potential to deepen their learning, they may also pose challenges to students. For instance, there is evidence that use of detailed concrete situations that include rich perceptual information can prevent students from identifying the abstract structural characteristics that are needed to transfer their experiences to other settings.[48,49,50]

Implications for the design of integrated STEM initiatives

Taken together, the findings from research have implications for the design of integrated STEM education initiatives. Three key implications are

1. Integration must be made explicit. Observations in a number of STEM settings show that integration across representations and materials, as well as over the arc of multi-day units, is not spontaneously made by students and therefore cannot be assumed to take place. This highlights the importance of designing integrated experiences that provide intentional and explicit support for students to build knowledge and skill both within the disciplines and across disciplines. In many integrated STEM experiences, such supports are missing or only implicitly embedded within the classroom activities or the CAD software, measurement instruments, and computational tools used in the classroom.[51,52]

2. Students' knowledge in individual STEM disciplines is a precondition to effective STEM integration. Connecting ideas across disciplines is challenging when students have little or no understanding of the relevant ideas in the individual disciplines. Also, students do not always or naturally use their disciplinary knowledge in integrated contexts. Students will thus need support to elicit the relevant scientific or mathematical ideas in an engineering or technological design context, to connect those ideas productively, and to reorganize their own ideas in ways that come to reflect normative, scientific ideas and practices.

3. More integration is not necessarily better. Integration is highly demanding of cognitive and social resources for both learners and instructors. The potential benefits and challenges of making connections across the STEM subjects suggest the importance of a measured, strategic approach to implementing integrated STEM education that accounts for the potential trade-offs in cognition and learning.

Context for implementing integrated STEM education experiences

The committee identified three contextual factors likely to present both opportunities and challenges to the implementation of integrated STEM education at the K-12 level: standards, assessments, and educator supports.

The recently published Common Core State Standards in Mathematics[53] (CCSSM) and the NGSS[8] have the potential to focus educators on helping students make connections across the disciplines. The committee recognizes that not all states will adopt the CCSSM or the NGSS. However, the underlying principles that inform both sets of standards are likely to influence approaches to mathematics and science education, even in those states that do not formally adopt the new standards. These underlying principles include active engagement of students in authentic tasks, supporting the development of conceptual knowledge and reasoning, and application of knowledge in real-world contexts.

One challenge of taking advantage of the opportunities for integration presented by the CCSSM and NGSS is attending to developing disciplinary knowledge while also supporting students in making connections across disciplines. This concern is highlighted by research showing that curricula integrating mathematics or science with other STEM subjects are less likely to produce positive learning outcomes in mathematics than they are in science, although effect sizes can vary greatly depending on how science and mathematics are offered (sequentially, in parallel, together and separately, or together either with one subject as the dominant theme of the lesson or with both subjects completely integrated). A second challenge is presented by the partial overlap in some of the practices identified in the CCSSM and NGSS, where the same terms have different meanings for experts in different fields. For example, argumentation in mathematics differs from argumentation in science. In order for students to engage in argumentation in both disciplines, they will need to understand what makes scientific arguments different from mathematical arguments.

Assessments—from formative assessment at the classroom level to large-scale state assessment for accountability—have the potential to limit the extent to which integrated STEM can be incorporated into K-12 education. Existing assessments tend to focus on knowledge in a single discipline. Furthermore, they typically focus on content knowledge alone and give little attention to the practices in the disciplines and applications of knowledge. In terms of innovative approaches, large-scale assessments pose the biggest challenges, though some innovative examples do exist, such as the National Assessment of Educational Progress (NAEP) probe assessment of technology and engineering literacy being fielded in a sample of US eighth graders in 2014.[54] Other potential models of assessments that might be adapted to address STEM integration include the recently restructured AP biology exam from the College Board[55] and the computer-based tasks on the 2009 NAEP Interactive Computer and Hands-On Tasks Science Assessment.[56] More generally, digital and networking technologies have the potential to expand the range of outcomes (e.g., progressions of integrated STEM learning) that can be measured.

The expertise of educators working in classrooms and in after-/out-of-school settings is a key factor—some would say *the* key factor—in determining whether integrated STEM education can be done in ways that produce positive outcomes for students. One limiting factor to teacher effectiveness and self-efficacy is teachers' content knowledge in the subjects being taught. For example, most K-12 science and mathematics teachers have taken fewer courses in the subject area(s) in which they were prepared than recommended by their respective teacher professional associations and many have taken few courses in other areas of STEM.[57] Low content knowledge and self-efficacy are especially notable for teachers grades K-8, who are much less likely than secondary teachers to have a bachelor's degree in their field of instruction. The small amount of available data for K-12 technology teachers, many of whom are providing engineering instruction, suggests their preparation in mathematics and science is quite limited.[58] Furthermore, surveys find that teachers of K-12 mathematics and science lack confidence in their ability to teach engineering.

Apart from subject-specific content knowledge, the ability and confidence to teach across subjects will be critical for educators called upon to deliver integrated K-12 STEM education. Educators will need to know how to provide instructional supports that help students recognize connections between disciplines, and they will need to support students' developing proficiency in individual subjects in ways that complement students' learning through integrated activities. Teacher educators refer to this as *pedagogical content knowledge* because it reflects the importance of applying one's content knowledge into effective instructional practices.[59,60] At the present time, there are a very small number of teacher education programs around the country making efforts to prepare prospective teachers with appropriate content knowledge in more than one STEM subject, or the pedagogical content knowledge necessary to promote effective STEM integration. A larger number of programs exist that provide in-service professional development related to integrated STEM education[61]; most of these efforts are connected to existing curriculum projects.

Many of the changes likely to be needed to successfully implement integrated STEM education will require additional financial resources. Money, as well as time and planning, will be required to help educators acquire content and pedagogical content knowledge in disciplinary areas beyond their previous education or experience. And funds will be needed to design, pilot test, and implement any large-scale assessment.

Recommendations

Based on its data gathering and discussion, the committee developed 10 recommendations: two directed at multiple stakeholders in K-12 integrated STEM education; four directed at those involved in designing integrated STEM education initiatives; one intended for those charged with developing assessments; and three that target researchers.

Recommendations for multiple stakeholders

- Researchers, program designers, and practitioners focused on integrated STEM education, and the professional organizations that represent them, need to develop a common language to describe their work. The committee's report can serve as a starting point.

- To allow for continuous and meaningful improvement, designers of integrated STEM education initiatives, those charged with implementing such efforts, and organizations that fund the interventions should explicitly ground their efforts in an iterative model of educational improvement.

Recommendations for Designers of Integrated STEM Experiences

- Designers of integrated STEM education initiatives need to be explicit about the goals they aim to achieve, and design the integrated STEM experience purposefully to achieve these goals. They also need to better articulate their hypotheses about why and how a particular integrated STEM experience will lead to particular outcomes and how those outcomes should be measured.

- Designers of integrated STEM education initiatives need to build in opportunities that make STEM connections explicit to students and educators (e.g., through appropriate scaffolding and sufficient opportunities to engage in activities that address connected ideas).

- Designers of integrated STEM experiences need to attend to the learning goals and learning progressions in the individual STEM subjects so as not to inadvertently undermine student learning in those subjects.

- Programs that prepare people to deliver integrated STEM instruction need to provide experiences that help these educators identify and make explicit to their students connections among the disciplines. These educators will also need opportunities and training to work collaboratively with their colleagues, and in some cases administrators or curriculum coordinators will need to play a role in creating these opportunities. Finally, some forms of professional development needs to be designed as partnerships among between educators, STEM professionals, and researchers.

Recommendation for assessment developers

- Organizations with expertise in assessment research and development should create assessments appropriate to measuring the various learning and affective outcomes of integrated STEM education. This work should involve not only the modification of existing tools and techniques but also potentially novel approaches. Federal agencies with a major role in supporting STEM education in the United States, such as the Department of Education and the National Science Foundation, should consider supporting these efforts. (Recommendation 9)

Recommendations for researchers

- In future studies of integrated STEM education, researchers need to document the curriculum, program, or other intervention in greater detail, with particular attention to the nature of the integration and how it was supported. When reporting on outcomes, researchers should be explicit about the nature of the integration, the types of scaffolds and instructional designs used, and the type of evidence collected to demonstrate whether the goals of the intervention were achieved. Specific learning mechanisms should be articulated and supporting evidence provided for them.

- Study outcomes should be identified from the outset based on clearly articulated hypotheses about the mechanisms by which integrated STEM education supports learning, thinking, interest, identity, and persistence. Measures should be selected or developed based on these outcomes.

- Research on integrated STEM education that is focused on interest and identity should include more longitudinal studies, use multiple methods, including design experiments, and address diversity and equity.

Research agenda

To help guide future research, the committee posed questions aligned to the descriptive framework that, if addressed, have the potential to provide useful data for advancing the quality and effectiveness of integrated K-12 STEM education in the United States. The questions fall under three broad categories referenced earlier: outcomes of integrated STEM education, the nature of integrated STEM education, and design and implementation of integrated STEM education. Within each category, specific research questions are identified. For example, “What instructional approaches or contexts are most likely to lead to student outcomes related to making connections between and among the STEM disciplines?” And, “How should integrated STEM experiences be designed to account for educators’ and students’ varying levels of experience with integrated learning and STEM content?” Taken together, the questions, which are listed in the committee’s report, comprise a research agenda for integrated STEM education.

Final thoughts

There is much more that can and should be learned about the outcomes, nature, and design and implementation of integrated STEM education. This should not discourage those designing, implementing, or studying integrated STEM education programs. On the contrary, the committee's findings, recommendations, and research agenda strongly suggest the *potential* of some forms of integrated STEM education to make a positive difference in learning, interest, and other valued outcomes.

The level of evidence gathered by the committee is not sufficient to suggest integrated STEM education could or should replace high-quality education focused on individual STEM subjects. Indeed, integrated STEM education requires that students hone their expertise in the very disciplines that are being connected. However, parts of the STEM education community are already moving toward integration. This suggests that the energy, creativity, and resources of researchers, practitioners, and concerned funders should be directed at generating more thoughtful, high-quality, and evidence-based work exploring the benefits and limitations of integrated STEM education. Given the inherent complexities, it will not be a surprise to find that designing and documenting effective initiatives will be time consuming and expensive. Despite these challenges, the possibility of adding new tools to the STEM education toolbox is exciting and should be coupled with rigorous research and assessment of implementation efforts.

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APPENDIX

List of Reviewed Programs[2]

Formal Programs

Active Physics (http://its-about-time.com/physics/ap.html)
A World in Motion® (www.awim.org)
Biological Sciences Curriculum Study (www.bscs.org)
Engineering by Design—EbD-TEEMS™ (www.engineeringbydesign.org)
Engineering is Elementary (www.eie.org/)
Engineering the Future (www.mos.org/etf/)
Everyday STEM (www.shop.pitsco.com/store/item.aspx?art=4725)
Engaging Youth through Engineering (www.maef.net)
Harrisonburg Public Schools (www.i-stem-harrisonburg.com/)
I-STEM Summer Institute (www.sde.idaho.gov/site/istem)
Integrated Mathematics, Science, and Technology (http://cemast.illinoisstate.edu/educators/stem/index.shtml)
Manor New Tech High (http://mnths.manorisd.net)
The National Center for STEM Elementary Education (www.stem.stkate.edu/stk/center.php)
WISEngineering (www.wisengineering.org)

Informal Programs

Build IT (http://.buildit.sri.com/index.html)
Camp Invention (www.invent.org)
CSTEM Challenge (www.cstem.org)
Design It! (http://npass2.edc.org/resources/design-it)
Design Squad Nation (www.pbskids.org/designsquad/)
DREAM - Achievement Through Mentorship (http://.dream.rice.edu)
Family Engineering (www.familyengineering.org)
Jr. FIRST LEGO League, FIRST LEGO League, FIRST Tech Challenge, FIRST Robotics Competition (www.usfirst.org)
MathAlive! (www.mathalive.com)
National Partnerships for Afterschool Science (NPASS) and NPASS2 (http://.npass2.edc.org)
Techbirdge (www.techbridgegirls.org)
TechXcite (www.techxcite.org)
Tinkerer's Workshop [3]
Waterbotics (www.waterbotics.org)

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[2] Accessed November 15, 2013.
[3] This long-running exhibit at the Austin Children's Museum (now, The Thinkery), which emphasized the processes of tinkering and engineering design, no longer exists.