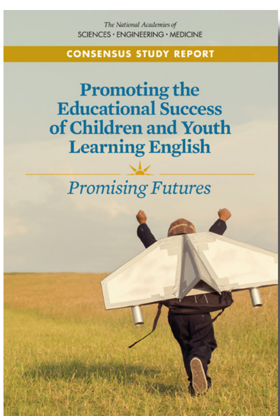
English Learners and Early STEM Learning

Science, technology, engineering, and mathematics (STEM) have the potential to be rich learning contexts for children who are English learners (ELs). A series of reports from the National Academies of Sciences, Engineering, and Medicine explain how learning experiences in STEM can be designed to foster learning for young children. In this highlights, we bring together key findings from this set of reports and point out those insights that are most relevant for ELs.

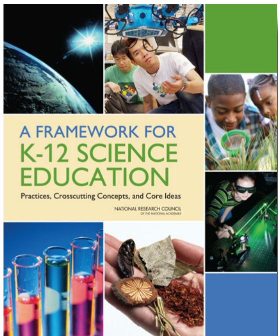


PROMOTING THE EDUCATIONAL SUCCESS OF CHILDREN AND YOUTH LEARNING ENGLISH: PROMISING FUTURES (2017)

This report from the National Academies examines how evidence about the development of ELs can inform policies and practices to yield better educational outcomes for children and youth (birth to age 21) **The population of ELs is diverse**, varying in their home language, language proficiency, age, race/ethnicity, immigration circumstances, academic achievement, parental characteristics, socioeconomic resources, and other demographic attributes. **Students with limited proficiency in English can face a high barrier to academic learning and performance in schools where English is the primary language of instruction and assessment.** Many ELs face additional barriers to educational success, such as poverty, living in families with low levels of education, and attending underresourced schools.

At the same time, ELs have assets that may serve them well in their education and future careers. Those who become proficient in both English and a second or even third language are likely to reap benefits in cognitive, social, and emotional development and may also be protected from brain decline at older ages. In addition, their varied cultures, languages, and experiences are assets for their development, as well as for the nation.

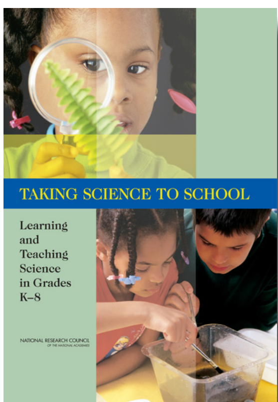
While *Promising Futures* does not focus on learning in specific academic content or subject areas, it highlights the importance of language in learning across the content areas. The report also explores the ways that ELs can be supported to become both proficient in English and to learn academic content.



A FRAMEWORK FOR K-12 SCIENCE EDUCATION (2012)

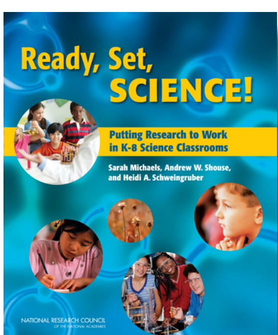
A Framework for K-12 Science Education outlines a new vision for K-12 science education, offering guidance about what decades of research findings mean for classroom practice. **This framework emphasizes building on the natural curiosity all students have about the world around them and guides educators to provide varied learning experiences with entry points for students from diverse backgrounds.**

This framework served as the blueprint for the development of the *Next Generation Science Standards*. Many states, schools, and districts are changing curriculum, instruction, and professional development to align with these standards or others that are based on the framework. **The framework and standards developed from it are based on current understanding of *how* kids learn—and how science teaching can be aligned with the way scientists and engineers do their work.** They are designed so that students will do science themselves, not just learn about how other people have done it or memorize facts. **A key idea from that research is that in order for learning to really "stick," students require continuous opportunities to engage in scientific thinking and activities and to gradually build their understanding of how their new knowledge fits with what they already know.** Importantly, the framework stresses that ALL children have the capacity to learn science by engaging in the scientific process of inquiry, starting in the early grades.[1]



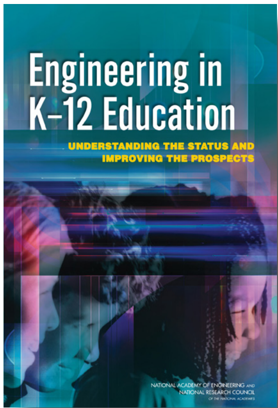
TAKING SCIENCE TO SCHOOL: LEARNING AND TEACHING SCIENCE IN GRADES K-8 (2007) AND *READY SET SCIENCE!: PUTTING RESEARCH TO WORK IN K-8 SCIENCE CLASSROOMS* (2008)

This pair of reports provides guidance about learning and teaching science in grades K-8, with particular emphasis on building on the assets children bring into the classroom. In contrast to the commonly held and outdated view that young children are concrete and simplistic thinkers, the research evidence now shows that their thinking is surprisingly sophisticated. **Children entering school already have substantial knowledge of the natural world, which serves as important building blocks for learning science.** Children learn about their world based on direct experiences with the physical environment, such as watching objects fall or collide, and observing animals and plants. They also learn about the world by talking with their families, watching television and engaging with technology, going to parks, and playing outside. **Children can build on this knowledge to develop their understanding of scientific concepts.**



In order to capitalize on the competencies children bring to school, classrooms should provide opportunities to engage in solving meaningful problems in science class and to "do" science. **Social interaction, including communication in written and oral form, is a central feature of both scientific practice and productive learning generally, and it plays an important, specialized role in K-8 science learning.** Teaching that will help all students to make sense of science also requires that teachers understand the particular students and the student groups they teach, including those who come from cultural backgrounds different from their own. At the classroom level, teachers need to recognize cultural differences and understand how they can impact students' interactions with science.

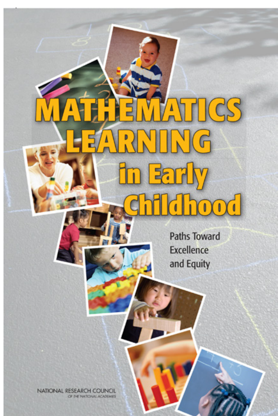
[1]Two National Academies reports provide more information about research on learning: *How People Learn: Brain, Mind, Experience, and School: Expanded Edition* (2000), http://www.nap.edu/catalog/9853 and *How Students Learn: Science in the Classroom* (2005), http://www.nap.edu/catalog/11102.



ENGINEERING IN K-12 EDUCATION: UNDERSTANDING THE STATUS AND IMPROVING THE PROSPECTS (2009)

In comparison to K-12 education in science and mathematics, efforts to incorporate engineering into K-12 education are still in their infancy in the United States. This report outlines three general principles for K-12 engineering education: (1) it should emphasize the engineering design process; (2) it should incorporate important and developmentally appropriate mathematics, science, and technology knowledge and skills; and (3) it should promote engineering habits of mind, which align with what many believe are essential skills for citizens in the 21st century—systems thinking, creativity, optimism, collaboration, communication, and attention to ethical considerations.

While having considerable inherent value, the most intriguing possible benefit of K-12 engineering education relates to improved student learning and achievement in mathematics and science and greater interest in these subjects because of their relevance to real-world problem solving. The authors of this report also find that the lack of diversity is a serious issue for the engineering profession. Given the demographic trends in the United States and the challenges of attracting girls, African Americans, Hispanics, and some Asian subpopulations to engineering studies, K-12 engineering curricula should be developed with special features, which appeal to students from these underrepresented groups and programs that promote K-12 engineering education should be strategic in their outreach to these populations.



MATHEMATICS LEARNING IN EARLY CHILDHOOD: PATHS TOWARD EXCELLENCE AND EQUITY (2009)

As in science, children learn mathematics, in part, through everyday experiences in the home and the larger environment, beginning in the first year of life. Families support mathematics learning through their activities at home, conversations, attitudes, materials they provide to their children, expectations they have about their performance, the behaviors they model, and the games they play. Parents also build connections with their children's educational settings—all of which can shape children's early mathematics development. Children require rich mathematical interactions and guidance, both at home and school, to be well prepared for the challenges they will meet in formal schooling.

Most early childhood programs spend little focused time on mathematics, and most of it is of low instructional quality. Many opportunities for learning mathematics over the course of the preschool day are, therefore, missed. **Emerging evidence from a few studies of rigorous mathematics curricula show that children who experience focused activities in which the teaching of developmentally appropriate mathematical concepts is the major goal have higher gains in mathematics and report enjoying the subject more than those who do not.** Providing opportunities for children to use mathematics during play—for example, allowing them to recreate events or situations they have experienced or providing concrete materials for exploration (e.g., blocks, puzzles, manipulatives, and interactive computer software)—can provide children with the opportunity to "practice" mathematics in a meaningful and engaging context.

SUMMARY

There is compelling evidence that children show early STEM-related strengths and are capable of sophisticated learning in these subject areas. Even young children have substantial knowledge of the natural world and are able to engage in problem solving and complex reasoning that form a foundation for science, engineering, and mathematics. It is important to design learning experiences in STEM so that children's early strengths can be built on systematically throughout the elementary grades.

As a follow up to the *Promising Futures* report and to build from the STEM education reports highlighted above, the National Academies have undertaken a new study funded by the National Science Foundation to examine promising approaches to support English learners in learning STEM.[2] STEM opens opportunities for work and life, as more and more careers require STEM knowledge and skills. Learning STEM helps young children to develop thinking, reasoning and problem-solving skills, as well as literacy, language, and social skills.

[2]See http://sites.nationalacademies.org/DBASSE/BOSE/CurrentProjects/DBASSE_175757 for more information about this project. The report will be released in late 2018/early 2019.

PDFs of all reports referenced above are available to be downloaded free of charge from the National Academies Press at https://www.nap.edu/.

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