



Science and Technology Resources on the Internet

STEM Education in the United States: Selected Web Resources

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Introduction

Over the last few decades, interest in science, technology, engineering, and math (STEM) education has flourished. Fueled by concerns that the United States' global prominence in scientific and technological innovations is faltering, and the decline in young people's interest in STEM careers, many new initiatives to bolster STEM learning have emerged ([National Research Council 2012](#)). Some have focused on the formal education system (K-12 and higher education), including updating standards, improving teacher training and professional development, improved assessment, and wider sharing of best practices. The National Academies of Sciences and Engineering have led many of these programs and projects. Other initiatives have targeted out-of-school time, creating communities of practice and networks, such as the Afterschool Alliance and Natural Start Alliance, which provide resources and training for individuals or groups interested in promoting STEM education.

Several initiatives also focus on increasing the participation of women and minorities in STEM. Although women have made great strides in many professions, their numbers still lag in STEM fields. In 2013, the following were the percentages of women in particular STEM positions: biological and life scientist - 47%; chemist - 38.8%; engineer - 11.7%; and mathematical or computer scientist - 26.1% ([National Center for Science and Engineering Statistics 2013](#)). The picture is equally bleak for minorities; in 2012, of the total number of all undergraduate science and engineering degrees awarded in the U.S., only 0.6% were awarded to Native Americans, 8.8% to African Americans, and 10.3% to Latinos ([National Center for Science and Engineering Statistics 2013](#)). To ensure a diversity of ideas and new innovations that address the needs and challenges faced by all Americans, the STEM fields need to better reflect the changing face of our country.

Improving STEM education and increasing access to it benefits all students, regardless of whether or not they pursue STEM careers. Many skills necessary for the STEM fields, such as making observations, logical thinking, curiosity, and working in teams, are transferrable to a multitude of fields and careers. Several studies and reports have shown the shortcomings of

science education and scientific literacy in the U.S. ([Griffith and Scharmann 2008](#); [National Research Council 2009](#); [Impey et al. 2011](#); [Rudolph 2014](#)), yet it is increasingly important that individuals possess a basic understanding of science. Through more widespread access to higher quality STEM education, students will be better equipped to weigh in on scientific policy questions, make better personal finance and health decisions, and confront the various environmental problems we face.

Scope & Methods

The purpose of this webliography is to provide an overview of STEM education in the U.S. It provides easy access to research and best practices in the field, as well as specific programs, activities, and lesson plans that formal and informal educators can implement. The webliography also includes links to advocacy programs and resources for promoting STEM education and increased diversity in STEM fields.

Resources were identified for this webliography based on the author's previous work as a librarian and educator in a natural history museum and her research in STEM and environmental education. Many of these web resources contain extensive databases and/or bibliographies, which led to the identification of additional resources to include here. Resources for this webliography were selected based on their currency and ability to provide a broad overview of the many facets of STEM education. In addition, only web sites with resources available for free, such as lesson plans, toolkits, and reports, were included. The webliography does not represent an exhaustive list of all of the available STEM-related resources or organizations in the U.S.

The first two sections of the webliography provide an overview of the current landscape of STEM education in both formal and informal educational environments. Formal educational environments are K-12 schools, colleges, and universities. Informal educational settings include anything that falls outside of the realm of in-school time, such as museums, libraries, nature centers, camps, scout programs, and afterschool programs. These resources highlight some of the challenges facing STEM education, its various benefits, potential avenues of collaboration to make STEM education more effective, and current research in STEM education. A third section highlights research on diversity in STEM, including organizations working to promote greater representation of women and minorities in STEM fields. The final section focuses on tools, such as hands-on activities, formal lesson plans, and assessment methods, that can be used to develop, deliver, and evaluate STEM educational programs.

Audience

The intended audience for this webliography is quite broad. Both formal and informal educators can use it to find lesson plans, activities, assessment tools, and professional development opportunities. Undergraduate and graduate students can access the resources for their own research and teacher preparation. Academic, school and public librarians can use it to assist in planning their own outreach programs, as well as when working with patrons. It also will be of interest to parents and other members of the general public interested in expanding the reach and impact of STEM education.

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Resources

Formal Education

General

National Research Council. 2014. Exploring opportunities for STEM teacher leadership: Summary of a convocation. Washington, DC: The National Academies Press.

<http://www.nap.edu/catalog/18984/exploring-opportunities-for-stem-teacher-leadership-summary-of-a-convocation>

In response to the lack of classroom teachers' direct involvement in STEM education policy, the National Research Council held a convocation that brought together representatives, including classroom teachers, from a wide-range of both public- and private-sector organizations. This report summarizes the themes that emerged in the presentations and break-out discussions at the event, which included the benefits of incorporating teachers' voices in policy, models for engaging teachers in decision-making, professional development for STEM teacher leaders, and fostering teacher researchers. Rather than being prescriptive, this report provides food for thought for STEM teachers, educational administrators, and policy makers.

National Research Council. 2013. Educating engineers: Preparing 21st century leaders in the context of new modes of learning. Washington, DC: The National Academies Press.

<http://www.nap.edu/catalog/18254/educating-engineers-preparing-21st-century-leaders-in-the-context-of-new-modes-of-learning>

This report summarizes a forum held at the National Academy of Engineering's 2012 meeting. The first half focuses on highlights from presentations given by the six speakers at the forum -- leaders in academia, industry, and online learning. Taken together they present a vision for the future of engineering education, stressing the importance of hands-on, interdisciplinary, technology-enhanced, project-based, and creativity-driven education. The second-half of the report focuses on specific ways to implement this new vision.

National Research Council. 2013. Preparing the next generation of earth scientists: An examination of federal education and training programs. Washington, DC: The National Academies Press.

<http://www.nap.edu/catalog/18369/preparing-the-next-generation-of-earth-scientists-an-examination-of>

With continued pressure on our mineral and water resources, as well as the fact that many people live in areas strongly affected by natural disasters, the need for earth science professionals continues to grow. To meet these challenges, it becomes imperative to have a workforce that draws on the creativity and knowledge of all citizens, including women and minorities. This study of 25 federally-funded earth science educational programs (excluding ocean, atmospheric, and space sciences) led to the development of a

framework that can be used to systematically assess these types of programs, identify potential collaborations and gaps, and ultimately leverage the findings from this work to diversify the earth sciences field.

National Research Council. 2012. Rising above the gathering storm: Developing regional innovation environments: A workshop summary. Washington, DC: The National Academies Press.

<http://www.nap.edu/catalog/13391/rising-above-the-gathering-storm-developing-regional-innovation-environments-a>

Dire warnings about the U.S. losing its global edge as a leader in scientific and technological innovation first appeared in a 2005 National Research Council report, *Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future*. It outlined key recommendations that need to be implemented to turn the tide. A follow-up report five years later painted a picture of further decline, rather than improvement. The federal government, however, is not the only entity that can make a difference. This report provides a summary of a workshop in 2012 that brought together leaders from the education, business, and local government sectors to examine the role states and regional centers can play in STEM education. They focused on four main approaches to reassert the U.S.'s leadership in science, technology and innovation, which are highlighted in chapters 2-5 of the report. The final chapter outlines overall observations from the workshop and recommendations for future steps.

Science & Engineering Indicators, National Science Foundation

<http://www.nsf.gov/statistics/seind/#tabs-1>

This biennial report, last published in 2014, contains a wide range of quantitative data on the science and engineering environment in the U.S. in areas such as formal education, academic research, and public understanding of science. Data is available going back to 1993 and is presented in a variety of formats, including tables, graphs, and presentation slides. More recent reports include tools that allow readers to analyze the data and create their own customized maps, graphs and tables. The publication is policy neutral, but each report includes narrative chapters that summarize the data and provide contextual background related to the data.

STEMconnector

<http://www.stemconnector.org/>

STEMconnector is a coalition of industry, non-profit organizations, professional societies, and governmental agencies that work in the area of STEM education. The web site contains a STEM directory of over 3,700 organizations, state STEM profiles that highlight key initiatives and possible partner organizations in each state, and *STEMdaily*, a newsletter that aggregates STEM-related news. The web site also highlights *STEMconnector's* various projects and ways to get involved. These include Town Hall Conference Calls, the STEM Higher Education Council, the STEM Food & Ag Council, and the STEM Innovation Task Force.

STEM Education Coalition

<http://www.stemedcoalition.org/>

The *STEM Education Coalition* brings together more than 500 professional societies, businesses, and educational organizations that work "to raise awareness in Congress, the Administration, and other organizations about the critical role that STEM education plays in enabling the U.S. to remain the economic and technological leader of the global marketplace of the 21st century." Their web site includes an outline of their policy principles and recommendations, an overview of their advocacy work in the U.S. Congress, fact sheets on STEM education, and reports on the work of STEM education panels and commissions.

STEMx

<http://www.stemx.us/>

STEMx is a grass-roots network that connects state-level STEM networks. *STEMx* provides a platform to share best practices, scale-up local projects, evaluate programs, and drive policy. In addition to links to specific resources, the web site includes a "News" section focused on new research, emerging trends, and events related to STEM education.

Higher Education

National Research Council. 2014. Undergraduate chemistry education: A workshop summary. Washington, DC: The National Academies Press.

<http://www.nap.edu/catalog/18555/undergraduate-chemistry-education-a-workshop-summary>

Undergraduate chemistry education has witnessed many changes over the past few years, and likely will face further reform with upcoming modifications to the Medical College Admission Test (MCAT). This document reports on a workshop held in 2013 that focused on examining the current state of undergraduate chemistry education. Various speakers from academia and industry presented on the main themes of the workshop: drivers of change to undergraduate chemistry curricula, examples of innovative teaching practices, methods for assessing the effectiveness of these new teaching approaches, and the barriers to implementing these changes. Many best practices emerged that can be transferred to other institutions.

National Research Council. 2013. Adapting to a changing world: Challenges and opportunities in undergraduate physics education. Washington, DC: The National Academies Press.

<http://www.nap.edu/catalog/18312/adapting-to-a-changing-world--challenges-and-opportunities-in-undergraduate-physics-education>

The Committee on Undergraduate Physics Education Research (part of the National Research Council's Board on Physics and Astronomy) drafted this report based on their thorough examination of the current state of undergraduate physics education. They found that many challenges exist, including "systemic challenges" that need to be resolved, while at the same time, there have been innovations in the field. There is a strong foundation in physics education research, but wider dissemination of best practices is still needed. The report includes a discussion of specific recommendations for the various stakeholders required to play an active and collaborative role to support effective and sustainable undergraduate physics education.

National Research Council. 2013. The mathematical sciences in 2025. Washington, DC: The National Academies Press.

<http://www.nap.edu/catalog/15269/the-mathematical-sciences-in-2025>

This document represents the results of a study commissioned by the Division of Mathematical Sciences of the National Science Foundation -- the first comprehensive strategic study of the field since the late 1990s. The research, which focused on the many advances that have been made in mathematical sciences over the past few decades, was conducted by a committee consisting of a diverse mix of individuals from both the mathematical sciences and related disciplines. Most of these advances have been in the areas of computer simulation and working with big data. Their impacts have influenced many fields, not just the mathematical sciences, as well as affecting the everyday lives of the general public. The authors map out specific recommendations for steps that should be implemented by 2025, including undergraduate curricular reforms, greater financial and institutional support for collaborative and interdisciplinary research, and raising

awareness about what mathematicians actually do in the hopes of attracting a broader representation of the general population to the field.

National Research Council. 2012. Challenges in chemistry graduate education: A workshop summary. Washington, DC: The National Academies Press.
<http://www.nap.edu/catalog/13407/challenges-in-chemistry-graduate-education-a-workshop-summary>

Many graduate students in chemistry programs face an increasingly uncertain future. Budget constraints on the majority of public universities have meant fewer new faculty hires. Federal funding for research is down, and pharmaceutical companies, once the bastion of employment for chemists, have reduced their research departments. In response to these challenges, the National Academies' Board on Chemical Sciences and Technology held a workshop to begin a conversation to explore the current state of chemistry graduate education and how it might need to evolve given new funding models and changing skill sets necessary for the future job market, where chemists might be taking on new and different roles, particularly in the areas of energy and sustainability. The report does not make any specific conclusions or recommendations, but it can act as a springboard for new directions and innovations in chemistry graduate programs across the country.

National Research Council. 2012. Community colleges in the evolving STEM education landscape: Summary of a summit. Washington, DC: The National Academies Press.
<http://www.nap.edu/catalog/13399/community-colleges-in-the-evolving-stem-education-landscape-summary-of>

Community colleges play an increasingly important role in the development of the STEM workforce in the U.S., yet they are often overlooked in STEM policy discussions and initiatives. This report summarizes the presentations and discussions that took place at a one-day summit focused on community college and STEM education. Bringing together educators, policymakers, businesspeople, researchers, and community college students, participants focused on possible collaborations between community colleges and universities, ways to increase the participation of women and minorities in STEM fields, how to stave off attrition of students pursuing STEM degrees, and transfer issues for community college students moving to four-year institutions.

National Research Council. 2012. Infusing real world experiences into engineering education. Washington, DC: The National Academies Press.
<http://www.nap.edu/catalog/18184/infusing-real-world-experiences-into-engineering-education>

This publication highlights 29 model engineering education programs at universities and colleges across the U.S. All of the projects have successfully incorporated real world experiences into their programs, thereby fostering future engineers that have the necessary skills to thrive in an increasingly globalized workforce. The diverse programs are grouped by the following categories: capstone, course/curricular, co-op, extracurricular, first-year, global, and service learning. The report contains extensive descriptions of each program so that engineering departments and faculty members across the country can easily adapt and implement them in their own institutions. Prior to the program descriptions, a discussion of some of the challenges associated with adopting these types of programs, as well as ways to overcome those obstacles, is also included.

K-12

Kaczmarczyk, L. & Dopplick, R. 2014. Rebooting the pathway to success: Preparing students for computing workforce needs in the United States. New York: Association for Computing

Machinery.

<http://pathways.acm.org/>

Based on a 2013 study conducted by the Association for Computing Machinery's Education Policy Committee, this report represents a call to action for each state to develop plans to ensure that K-12 programs equip students with the necessary skills and knowledge to pursue degrees in computer science and enter the ever-expanding computer science workforce. It outlines the current state of K-12 computer science education and provides examples of exemplary initiatives that could be adapted and replicated elsewhere to achieve the 10 specific recommendations put forth in the report. An appendix includes state-level data on the computer science employment outlook, the number of post-secondary degrees in computer science awarded, and the overall computer and technology landscape in each state.

National Research Council. 2014. Literacy for science: Exploring the intersection of the next generation science standards and common core for ELA standards: A workshop summary. Washington, DC: The National Academies Press.

<http://www.nap.edu/catalog/18803/literacy-for-science-exploring-the-intersection-of-the-next-generation>

This report outlines the presentations and discussion undertaken at a two-day workshop convened by the National Research Council's Board on Science Education in 2013. The new common educational standards, including the Common Core State Standards for English Language Arts (CCSS for ELA) and the Next Generation Science Standards (NGSS), hold the promise of improving K-12 student learning outcomes across the country. Although, CCSS for ELA and NGSS were developed separately, commonalities exist between the two that could be utilized to strengthen the implementation of both standards for the benefit of both teachers and students. Through presentations and discussions, this workshop brought together educational researchers and classroom teachers to explore ways the two sets of standards can work in concert, demonstrate concrete examples of how this can be done, determine the professional development needs of teachers to implement these curricular changes, and examine the role of institutional and district leaders in supporting this process.

National Research Council. 2014. STEM integration in K-12 education: Status, prospects, and an agenda for research. Washington, DC: The National Academies Press.

<http://www.nap.edu/catalog/18612/stem-integration-in-k-12-education-status-prospects-and-an>

Many of the STEM education initiatives and research of the last few decades have focused on each of the disciplines in isolation. This report is the result of a two-year study conducted by the national Committee on Integrated STEM Education, which examined the current state of integrated K-12 STEM education both nationally and internationally and across all types of educational settings. By examining current approaches, as well as the benefits, challenges, and potential opportunities of integrated STEM education, the committee developed a research agenda to advance this area of STEM education, with specific recommendations for various stakeholders. This report will be of interest not only to educational researchers, but also to educators, school administrators, and policy makers.

National Research Council. 2012. A Framework for K-12 science education: Practices, crosscutting concepts, and core ideas. Washington, DC: The National Academies Press.

<http://www.nap.edu/catalog/13165/a-framework-for-k-12-science-education-practices-crosscutting-concepts>

Science literacy among the general public of the U.S. is lacking, yet science and technology play an integral part of our lives. This book outlines a framework for K-12 education that ensures that all students, regardless of whether or not they go into a career in a STEM field, possess the necessary skills and knowledge to be able to participate as

active citizens in policy and decision-making related to the various science issues we face today, including environmental and health-related topics. The framework focuses on three main dimensions: crosscutting concepts, disciplinary core ideas, and scientific and engineering practices. It is not prescriptive, but rather meant to be a guide for educators, administrators, and policy-makers to draft national science standards, develop curricular, instructional and assessment tools, and direct professional development activities. Appendices include feedback given on a draft document of the framework and a bibliography of sources used in devising the framework, including those that were not directly cited in this book.

National Research Council. 2011. Successful K-12 STEM education: identifying effective approaches in science, technology, engineering, and mathematics. Washington, DC: The National Academies Press.

<http://www.nap.edu/catalog/13158/successful-k-12-stem-education-identifying-effective-approaches-in-science>

This brief report represents the work of the Committee on Highly Successful Schools or Programs for K-12 STEM Education, which falls under the National Research Council's Board on Science Education. The committee conducted a review of current research on measuring the effectiveness of K-12 STEM education. Focusing only on science and math, the subjects most widely taught in K-12 schools, the document proposes three main criteria for identifying highly successful STEM schools and programs, while recognizing the challenges associated with applying each of these criteria and highlighting gaps in the research. Based on their review of the K-12 STEM education landscape, they provide recommendations for schools, districts, and policy makers to improve and foster quality STEM education for all students. The original intent of this report was to guide the presentations and discussions in a workshop convened by the committee, but it also stands on its own as a resource for teachers, principals, curriculum developers, and decision makers at all levels of government.

Successful STEM Education

<http://successfulstemeducation.org/>

The impetus for creating this web site grew out of the National Research Council's (NRC) report, *Successful K-12 STEM Education: Identifying Effective Approaches in Science, Technology, Engineering, and Mathematics* (2011), which highlighted highly successful schools and programs in STEM. Developed and maintained by the Community for Advancing Discovery Research in Education (CADRE), it contains links to this 2011 report and other NRC reports. It also includes information about past and future "STEM Smart" workshops, held across the U.S. to promote the findings of the report, foster discussion, and share best practices in STEM education. A resource directory includes recordings of these workshop presentations, STEM Smart workshop briefs, and PowerPoint slides from workshop presentations.

Preschool

Collected Papers from the SEED (STEM in Early Education and Development) Conference 2010

<http://ecrp.uiuc.edu/beyond/seed/index.html>

This two-day conference, organized by the Center for Early Education in Science, Technology, Engineering, and Mathematics (CEESTEM) at the University of Northern Iowa, was held in May 2010. It brought together leaders in early childhood and science education to explore issues in this growing field. Participants shared research and best practices in early childhood STEM education programs and professional development

programs for teachers. Based on these discussions, they devised a research agenda for the field. These collected papers represent some of the invited papers shared with attendees prior to the conference to guide discussions and help shape future goals for the field.

National Research Council. 2009. Mathematics learning in early childhood: paths toward excellence and equity. Washington, DC: The National Academies Press.

<http://www.nap.edu/catalog/12519/mathematics-learning-in-early-childhood-paths-toward-excellence-and-equity>

Widespread support for formal preschool educational experiences has grown over the last few decades because of its many benefits. Often, however, these programs focus more on language literacy rather than mathematics. This report provides a thorough literature review of research on mathematical teaching and learning in early childhood, as well as an overview of best practices. A great deal of research in this area exists, but it has not been widely disseminated or implemented. Focusing on children aged 3 to 6 years-old, the authors propose evidence-based "teaching pathways" that can serve to guide curriculum development, teaching practices, and policy directions in early childhood mathematics education. They outline a series of recommendations that include clearly delineated steps to assist with their successful implementation. Research shows that nearly all children have the capability and curiosity to develop mathematical skills from an early age, which can build a solid foundation for future academic success. This document will help both formal and informal educators, administrators, and parents guide young children on a pathway to a life-long love of math.

Natural Start Alliance

<http://naturalstart.org/>

Coordinated by the North American Association for Environmental Education (NAAEE), the *Natural Start Alliance* brings together educators, organizations, and parents that work to provide experiences with nature to preschool-aged children. The site includes research briefs in the area of early childhood environmental education, a directory of resources and professional development opportunities, and information on nature-based preschools.

STEM Sprouts--Boston Children's Museum

<http://www.bostonchildrensmuseum.org/stem-sprouts>

This web site includes a variety of STEM resources created by educators at the Boston Children's Museum. The "STEM Sprouts Teaching Guide," available in both English and Spanish, has background information and activities for early childhood educators to introduce children to the wonders of science and math. The "Parent Tip Sheets" highlight ways parents can incorporate STEM learning into everyday activities with their preschoolers. The "STEM Activities" sheets outline simple experiments families can do at home, and the "I am a Scientist" workbook allows preschoolers to explore and see themselves as a scientist.

Informal Education

Afterschool Alliance—STEM & Afterschool

<http://www.afterschoolalliance.org/STEM.cfm>

The *Afterschool Alliance* is a public and private sector collaboration that, "works to ensure that all youth have access to affordable, quality afterschool programs." The Alliance's "STEM & Afterschool" initiative includes an advocacy toolkit to make a case for afterschool STEM programs, a funding sources directory, and webinars on developing and delivering STEM afterschool programs. Research reports found on the web site highlight the positive outcomes of STEM afterschool programs: "improved

attitudes toward STEM fields and careers; increased STEM capacities and skills; and higher likelihood of graduation and pursuing a STEM career."

Children and Nature Network

<http://www.childrenandnature.org/>

The mission of this non-profit is "to connect all children, their families and communities to nature through innovative ideas, evidence-based resources and tools, broad-based collaboration and support of grassroots leadership." This global network was co-founded by Richard Louv, author of the influential book *Last Child in the Wood: Saving Our Children from Nature-Deficit Disorder*, and others who are passionate about nature-based education. The organization provides online and in-person training for teachers, civic leaders, and parents. Several free toolkits on various topics can be downloaded from the site, including starting nature clubs for families, strategies for pediatricians, and community action guides.

InformalScience.org

<http://informalscience.org/>

Maintained by the Center for Advancement of Informal Science Education (CAISE), *InformalScience.org* is a rich portal to information on informal science education projects, research, and assessment. Resources found on the web site include descriptions of all informal science education programs funded by the National Science Foundation; the Informal Science Education (ISE) Wiki, which provides "easy to read summaries of evidence that characterizes the benefits and outcomes of ISE experiences"; and evaluation tools for various types of learning environments.

National Research Council. 2014. STEM learning is everywhere: Summary of a convocation on building learning systems. Washington, DC: The National Academies Press.

<http://www.nap.edu/catalog/18818/stem-learning-is-everywhere-summary-of-a-convocation-on-building>

Many STEM educational initiatives focus on strategies for the formal school system, but over their academic careers, students actually spend a larger amount of time outside of rather than in school. This document summarizes the presentations, discussions, and reports from break-out groups at a meeting convened in February 2014 to explore ways to seamlessly align STEM learning for elementary and middle school students across all types of learning environments—schools, libraries, museums, camps, and at home. Sponsored by the Teacher Advisory Council of the National Research Council, in association with the California Teacher Advisory Council, over 100 representatives from both the formal and informal education sector began the process of envisioning the future of successful STEM education and devising concrete action plans to achieve that vision.

National Research Council. 2010. Surrounded by science: Learning science in informal environments. Washington, DC: The National Academies Press.

<http://www.nap.edu/catalog/12614/surrounded-by-science-learning-science-in-informal-environments>

This book builds upon the information and data gathered in a previous National Research Council publication, *Learning Science in Informal Environments: People, Places, and Pursuits* (2009). It distills the current research and best practices in informal science education that were included in the previous report and presents them in a more accessible way. Through a variety of case studies sprinkled throughout the book, the authors demonstrate ways to translate the research into practice in areas such as: exploring the connections between science and culture, using media to enrich science learning experiences, and creating linkages between informal and formal educational settings.

National Research Council. 2009. Learning science in informal environments: People, places, and pursuits. Washington, DC: The National Academies Press.

<http://www.nap.edu/catalog/12190/learning-science-in-informal-environments-people-places-and-pursuits>

This book represents the work of the National Research Council's Committee on Learning Science in Informal Environments, which included experts from a variety of fields, such as education research, museum studies, psychology, and media. The committee conducted a broad assessment of the body of research and practices in science learning, across learning environments and age groups from youth to adults, in order to gain an understanding of our current knowledge, identify the benefits of and opportunities in informal science learning, and develop a research agenda. They gathered ample evidence that informal environments can promote science learning in a variety of ways, created a "strands of science learning" framework that can serve as a resource to guide practice and future research, and outlined specific recommendations for exhibit and program designers and informal educators to help create sparks of interest for and an appreciation of science among the general public.

Relating Research to Practice

<http://relatingresearchtopractice.org/>

This web site addresses the disconnect between the growth in the informal science education field and the educational research community, much of whose work is still done in traditional classrooms. *Relating Research to Practice* contains research briefs on peer-reviewed education research published since 2009. It also includes synthesis papers on selected "hot topics," including communicating about climate change, connecting informal and formal STEM learning, and the role of culture and identity on learning. Researchers at the Center for Informal Learning and Schools (CILS) at the Exploratorium, a science center in San Francisco, oversee this project in collaboration with researchers at the Learning in Informal and Formal Environments (LIFE) Center at the University of Washington, King's College London, and the Afterschool Alliance.

Increasing Diversity in STEM

American Indian Science and Engineering Society (AISES)

<http://www.aises.org/>

The American Indian Science and Engineering Society (AISES), which includes members from over 200 tribal nations, seeks to increase the participation of American Indians and Native Alaskans in STEM fields through targeted programs for K-12 students, college students, and professionals. The web site includes a job board, information on scholarships and internships, and the current digital edition of the organization's magazine, *Winds of Change*.

Building a STEM Pipeline for Girls and Women—American Association of University Women (AAUW)

<http://www.aauw.org/what-we-do/stem-education/>

The American Association of University Women (AAUW) strives to break down barriers and shatter stereotypes that have prevented women from pursuing careers in STEM fields. Through research reports and policy recommendations, national and local STEM programs for girls, and fellowships for women seeking degrees in STEM fields, AAUW hopes to bring more female representation to the world of STEM.

Center for Minorities in Science and Engineering

<http://www.cmse.umd.edu/>

Housed at the University of Maryland, College Park's School of Engineering, the Center for Minorities in Science and Engineering, "provides academic support services and outreach programs designed to recruit, retain, and graduate African American, Hispanic American, and Native American engineering students." In addition to working with current college students, the Center also offers a variety of programs for local elementary and secondary students, including summer camps, on-campus lab visits, and science fairs.

GirlsRISEnet

<http://www.girlsrisenet.org/>

GirlsRISEnet is a network of science centers and museums working to strengthen the "professional capacity of informal science educators to engage and motivate minority girls in grades 6-12 to explore and pursue science and engineering careers." Using a train-the-trainer model, the organization offers regional workshops for informal educators and continued support through mini-grants and other resources found on its web site.

Great Minds in STEM

<http://www.greatmindsinstem.org/index.htm>

Great Minds in STEM is a national non-profit that seeks to recruit and retain Latinos in STEM fields. They coordinate targeted K-12 STEM education programs, scholarships for college students, and professional support. Both students and educators can find inspiration in the "Educator of the Week," "Scholar of the Week," and "STEM Professional of the Week" highlighted on the web site.

National Center for Women and Information Technology (NCWIT)

<http://www.ncwit.org/>

The National Center for Women and Information Technology (NCWIT) is a national non-profit that brings together representatives from universities, industry, NGOs, and government agencies to work to increase the participation of women in the information technology field. The following sub-groups of the organization lead various initiatives: Academic Alliance, Affinity Group Alliance, Entrepreneurial Alliance, K-12 Alliance, Workforce Alliance, and Social Science Advisory Board. The organization's web site features a variety of resources in both Spanish and English, including a toolkit for high school counselors, college course materials, conversation starters, and inspirational videos.

National Girls Collaborative Project (NGCP)

www.ngcproject.org

Working through regional collaboratives, the National Girls Collaborative Project (NGCP) unites organizations throughout the U.S. to increase dramatically the participation of girls in STEM fields. Specifically, NGCP seeks to "maximize access to shared resources," "strengthen capacity of existing and evolving projects," by sharing best practices and current research, and "use the leverage of a network...to create the tipping point for gender equity in STEM." The regional collaboratives implement a variety of approaches to achieve these goals, including webinars, professional development events, mini-grants, and publications.

National Research Council. 2014. *Surmounting the barriers; Ethnic diversity in engineering education: Summary of a workshop.* Washington, DC: The National Academies Press.

<http://www.nap.edu/catalog/18847/surmounting-the-barriers-ethnic-diversity-in-engineering-education-summary-of>

A plethora of studies have been conducted and initiatives implemented to increase diversity in the engineering field over the last few decades, but change remains slow to emerge. This report summarizes a workshop convened by the National Science

Foundation, the National Academy of Engineering, and the American Society for Engineering Education to confront this reality. The goals of the workshop included identifying the key impediments to increasing diversity and sharing success stories of programs that overcame these barriers and could be replicated elsewhere. Participants included educators from 2 and 4 year colleges and representatives from the sponsoring organizations. The document includes an overview of the results of a pre-workshop survey that guided the topic selections for small group discussions at the event, which are also summarized. Highlights from formal talks given by leaders in the field are also included.

National Research Council. 2011. Expanding underrepresented minority participation: America's science and technology talent at the crossroads. Washington, DC: The National Academies Press.

<http://www.nap.edu/catalog/12984/expanding-underrepresented-minority-participation-americas-science-and-technology-talent-at>

This report moves beyond the limitations of a 2005 National Research Council report, *Rising Above the Gathering Storm*, to not only address the need to grow the United States' STEM workforce, but also to specifically increase minority participation in STEM fields. It outlines areas of key importance for creating a successful STEM pipeline for minority students, provides specific recommendations and action steps for increasing minority involvement, and highlights avenues and approaches for future research.

SciGirls

<http://pbskids.org/scigirls/>

This is the accompanying web site to the PBS show *SciGirls*. Targeted at 8-12 year-olds, each episode of the program features a group of girls who undertake a scientific challenge. The web site includes video clips and full episodes, a directory of projects undertaken by girls throughout the country, and a social media section where girls can create their own profile pages and connect with others. There are also links to STEM resources for parents and educators.

Techbridge

<http://www.techbridgegirls.org/>

Techbridge started in 2000 as a program at the Chabot Science & Space Center in Oakland, CA, but has since become an independent non-profit organization. Through hands-on afterschool and summer programs, professional development opportunities for formal and informal educators, and a partnership with Girl Scout Councils across the country, *Techbridge* strives to increase interest and excitement around STEM among girls and underrepresented minorities. The web site includes links to activity ideas for families, training materials for educators, and manuals for use with Girl Scouts.

Women, Minorities, and Persons with Disabilities in Science and Engineering, 2013

<http://www.nsf.gov/statistics/wmpd/2013/>

This biennial report, prepared by the National Science Foundation (NSF), collates data from surveys conducted by NSF and other governmental and non-governmental agencies. The data provide an overview of the status of the participation of women, minorities, and people with disabilities in STEM fields by looking at undergraduate and graduate enrollment, degrees awarded, and employment. Data is available in both PDF format and Excel spreadsheets.

Tools for STEM Education

Activities/Lesson Plans

Connect a Million Minds

<http://www.connectamillionminds.com/>

In 2009, Time Warner Cable (TWC) launched *Connect a Million Minds* as a challenge for "parents, mentors and others to connect over one million students to afterschool STEM activities" to address the declining interest in STEM fields among young people. Visitors to the site can search the "Connectory" for STEM-related events in their area and watch a variety of inspirational videos, including the "STEM in Sports" series and the "It Ain't Rocket Science" web TV show. Information for non-profits that deliver informal STEM programming about applying for mini-grants and in-kind support can also be found on this web site.

Curiosity Machine

<https://www.curiositymachine.org/challenges/>

The *Curiosity Machine*, overseen by Iridescent, a science education non-profit, is an online learning portal that connects kids with volunteer mentors from various engineering fields. The web site presents a series of challenges, such as designing a skyscraper to withstand wind or building a gravity well, that kids can undertake while learning about the engineering design process. As they work through the challenges, they can take pictures or shoot video of the process and send it to a mentor for feedback. All of the challenges use easy-to-obtain and low-cost materials and take about 90 minutes to complete.

Design Squad Nation--Resources

<http://pbskids.org/designsquad/parentseducators/index.html>

Based on topics covered in PBS' successful show *Design Squad Nation*, this web site includes hands-on experiments and design challenges, video profiles of engineers, animations that explain engineering concepts, and clips from episodes of the show. Formal and informal educators and parents can use these resources to get young people excited about engineering.

DiscoverE—Cool Content & Activities

<http://www.discovere.org/our-activities>

This web site is maintained by *DiscoverE*, formerly known as The National Engineers Week Foundation, whose mission is "to sustain and grow a dynamic engineering profession through outreach, education, celebration, and volunteerism." The engineering-focused educational resources include hands-on activities, videos, field trip ideas, and games.

Howtosmile.org

<http://www.howtosmile.org/>

Howtosmile.org is a portal of science and math activities that are freely available, but are specifically geared towards informal STEM educators. Maintained by a group of museum professionals, site users can create an account to add new resources and/or add comments to existing resources; all added resources are vetted before being made visible to others.

NASA Education

www.nasa.gov/offices/education/about/

The major educational goals of NASA are: "strengthening NASA and the Nation's future workforce; attracting and retaining students in science, technology, engineering and mathematics, or STEM, disciplines; and engaging Americans in NASA's mission." NASA's web site offers a wealth of educational resources including: traditional lessons

plans, citizen science projects, free e-books, apps, web chats with NASA scientists, regional events, robotics competitions, and homework topic FAQs.

National Science Digital Library (NSDL)

<https://nsdl.org/>

The *National Science Digital Library* (NSDL) is an extensive database of STEM educational materials for all ages that can be used in both formal and informal settings. Resources include lesson plans, labs, simulations, videos, images, and assessment tools. The site has an advanced search option, and resources can be filtered by education level, subject, and resource type.

Plum Landing

<http://pbskids.org/plumlanding/educators/index.html>

Plum Landing is an online environmental science program, targeted at kids aged six to nine, developed by WBGH Boston, a public media provider. In addition to the online videos, games, and activities for kids, they also have various curriculum pathways that can be used by informal educators at afterschool centers, libraries, zoos, and camps. The activities in the curriculum pathways incorporate videos, hands-on activities, and ideas for delving more deeply into the topic. They can be used as stand-alone activities or weaved together for a multi-day program.

Sid the Science Kid—Activities

<http://www.pbs.org/parents/sid/activities/>

These easy-to-do, preschool-based science activities are found in the parents' section of the companion web site to the PBS show *Sid the Science Kid*. Each activity includes a materials list, step-by-step instructions, a video clip of the associated episode, and ideas to further extend the experience.

Smithsonian Education—Science & Technology

http://smithsonianeducation.org/educators/lesson_plans/science_technology.html

This web site provides a collection of lesson plans for grades K-12 that incorporate Smithsonian exhibits and collections, but do not require a visit to any of the museums or zoo. Topics include archaeology, space, botany, and podcasting, among others.

ZOOM—Activities from the Show

<http://pbskids.org/zoom/activities/>

From experiments that explore unusual phenomena to things you can build to places to volunteer, this companion site to the PBS show *ZOOM* has a plethora of activity ideas for 6 to 13 year-olds, which were submitted by kids from across the U.S.

Assessment

Assessing Women and Men in Engineering (AWE)

<http://www.engr.psu.edu/awe/misc/about.aspx>

Assessing Women and Men in Engineering (AWE), funded by the National Science Foundation, is a suite of assessment instruments and supporting documents that can be used to evaluate K-12 engineering-related outreach and programming in both formal and informal settings. After creating a free account, users can access ready-made surveys that focus on assessment in a variety of areas, including persistence/leaving the engineering field, engineering students' self-efficacy, and mentor/mentee programs. Tips on collecting and managing data, obtaining Institutional Review Board Approval, and ways to apply research to practice can also be found on this web site. AWE's survey tools were

created and field-tested by researchers at seven academic institutions as part of a National Science Foundation grant.

Assessment Tools in Informal Science (ATIS)

<http://pearweb.org/atis/>

Funded by the Noyce Foundation, *Assessment Tools in Informal Science* (ATIS) is a database of assessments tools, including interviews, multiple choice surveys, point scale surveys, short response, long response, and drawing exercises, which can be used to evaluate out-of-school STEM activities. Visitors can add reviews of the different tools to the database. The tools were originally reviewed and collated into this database by researchers from the Program in Education, Afterschool and Resiliency (PEAR), which is located at Mclean Hospital and Harvard Medical School. PEAR plans to continuously update the database in collaboration with researchers from 4-H.

National Research Council. 2014. Developing assessments for the next generation science standards. Washington, DC: The National Academies Press.

<http://www.nap.edu/catalog/18409/developing-assessments-for-the-next-generation-science-standards>

New assessment strategies and tools will be needed as teachers across the U.S. begin to implement the recently released Next Generation Science Standards (NGSS) and the recommendations outlined in the National Research Council report *A Framework for K-12 Science Education* (2012). Both the NGSS and the framework represent a new approach to science teaching, and this e-book offers guidelines on coordinating and undertaking assessment using a variety of strategies and at a variety of levels to ensure that the learning outcomes outlined in these new standards are being met.

National Research Council. 2013. Monitoring progress toward successful K-12 STEM education: A nation advancing? Washington, DC: The National Academies Press.

<http://www.nap.edu/catalog/13509/monitoring-progress-toward-successful-k-12-stem-education-a-nation>

This document builds on the work of a 2011 National Research Council report, *Successful K-12 STEM Education*. At the request of Congress and the National Science Foundation, a committee developed fourteen indicators based on the recommendations outlined in the 2011 report. These indicators provide a systematic way to assess student learning, interest, and engagement with STEM, educators' professional capacity to deliver quality STEM programs, and the effectiveness of policy and funding initiatives at a national level. The report discusses approaches to research and data gathering necessary to implement the proposed monitoring and progress system, which will assist educators, administrators, and policy makers in making informed decisions about the future of K-12 STEM education.

Professional Development for Classroom Teachers/Informal Educators

American Museum of Natural History (AMNH) Coursera Courses for Educators

<https://www.coursera.org/amnh>

Museum educators and curators at the American Museum of Natural History (AMNH) have created three massively open online courses (MOOCs) for K-12 educators. These four-week courses, "Genetics and Society," "The Dynamic Earth," and "Evolution," draw upon AMNH's rich collections and field sites around the world where AMNH researchers work. They introduce educators to the latest research in each of these fields and inspire them to share the wonders of the natural world with their students.

California Academy of Sciences iTunes U Courses

<http://www.calacademy.org/educators/itunes-u-courses-for-educators>

These three online courses, "Biodiversity," "Earthquake," and "How Science Works," allow middle and high school teachers to increase their content knowledge, while also gaining access to videos, worksheets, and activities they can use in their classrooms. The courses were developed by the California Academy of Sciences, a natural history museum, aquarium, and planetarium in San Francisco, in partnership with KQED, a public television station in Northern California, and the University of California Museum of Paleontology.

Click2Science

<http://www.click2sciencepd.org/>

Developed by the University of Nebraska, Lincoln, with support from the Noyce Foundation, *Click2Science* is a free online STEM professional development portal for all types of staff and volunteers that work in informal educational programs or centers. All of their training materials emphasize skills rather than content and focus on three main areas: "planning STEM learning experiences, interacting with youth doing STEM, and building STEM skills." Materials include a mixture of videos and step-by-step instructions for in-person training and guided meetings. The web site also includes community of practice features, such as discussion boards, a blog, and an "Ask a Scientist" service.

You for Youth

<https://www.y4y.ed.gov/>

Developed by the U.S. Department of Education, *You for Youth* is an online professional development web site for staff that work in afterschool centers and programs. It is designed for any type of afterschool program, but has specific training and resources focused on STEM learning. The web site includes ready-to-go materials for staff training, webinars, tools for designing, implementing and assessing STEM programs, and program spotlights where users can share projects and programs they have led.

ZOOMsci Training

<http://www.pbs.org/parents/zoom/scitraining/>

The interactive, online training tools found on this web site will convince you that anyone who wants to can lead science activities with kids aged 8–11 years old. With demonstration videos, tip sheets, an activity planner guide, and loads of activity ideas, this web site, developed in conjunction with the PBS show *ZOOM*, will get both adults and kids excited about science.

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