Education Development Center

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Supporting Future Scientists

An Annotated Bibliography of Elementary Science Resources

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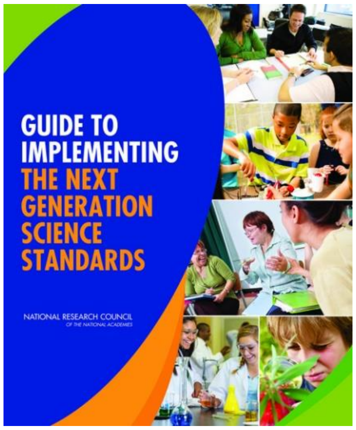
About This Bibliography

The Coalition for Elementary Science at EDC compiled this annotated bibliography of resources on elementary science education for our members and the public. This is not an exhaustive list, but a "starter set" that includes key research reports, practice briefs, policy papers, and a variety of other tools and materials to inform efforts to strengthen elementary science in schools and communities. We encourage readers to seek out new and useful materials and send them to us so we can expand this bibliography.

Reports from the National Academies of Science

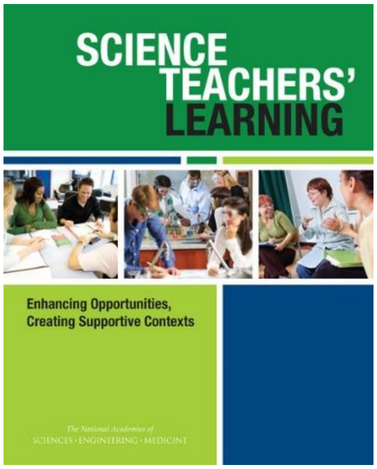
The eight landmark reports below present syntheses of research and expert opinion on a variety of topics specific to elementary science education and/or science education in general. They are downloadable at no cost from the National Academies of Science.

National Research Council. 2015. *Guide to Implementing the Next Generation Science Standards*. Washington, DC: The National Academies of Sciences. **https://go.edc.org/NRC2015**



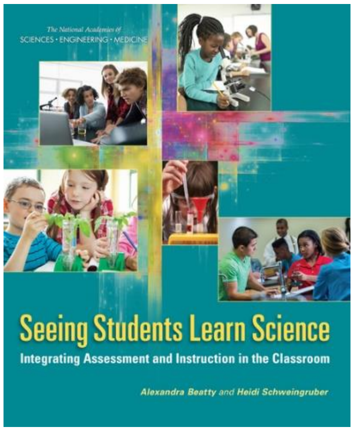
- Provides guiding principles to inform school and district leaders' planning and implementation process
- Offers guidance with regard to supporting changes in curriculum, instruction, professional learning, policies, and assessment that will align with new standards
- Suggests strategies for addressing anticipated challenges

National Academies of Sciences, Engineering, and Medicine. 2015. *Science Teachers' Learning: Enhancing Opportunities, Creating Supportive Contexts*. Washington, DC: The National Academies Press. **https://go.edc.org/NAS2015**



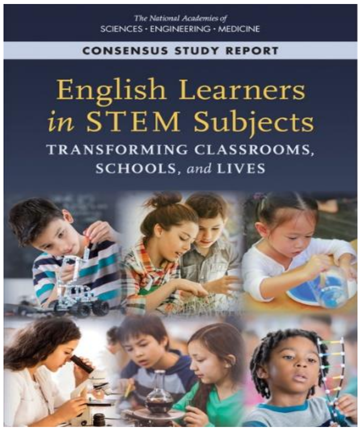
- Provides specific recommendations for supporting teachers' learning as they adapt their instruction to align with the new science standards
- Offers guidance on developing effective professional development programs for schools and districts
- Considers policy approaches that will support teachers' ongoing learning and instructional change

National Academies of Sciences, Engineering, and Medicine. 2017. *Seeing Students Learn Science: Integrating Assessment and Instruction in the Classroom*. Washington, DC: The National Academies Press. **https://go.edc.org/NAS2017**



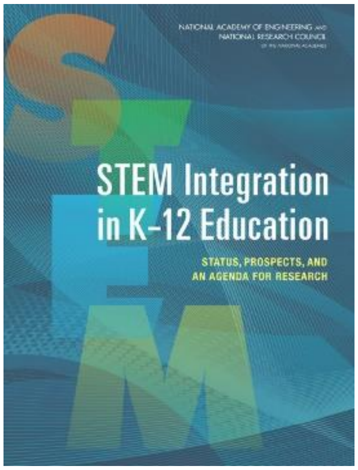
- Strengthens educators' understanding of how students learn science to help them more effectively adapt their instruction
- Provides guidance on developing new approaches to assessing student learning that will support learning and teaching new standards
- Provides examples of new assessment formats and formative assessment strategies, and offers suggestions for making use of assessment information to shape instruction

National Academies of Sciences, Engineering, and Medicine. 2018. *English Learners in STEM Subjects: Transforming Classrooms, Schools, and Lives.* Washington, DC: The National Academies Press. https://go.edc.org/NAS2018



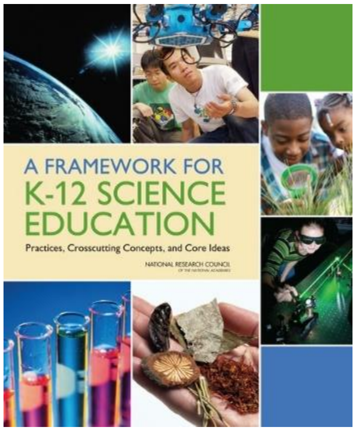
- Presents what is known about English learners and learning, teaching, and assessing STEM subjects.
- Pays particular attention to the complexities of language in mathematics and science, as well as the diversity of English learners' capacities and needs
- Offers strategies for strengthening learning outcomes for English learners

National Academy of Engineering and National Research Council. 2014. *STEM Integration in K-12 Education: Status, Prospects, and an Agenda for Research*. Washington, DC: The National Academies Press. https://go.edc.org/NAENRC2014



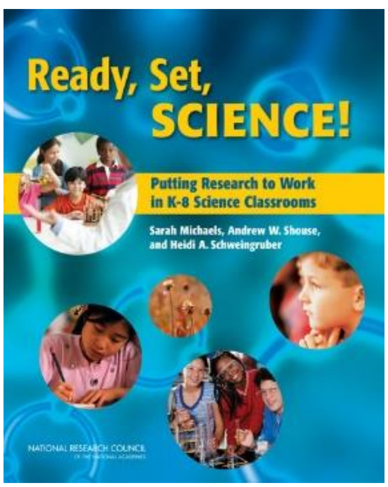
- Describes existing approaches to integrating learning and teaching across STEM disciplines
- Presents evidence of the impact of integrating STEM disciplines on a variety of student outcomes
- Offers recommendations for designing and documenting effective integrated STEM learning and teaching efforts
- Offers a common structure and vocabulary to use to consider and discuss integration of STEM disciplines in general and in relation to specific strategies and initiatives

National Research Council. 2012. *A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas*. Washington, DC: The National Academies Press. https://go.edc.org/NRC2012



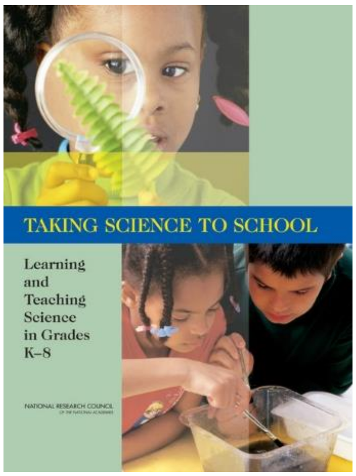
- Outlines a broad set of expectations for students in science and engineering in grades K–12
- Informs the development of new standards for K–12 science education and, subsequently, revisions to curriculum, instruction, assessment, and professional development for educators
- Identifies three dimensions that convey the core ideas and practices around which K–12 science and engineering education should be built: crosscutting concepts, science and engineering practices, and disciplinary core ideas

National Research Council. 2008. Ready, Set, SCIENCE!: Putting Research to Work in K-8 Science Classrooms. Washington, DC: The National Academies Press. https://go.edc.org/NRC2008



- Presents a vast body of cutting-edge research and syntheses of research on the teaching and learning of science in Kindergarten through eighth grade
- Provides real, classroom-based case studies of instruction that embody the findings and help educators implement successful practices and approaches
- Offers examples of how teachers choose and/or create effective and motivating instructional experiences, manage classrooms, facilitate productive discussions among diverse learners, and help learners share their thinking in a variety of ways, using several different tools

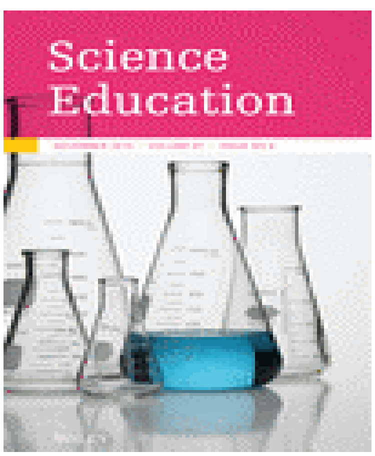
National Research Council. 2007. *Taking Science to School: Learning and Teaching Science in Grades K-8*. Washington, DC: The National Academies Press. **https://go.edc.org/NRC2007**



- Draws on a comprehensive evidence base to present what is known about learning and teaching science from Kindergarten through eighth grade
- Provides a research-based foundation on which educators can build programs for supporting the learning and teaching of science
- Brings existing research to consideration of specific questions that inform instructional approaches such as, "How can science education capitalize on children's natural curiosity?" and "What are the best tasks for books, lectures, and hands-on learning?"

Other Research of Interest

Blank, R.K. 2013. "What is the Impact of Decline in Science Instructional Time in Elementary School?" *Science Education*. **https://go.edc.org/Rolf2013**



- Spotlights the important role of elementary science
- Presents and discusses national trend data showing decline in instructional time for science
- Describes associations between time for science and science achievement scores

Tai, R. H., Liu, C., Maltese, A., & Fan, X. 2006. "Planning for Early Careers in Science." *Science*. https://go.edc.org/researchgate2006

EDUCATIONFORUM

CAREER CHOICE

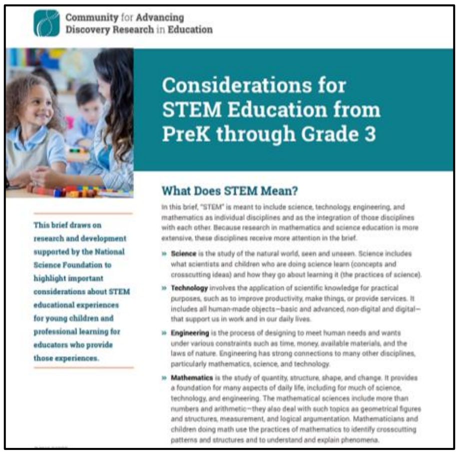
Planning Early for Careers in Science

Robert H. Tai,* Christine Di Liu, Adam V. Maltese, Xitao Fan

Young adolescents who expected to have a career in science were more likely to graduate from college with a science degree, emphasizing the importance of early encouragement.

- Presents and discusses data showing associations between career expectations and interest of eighth grade students and their subsequent career path
- Spotlights the important role that encouraging and supporting youth's interest in science in the middle grades—and even earlier in school—plays in their pursuit of science careers

Sarama, J., Clements, D., Nielsen, N., Blanton, M., Romance, N., Hoover, M., Staudt, C., Baroody, A., McWayne, C., & McCulloch, C. (2018). *Considerations for STEM Education from PreK through Grade 3.* Waltham, MA: Education Development Center. https://go.edc.org/CADRE2018



Community for Advancing Discovery Research in Education

Considerations for STEM Education from PreK through Grade 3

This brief draws on research and development supported by the National Science Foundation to highlight important considerations about STEM educational experiences for young children and professional learning for educators who provide those experiences.

What Does STEM Mean?

In this brief, "STEM" is meant to include science, technology, engineering, and mathematics as individual disciplines and as the integration of those disciplines with each other. Because research in mathematics and science education is more extensive, these disciplines receive more attention in the brief.

- **Science** is the study of the natural world, seen and unseen. Science includes what scientists and children who are doing science learn (concepts and crosscutting ideas) and how they go about learning it (the practices of science).
- **Technology** involves the application of scientific knowledge for practical purposes, such as to improve productivity, make things, or provide services. It includes all human-made objects—basic and advanced, non-digital and digital—that support us in work and in our daily lives.
- **Engineering** is the process of designing to meet human needs and wants under various constraints such as time, money, available materials, and the laws of nature. Engineering has strong connections to many other disciplines, particularly mathematics, science, and technology.
- **Mathematics** is the study of quantity, structure, shape, and change. It provides a foundation for many aspects of daily life, including for much of science, technology, and engineering. The mathematical sciences include more than numbers and arithmetic—they also deal with such topics as geometrical figures and structures, measurement, and logical argumentation. Mathematicians and children doing math use the practices of mathematics to identify crosscutting patterns and structures and to understand and explain phenomena.

- Synthesizes NSF-funded research and development work that builds understanding of STEM learning for young children and professional learning for STEM educators
- Summarizes the many benefits of STEM learning for young children and describes necessary supports for early educators

Position Papers from the National Science Teaching Association

Elementary Science Education, 2018 https://go.edc.org/ESE2018

- Offers four key principles to guide effective science learning in the elementary grades
- Recommends supports for elementary science educators, including professional development
- Includes recommendations for policy makers, administrators, and curriculum specialists

Safety in Elementary Science, n.d. https://go.edc.org/SES-ND

- Makes the case for inquiry science as a key component of core elementary curriculum
- Provides guidance to ensure safety of elementary school science learning experiences
- Covers topics such as working safely with chemicals, physical science materials, and biological materials

Supports for Teachers and Administrators

Instructional Leadership for Science Practices, 2015 **https://go.edc.org/ILSP**

- Provides a wide range of tools designed to help leaders support teachers in enhancing science teaching and learning
- Includes supervision tools, instruction tools, and professional development tools
- Offers detailed information on instructional leadership and science practices and features sample lessons

Practice Briefs from the STEM Teaching Tools Initiative, 2015 **https://go.edc.org/STEM2015**

- The STEM Teaching Tools Initiative creates and provides tools to support STEM teaching
- Tools are developed to meet teachers' needs/interests
- Tools are authored and reviewed by teachers and researchers to inform how best to teach STEM subjects

Hill, L., Baker, A., Schrauben, M., Petersen, A., McCulloch, A., Renfrew, K., Winegarner, M., Zembal-Sul, C., & Cannon, M. 2019. *What does subject matter integration look like in elementary instruction? Including science is key!* **https://go.edc.org/Brief62**

Practice Brief 62 -- Topics: Instruction Equity Practices Implementation

What does subject matter integration look like in elementary instruction? Including science is key!

TWEET SAVE PDF EMAIL FEEDBACK -BACKGROUND

What is the Issue?

We do not live in disciplinary silos so why do we ask children to learn in that manner? All science learning is a cultural accomplishment and can provide the relevance or phenomena that connects to student interests and identities. This often intersects with multiple content areas. Young children are naturally curious and come to school ready to learn science. Leading with science leverages students' natural curiosity and builds strong knowledge-bases in other content areas. Science has taken a backseat to ELA and mathematics for more than twenty years. Integration among the content areas assures that science is given priority in the elementary educational experience.

Why It Matters To You

- **Educators** at all levels should be aware of educational standards across subjects and be able to make meaningful connections across the content disciplines in their teaching.
- **District staff & PD Providers** should consider how to provide professional development that allows teachers to experience exemplars and facilitate the design of integrated lessons.
- **School leaders** should support teachers in integrated teaching by

- Explores how science leverages students' natural curiosity
- Describes how science learning helps students build a strong knowledge base in other content areas
- Provides questions, points to consider, and actions that educators and leaders can take

Cafarella, J., McCulloch, A., & Bell, P. 2017. *Why do we need to teach science in elementary school?* **https://go.edc.org/Brief43**

Practice Brief 43 -- Topics: Background Implementation

Why Do We Need to Teach Science in Elementary School?

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What Is The Issue?

Our future depends on a public that can use science for personal decision-making and to participate in civic, political, and cultural discussions related to science. Though we have national goals for science education, science is often pushed to the side—particularly at the elementary school level. There are multiple reasons for science to be a core part of elementary school learning. It can support: (a) development of a knowledgeable citizenry, (b) meaningful learning of language and mathematics, (c) wonderment about how the natural world works, and (d) preparation for STEM-related careers.

Authors:

Why It Matters To You

- **Teachers** should support extended 3D investigations in elementary education for all students (e.g., by not allowing students to be pulled out during science). Keep images of science broad.
- **District Staff & PD Providers** should support elementary teachers in teaching science and school-building administrators in supporting science instruction.
- **School Leaders** should resource and support teams of elementary teachers by giving them ample time and materials to teach science.

- Discusses specific reasons why science should be a core part of elementary school learning including the need to foster scientific literacy
- Provides reflection questions and key considerations in ensuring equity in science education
- Spotlights the importance of "3D science investigations," starting in preschool and continuing onward

Bell, P. 2015. *What school building administrators should know about the new vision for K-12 science education.* https://go.edc.org/Brief21


Practice Brief 21 – Topics: Implementation Background

What school building administrators should know about the new vision for K-12 science education

TWEET SAVE PDF EMAIL FEEDBACK -BACKGROUND

What Is The Issue?

The new vision for K-12 science education described in the NRC Framework for K-12 Science Education and the Next Generation Science Standards (NGSS) is ambitious and exciting. It holds significant promise to support greater educational equity and learning in STEM. But given its new areas of emphasis for teaching and learning, it will be challenging to implement. Implementation should be done systematically and incrementally across several years. School building leaders play unique roles in resourcing and supporting teachers as they work to realize this new vision.

Authors:

Why It Matters To You

- **Teachers** should work with their peers and their administration to help develop a shared understanding of the new vision for science education.
- **District Staff & PD Providers** should help principals provide leadership in support of the new vision and see how to coordinate with other initiatives.
- **School Leaders** should learn how to recognize and support science and engineering learning

- Discusses ways that school building leaders can play unique roles in resourcing and supporting teachers as they strive to realize the new standards' vision for science learning
- Shares actions leaders can take related to messaging, building-level coherence, resourcing, and observations to support teachers in providing "3D science investigations"
- Provides useful reflection questions for leaders

Policy Papers

Atchison, B., Dounay Zinth, J., & Weyer, M. 2020. *Enhancing STEM in P-3 Education*. Education Commission of the States. https://go.edc.org/STEM-P3-2020


POLICY GUIDE

JAN 2020

Enhancing STEM in P-3 Education

Jennifer Zinth, Matt Weyer and Bruce Atchison

Until more recently, states often introduced programs supporting science, technology, engineering and math in the secondary grades. Yet the evidence of STEM's positive impact on young children's development makes a compelling case for engaging learners in pre-K through third grade in consistent, authentic and high-quality STEM experiences.

High-quality P-3 STEM learning need not — and should not — be viewed as an add-on to an already crowded set of learning objectives. Instead, states can integrate early STEM opportunities to advance developmentally appropriate practice and young learners' growth in literacy and numeracy, executive function and 21st century skills:

- **Developmentally appropriate practice.** Research suggests that hands-on, play-based and inquiry-based experiences — all cornerstones of developmentally appropriate practice in P-3 learning environments — are a natural component of high-quality early STEM experiences, which build upon children's innate curiosity about the world around them.

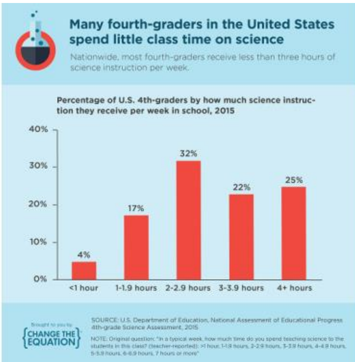
Young learners (even before preschool) are curious, experimental and engage in a variety of STEM-related activities (e.g., testing hypotheses).

Early STEM education provides the opportunity for P-3 students to engage in developmentally appropriate and authentic learning opportunities.

State policymakers have several policy options to consider in developing early STEM opportunities in their states.

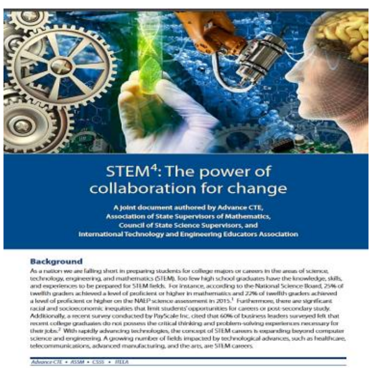
- Informed by experts in early education and STEM fields
- Identifies policies and actions states can adopt to bring STEM opportunities to Pre-K through third grade
- Provides extensive recommendations focused on equity, state and regional coordination, educator preparation and professional learning, curriculum, instruction, and assessment

Will Elementary Science Remain the Forgotten Stepchild of School Reform? Education Commission of the States, 2018. https://go.edc.org/ScienceStepchild



- Provides a detailed historical summary of the decline of elementary science, with explanations of the causes
- Underscores the role states can play in adopting policies to encourage more robust elementary science teaching
- Offers examples from two states that have elevated elementary science

STEM4: The power of collaboration for change, 2018. https://go.edc.org/STEM4-2018



- Authored by the nation's STEM education leadership groups: Advance CTE, the Association of State Supervisors of Mathematics, the Council of State Science Supervisors, and the International Technology and Engineering Educators Association
- Offers a strategy for improving and advancing learning across all STEM disciplines for all students

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