January 31, 2018

Dear Friends and Colleagues,

Educational programs in science, technology, engineering and math (STEM) — when coupled with literacy, reading, and comprehension skills — are critical to helping our children thrive in our 21st century workforce. Yet we know that many low-income, at-risk, and underserved youth struggle with access to learning resources that can help them gain those skills and attain academic and economic success.

Our agencies, STEM Next and The Molina Foundation, have extensive experience working with early childhood centers, after-school programs and K-12 campuses throughout the nation. We have seen that the strongest STEM educational programs interweave literacy-rich materials with hands-on investigation and experimentation.

But we wanted to look deeper at both the research and the current environment supporting the connections between literacy and STEM, especially in underserved and English language learner populations. We wanted to uncover findings that would help empower practitioners, educators, researchers, and policymakers with the right education tools to ensure our children are on a path for success.

And so, it's with great pride that we present — together with The Institute for Entrepreneurship in Education, the Caster Family Center for Nonprofit and Philanthropic Research at the University of San Diego and the Hoag Foundation — a report: **"The Role of Books and Reading in STEM: An Overview of the Benefits for Children and the Opportunities to Enhance the Field."**

Among the findings in the enclosed 31-page report:

- To learn STEM vocabulary, students need multiple exposures to target words and opportunities to engage in reading, writing, and speaking practice.
- There is a lack of culturally and linguistically relevant STEM books for underserved children.
- Although limited, there are strong programs, organizations, and materials that are helping bridge the gap between STEM and literacy.

On behalf of our colleagues and partners in this effort, we are pleased to draw attention to the important connections between literacy and STEM, and offer this contribution to the knowledge base that underlies the policies and practices of educators in our communities.

Ron Ottinger	*Martha Bernadett, M.D., MBA*
Executive Director	President
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The Role of Books and Reading in STEM:

An Overview of the Benefits for Children and the Opportunities to Enhance the Field

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University of San Diego
SCHOOL OF LEADERSHIP AND EDUCATION SCIENCES

Presented by:

Institute for Entrepreneurship in Education
Caster Family Center for Nonprofit and Philanthropic Research

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About STEM Next

STEM Next is a national leader in increasing opportunities in science, technology, engineering, and mathematics learning for youth across communities both in and out of school.

About the Institute for Entrepreneurship in Education

Merging research and practice, in partnership with school districts we (re)design learning to close opportunity gaps in a changing world through our Innovative Teaching & Learning and World of Work initiatives.

About the Caster Family Center for Nonprofit and Philanthropic Research

The mission of the Caster Center is to provide research, evaluation and consulting services that build the leadership and strategic and evaluative-thinking capacity of local nonprofits, as well as to be the leading source of information, data and research on the local nonprofit sector.

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TABLE OF CONTENTS

ABSTRACT

In April 2017, STEM Next, in partnership with the Hoag Foundation and the Molina Foundation, commissioned the Institute for Entrepreneurship in Education (IEE) and the Caster Family Center for Nonprofit and Philanthropic Research at the University of San Diego to provide an overview of literacy learning within the disciplinary context of Science, Technology, Engineering, and Math (STEM). This overview includes (1) a literature review on the benefits of integrating literacy and STEM for elementary and middle-school-aged children, (2) an environmental scan of reading programs, organizations, and materials that focus on Literacy in STEM, and (3) a set of criteria for identifying high-quality STEM reading materials and programs for school-aged children both in school and out of school.

Traditional narrative literature review served as the main approach to search, analyze, and summarize the body of literature on literacy in STEM. This was achieved by searching all the relevant literature on the topic using the following search engines: Educational Resources Information Center (ERIC), Scopus, and the Social Sciences Citation Index (SSCI), and by using the following search string: STEM OR science OR STEAM AND literacy OR reading OR books OR e-books OR informational text OR science text AND out of school time OR informal learning AND formal learning AND elementary AND/OR middle-school children/students. Each relevant work was then further examined to develop a synthesis that captures the benefits of integrating literacy and STEM.

The review of the literature revealed that students who experience science through a balance of reading informational text and hands-on experiences show greater gains on measures of science understanding, science vocabulary, and science writing. More research is needed to examine strategies for developing culturally relevant and contextualized STEM reading resources.

An environmental scan of existing STEM reading resources identified a wide range of providers across all three sectors (nonprofit, government, and business). The strongest STEM educational programs in both formal and informal settings incorporate literacy-rich materials with hands-on investigation and experimentation. Recommendations and a rubric for identifying high-quality STEM reading materials and programs are provided. Taken together, this report is designed to inform future charitable investments of the Molina Foundation in their efforts to support underserved children's access to STEM reading materials.

LITERATURE REVIEW STUDY ON THE BENEFITS OF READING STEM MATERIALS

Reading is enormously influential in children's development (including the affective, behavioral, cognitive, and metacognitive dimensions of learning); so much so that culturally we promote the attitude that all reading is good reading (Scammacca et. al., 2016). As science, technology, engineering, and mathematics—the STEM fields—have become increasingly prominent in many elementary and middle school classrooms as well as in out-of-school time settings, educators seek to connect children with high-quality reading materials (available in various formats, such as print books, e-books, reading apps, and other digital reading media) designed to bring STEM topics to young readers. This literature review outlines the current knowledge base on integrating literacy-rich activities into STEM learning and the implications for out-of-school time contexts.

Integrating Science and Literacy

Reading texts with STEM themes is one of the best ways for students to build literacy skills (including how to read, write, and reason with the language and text) while learning STEM content and cultivating dispositions of science (Pearson, Moje, & Greenleaf, 2010). In fact, an entire issue of *Science* in 2010 examined the synergies between inquiry science and literacy teaching and learning (see Pearson, Moje, & Greenleaf, 2010, for a review). The authors provide theoretical and empirical support for an integrated science literacy approach, advocating "science learning entails and benefits from embedded literary activities…literacy learning entails and benefits from being embedded within science inquiry." The fundamental principle of integrating science and literacy is to engage students in text-based inquiries along with hands-on science investigations (Cervetti, Pearson, Bravo, & Barber, 2006).

Children who are exposed to complex disciplinary texts have opportunities to acquire knowledge of vocabulary, background knowledge, and knowledge regarding how reading material is structured (Palincsar & Magnusson, 2001). High quality STEM reading content can support students' (a) involvement in inquiry experiences, (b) grasp of science concepts, and (c) understanding of the nature of science (Cervetti, Barber, et al., 2012; Cervetti, Bravo, et al., 2009). In sum, the science-literacy connection could be explained as "the acquisition of the knowledge, skills and dispositions of science as the end, and language and literacy as part of the array of means that can help students achieve that end" (Cervetti, Pearson, Bravo, & Barber, 2005, p.3; Pearson, Moje, & Greenleaf, 2010).

It is important to note that STEM fields contain separate content areas (i.e. science, technology, engineering, and math) and each distinct discipline's integration with literacy can vary significantly. For example, mathematics has its own language, specialized vocabulary, and domain-specific numerals, symbols, and computational procedures. Students need to learn to read these in order to develop their own algorithms and comprehend the underlying operational and mathematical concepts. Every STEM field is highly contextual and thus might require students use domain-specific thinking strategies and literacy skills to understand, express, and record their understandings (Skalinder & Satz, 2008). At the same time, there are also domain-general intellectual processes involved in the STEM-literacy interface (e.g., observing, classifying, inferring, predicting, and communicating); the very same thinking strategies are used "whether [students are] conducting science experiments or reading assigned science texts" (Padilla et al., 1991; Mayer, Otero, León, & Graesser, 2002).

Link Between Literacy Development and Success in STEM

A number of studies suggest an integrated approach to science and literacy for school-aged children both in school and out of school (e.g., Romance and Vitale, 1992; Yore, 2000; Cervetti & Barber, 2008; Varelas, Pappas, & Rife, 2006; Palincsar & Magnusson, 2001; Guthrie & Ozgungor, 2002). Using this approach, educators typically engage students in "reading text, writing notes and reports, conducting hands-on investigations, and discussing key concepts and processes to acquire inquiry skills and knowledge about science concepts" (Cervetti et al., 2012, p. 631).

One of the most significant proponents of the integrated approach to science and literacy is an NSF-funded curriculum development and research project, *Seeds of Science/Roots of Reading* (Seeds/Roots), a joint effort of the University of California, Berkeley Graduate School of Education and the Lawrence Hall of Science (LHS). Seeds/Roots seeks to advance our understanding of how reading and writing can be used as tools to support inquiry-based science learning. Seeds/Roots suggests a model in which texts can serve a number of roles that are supportive of science inquiry—before, during, and after firsthand investigations (Cervetti &

Barber, 2008). In short, “reading provides opportunities for students to revisit concepts about physical phenomena experienced directly or through models in the classroom, to view these phenomena in the wider context of the world outside of the classroom, and to learn about how these phenomena are studied by professional scientists” (Cervetti et al., 2012, p. 634).

This approach is supported by multiple empirical studies which demonstrate that students who experience science through a balance of reading informational text and hands-on experiences show greater gains on measures of science understanding, science vocabulary, and science writing compared to students who are either mostly involved in hands-on inquiry experiences or mostly reading science books (Cervetti et al., 2006; Cervetti et al., 2012). For example, in a randomized experimental study by Cervetti et al. (2012), students who were exposed to an integrated science-literacy unit on light and energy (where students engaged in reading text, writing notes and reports, and conducting firsthand investigations) made significantly greater gains on measures of science understanding, science vocabulary, and science writing compared to a group of students whose teachers taught their regular literacy instruction on a content-comparable unit using materials provided by their districts. Students in both conditions made similar gains in science reading comprehension. In the same vein, in one study, Palincsar and Magnusson (2001) constructed a fictional scientist's log that young children read and critiqued as they conducted their own investigations. This combination of deep content reading and firsthand investigations helped students improve their understanding of science concepts.

Similarly, in a longitudinal experimental study of an inquiry-based science program, 6th grade students (N=140) who participated in a reading infusion group in which they read science trade books outside of school made greater gains on science and reading assessments and received higher science grades than students (N=93) who participated in the inquiry-based program without reading infusion (Fang & Wei, 2010). The authors argue that even a modest amount of reading infusion can positively influence middle school students’ science literacy.

Another example of the integrated approach to science and literacy is the WordUp initiative that the Molina Foundation does to supplement their book distribution program, Book Buddies. Through their WordUp initiative, the Molina Foundation connects STEM concepts in pleasure-reading books to hands-on activities with parents and children. These activities range from planting actual carrot seeds that are taken home and grown to listening to the heartbeats of one another after making stethoscopes. All of the activities are tied to specific children's books (see examples of these resources at http://molinafoundation.org/programs/wordup/). The Molina Foundation reaches thousands of children and families each year[1] with activities and tips to foster health and literacy skills, helping to ensure that children are ready for kindergarten and success in school. This initiative provides materials in English and Spanish (written at a 6th-grade reading level or below) to help encourage families to continue learning at home.

Expanding the Use of Informational Texts in Reading Instruction

Recently, reading educators have shown an increased interest in anchoring early literacy instruction in informational texts (such as texts that teach about the natural or social world), as opposed to the fictional narrative texts, which have historically been dominant in the primary grades (Cervetti et al., 2012; Duke & Bennett-Armistead, 2003). Research suggests that the use

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[1] In 2016, 8,048 children participated in WordUp workshops. In addition, more than 500,000 people were reached with bilingual health and literacy activities and tips through print and social media. See 2016: Year of Amazing Growth, Annual Report http://molinafoundation.org/about-us/

of nonfiction in interactive read-alouds is beneficial in the vocabulary development of both preschool children (Marra, 2014) and students in the primary grades (Bortnem, 2008), yet juvenile fiction outsells nonfiction by more than 4 to 1 (Milliot, 2012). Existing research recognizes that exposing children to different genres expands their opportunities to learn new vocabulary, background knowledge, and the structural elements of various text types, and influences their reading motivation (RAND, 2002). Moreover, research studies suggest that students can retain more content knowledge when material is presented in an informational text format compared to when it is in a fictional narrative format (Cervetti et al., 2009).

Text Genre and Science Content

The literature review revealed several lines of evidence regarding children's ease of reading, ability to comprehend and recall, and preferences for scientific content presented in different text genres (i.e., informational text and fictional narrative text). It is now well established from a variety of studies that the story structure of a fictional narrative text may be less difficult for young children to comprehend, whereas informational text is different in language (e.g., academic vocabulary, necessity of the background knowledge) and structure (e.g., specific headings, the table of contents, photos with captions, glossaries), which can in turn impede text comprehension and content understanding (Duke & Pearson, 2002; Hoffmann, Collins, & Schickedanz, 2015). One of the greatest challenges associated with informational texts is related to the use of multiple text structures to present ideas; such texts typically require close reading with attention to detail. For example, one part of a chapter may describe Saurischia (lizard-hipped dinosaurs), while another part of a chapter might compare and contrast Saurischia with Ornithiscia (bird-hipped dinosaurs). Despite the potential difficulties, the ability to read and write informational text is one of the determining factors of academic achievement in a wide range of subjects for many students (Duke, 2000).

In one study by Cervetti and her colleagues (2009), 74 third and fourth graders were presented with the same scientific content but half the group received the content through reading a fictional narrative while the other half read an informational text. When tested after reading the material, students' accuracy, text-type preference, and reading rate were comparable across the two genres, but students who read the informational text answered more comprehension questions correctly and recalled more key concepts than those who read the fictional narrative text. Another approach proposed in the literature is called Twin Texts (where there are two books, one fiction and one nonfiction, on the same or related topic). It has been demonstrated that pairing fiction and nonfiction books on the same topic, along with interactive class strategies, can foster students understanding and enjoyment (Dreher & Kletzien, 2015; Camp, 2000; Topping, 2015).

This move towards increasing students' opportunities to read informational texts is apparent in the Common Core State Standards (CCSS). In order to foster the expansion of background knowledge, the CCSS recommend using informational texts in primary grades. According to these standards, students in fourth grade should read 50% informational texts and 50% literary texts. High school seniors are recommended to read 30% literary texts and 70% informational texts (Calkins, Ehrenworth & Lehman, 2012). The CCSS have been adopted by 42 states and primary grade teachers in those states are faced with reading standards that now, for the first time, suggest that students in grades K-3 be introduced to nonfiction reading opportunities in equal measure to fiction (National Governors Association Center for Best Practices and Council of Chief State School Officers, 2010). The first hurdle faced by these teachers is the profound lack of nonfiction reading resources at those grade levels. The second hurdle is understanding how to extract the most benefit from nonfiction reading opportunities.

Furthermore, the Next Generation Science Standards (NGSS), synergistically with the CCSS, advocate for the integration of three key dimensions of science (core ideas, practices, and crosscutting concepts) across subject areas to foster science learning for all students (more details can be found in Appendix D of the NGSS; visit https://goo.gl/WMCL9J). Such integration can foster the effective use of instructional time in English language arts, mathematics, and science, especially for students who have traditionally been underserved. Teachers who work with these groups of students often face pressure to spend instructional time developing literacy and numeracy at the expense of other subjects. Such integration enables multiple entry points to cultivate student competencies in multiple areas, including literacy skills. For example, English language learners who engage in the NGSS are expected to develop a line of argumentation from evidence, to obtain, synthesize, evaluate, and communicate information, and to build a knowledge base through content-rich texts across subject areas (Lee, Miller, & Januszyk, 2014).

Implications for Out-of-School Time

Dabney and her colleagues (2012) examined the association between exposure to out-of-school time science activities and later STEM career interest when in college. The authors found that those university students who had participated in science-related reading and science-related TV watching at least a few times a year were about 30 percent (or 1.3 times higher odds) more likely to select a STEM-related career once in college. Their study used data from the 'Persistence Research in Science and Engineering' survey (N= 6882), which employs a nationally representative sample of university students enrolled in introductory English courses.

Moje and her colleagues (2008) studied the reading practices of youth (n=209) from one urban, Midwestern high school community (predominantly comprised of Latino students) to determine adolescent preferences about what, how often, and why they read outside of school. The researchers found that reading only novels on a regular basis outside of school was shown to have a significant relationship to academic achievement as measured by school grades. However, the frequency of novel reading did not have a significant relationship to science grades or cumulative GPAs. Furthermore, most youth in this study expressed a lack of interest in science reading outside of school. The authors explain, "Youth read and write when they have a well-articulated purpose, a purpose that is usually centered in a network of social activity" (Moje et al., 2008; p. 28).

Similarly, Alexander et al. (2012) conducted a longitudinal study on the relationship between children's science interests and their opportunities for science learning (N=192; between 4 and 7 years old). Their data suggest that both reading and TV watching are more likely to inspire science-related questions from girls with science interests than from girls with no science interests. The authors also suggest, based on their data, that the children's science interests did not develop in isolation; they were supported by a family member who was able to answer domain-related questions and/or who shared a similar interest (e.g., a father interested in working with cars living with a child passionate about collecting car cards).

Factors Contributing to the Success of STEM Reading

A review of research on reading revealed several factors that influence students' knowledge, interests and attitudes about STEM, such as parental involvement, culturally and linguistically relevant resources, comprehension strategies, and multi-media presentations and representations.

Parental Influence

Parents have a large influence on their children's interests (e.g., Bergin, 2016; Crowley, Barron, Knutson, & Martin, 2015; Jacobs & Bleeker, 2004). According to Jacobs and Bleeker (2004), parents influence their children's interests by facilitating their interpretation of reality (e.g., Gunderson et al. (2012) found that parents tended to have higher mathematics expectations for boys than for girls), providing opportunities and resources, and modeling and offering explicit guidance.

Chandler (1999) found that parents directly influenced their youth's reading interests. Similarly, Alexander et al. (2012) found that parents of girls with science interests reported being significantly more interested in science themselves than parents of girls with no science interest. Parental level of education, parental support, and shared out-of-school time experiences influence student attitudes toward science (George & Kaplan, 1998). This clearly has implications for children whose parents do not have a strong educational background in science and have less access to literacy-rich science resources.

Culturally and Linguistically Relevant Science Resources

Overall, research has shown that it is important for science instruction to take into consideration prior linguistic and cultural knowledge in relation to science disciplines (Lee, 2005). However, appropriate high-quality materials that are also linguistically and culturally relevant and meet current science education standards are difficult to find (Garza et al., 2017; Ninnes, 2000). In attempting to make science education standards accessible to all students, the NGSS emphasize the importance of "funds of knowledge." According to the standards, "Funds of knowledge are culturally-based understandings and abilities that develop over time in family and neighborhood contexts, and the social and intellectual resources contained in families and communities can serve as resources for academic learning" (NGSS, 2013, Appendix D, p. 7). Teachers use cultural artifacts and community resources as well as ask questions that elicit students' funds of knowledge related to science topics. The NGSS Appendix D and its seven case studies provide examples of strategies classroom teachers can use to ensure that the NGSS are accessible to all students (for more details, visit http://www.nextgenscience.org/appendix-d-case-studies).

Empirical research on strategies for addressing the intersection between science content area learning and English language acquisition for adolescent English language learner (ELL) students is infrequent, fragmented, and inconclusive. Lee's (2005) extensive search of the literature revealed that relatively few intervention studies have been conducted on a large scale, with most studies consisting of descriptive case studies. Only a few studies were found that examined the impact of intervention programs on ELLs' achievement in both science and literacy (notable exceptions include Amaral et al., 2002 and Cleghorn, 1992; please note these studies were conducted outside of the United States context). For example, Cleghorn (1992) found that when teachers incorporate the use of local languages, science content was made more accessible to bilingual students. Another study conducted by Gonzalez-Espada et al. (2014) on the use of *¡Ciencia Boricua!* (a collection of multidisciplinary science essays written by Puerto Rican scientists to develop awareness of Puerto Rican science and scientists) among 57 elementary and middle school students showed that the contextualized activities improved the perception about science in many children, particularly boys. There are relatively few studies that examine strategies for developing culturally relevant and contextualized science education resources.

Another notable example is the research-based program funded by the Noyce Foundation that focused on the development and testing of a set of instructional approaches for ELLs in the context of the *Seeds of Science/Roots of Reading* curriculum program (see *Research and Development for Accommodation of English Language Learners*, 2010, for a review). The report puts an emphasis on competent teachers who play a vital role in helping ELL students learn science and develop academic language. For instance, one of the external evaluations was conducted (using a pre-post-test design) to examine the science-literacy integration model for Grade 5 ELL students (N=769) and general education students (N= 2,234) in the *Seeds of Science/Roots of Reading* program. The ELL students demonstrated learning gains in terms of science knowledge, vocabulary, and reading measures that were comparable to, or larger, than other subsets of students (Duesbery, Werblow, & Twyman, 2011).

Due to the increasing representation of ELL students in U. S. schools, their low academic proficiency in science content areas, and the need for more empirical research, it is critical to research strategies for concurrently facilitating the learning of science content, promoting English literacy skills, and improving students' satisfaction with science instruction.

Promising Reading Techniques

Reading researchers have studied a number of comprehension and vocabulary strategies that have been found to improve text comprehension and content understanding (e.g., Duke, 2013; Williams, Stafford, Hall, & Pollini, 2009; Zwier, 2010; Van Keer & Verhaeghe, 2005; Smith et al., 2006). Empirical studies on academic language acquisition in content areas like science suggest that students need to receive multiple exposures to target words as well as engagement through reading, writing, and speaking practice (Bowers et al., 2010; Carlisle, 2010; Scammacca et al., 2016). Students with limited academic language proficiency will not come to understand words like "structure" or "function" by memorizing definitions. Rather, it is repeated exposure to these words, and opportunities to practice using them in authentic contexts, that allows students to own these words and use them with facility to support their understanding of technical or theoretical ideas (Nagy et al., 2012).

For example, acknowledging that children need to hear and use new vocabulary in multiple contexts, Cervetti, Wright, and Hwang (2016) orchestrated a study in which fourth graders read multiple nonfiction passages on a single topic, in a purposeful and targeted fashion, in order to achieve both an understanding of domain-specific vocabulary and general knowledge of the topic. The results of this study showed that the students who read conceptually coherent text sets demonstrated more knowledge of the concepts and target words in their texts, and had better recall of the novel text in comparison with students who read unrelated texts.

Zwier (2010) suggests teaching students to identify different text structures by locating key words that alert students to the structure (e.g., the words "similar to" indicates that the author is comparing two concepts). Schneps et al. (2010) recommends a technique called Span-Limiting Tactile Reinforcement (SLTR) that can help students with reading disabilities manage attention and working memory demands when reading STEM content. SLTR facilitates close reading by reformatting the text into a single, newsprint-like column with only a few words per line (Schneps et al., 2010).

From Paper to E-Books

According to the Association of American Publishers (*Publishers Weekly*, 2012), sales of children's electronic books presented on phones, tablets, and e-readers reached 19.3 million in March 2012. This transition symbolizes the change in the "textual landscape" in which young children are growing up (Burnett, 2010).

From the pragmatic side of using electronic devices for reading, providers of school curricula and supplemental materials price their products for large purchases from school audiences, rather than for individuals and small, afterschool organizations, resulting in prices that are accessible only in bulk. The pricing strategies in this way prohibit parents from accessing materials of equal quality, thereby limiting home-school connections. However, utilizing mobile apps and app stores for the delivery of meaningful educational content restores equilibrium to this equation. Mobile apps are inexpensive and accessible to both school districts and parents alike, promoting a truly egalitarian opportunity in which to foster home-school collaboration.

On the other hand, research on preschool and kindergarten children from the perspective of cognitive science shows both positive and negative effects of e-reading practices (see a series of studies by Bus and collaborators, including De Jong & Bus, 2004; Kegel & Bus, 2012; Smeets & Bus, 2012; Verhallen, Bus, & de Jong, 2006). Technological enhancements that make the reading experience different from traditional paper books, such as interactive features like games and "hotspots," may cause cognitive overload due to task switching and/or multitasking, and eventually lead to poor performance on tests of vocabulary and story comprehension (Bus et al., 2015). On the positive side, well-designed e-readers with animated pictures and sound that are synced with the presented story's text can facilitate the integration of nonverbal information and language, thus promoting their storage in memory (Bus, Takacs, & Kegel, 2015).

Literature Review Summary

- Incorporating literacy-rich materials with hands-on investigation, instruction in reading science text, and experimentation could support students' (a) involvement in inquiry experiences, (b) grasp of science concepts, (c) awareness about how physical phenomena are studied by professional scientists, and (d) understanding of the nature of science.
    - Students who experience science through a balance of reading informational text and hands-on experiences show greater gains on measures of science understanding, science vocabulary, and science writing compared to students who are mostly involved in hands-on inquiry experiences or mostly reading science books without instruction (Cervetti et al., 2006; Cervetti et al., 2012).
- To learn STEM vocabulary, students need multiple exposures to target words and opportunities to engage in reading, writing, and speaking practice (Bowers et al., 2010; Scammacca et al., 2016). Repeated exposure to target words in informational texts, supplemented with instruction in reading science text and opportunities to practice using them in authentic contexts and hands-on investigations, enables students to own these words and use them with facility in the contexts in which they both garner and support meaning of technical or theoretical ideas (Nagy et al., 2012). This is in line with the Common Core State Standards (CCSS), which require that children from the primary grades up through high school increase the frequency with which they read informational texts.
- Students who read conceptually coherent text sets demonstrate more knowledge of the concepts and target words in their texts, and have better recall of information from the text in comparison with students who read unrelated texts (Cervetti, Wright & Hwang, 2016).
- Due to the increasing representation of ELL students in U. S. schools, their low academic proficiency in science content areas, and the need for more empirical research, it is critical to further research strategies to concurrently facilitate the learning

of science content, promote English literacy skills, and improve students' satisfaction with science instruction.

ENVIRONMENTAL SCAN

A preliminary scan of existing STEM reading resources for elementary and middle school students revealed a wide range of providers across all three sectors (nonprofit, government, and business). These providers offer programs and services that are designed to increase access to books with STEM content, integrate literacy into STEM curriculum, curate high quality fiction and nonfiction STEM texts, and research the impact of STEM education on children's learning outcomes. Several nationwide initiatives exist that aim to advance literacy in STEM (e.g., the Campaign for Grade-Level Reading and Reading is Fundamental) and some organizations, such as the STEM Education Coalition and the National Science Teachers Association (NSTA), are dedicated to advocacy and research on the subject. Multiple university-affiliated STEM initiatives for kids offer programs, curricula, and other resources, with UC Berkeley's Lawrence Hall of Science as perhaps the most prominent contributor in the field.

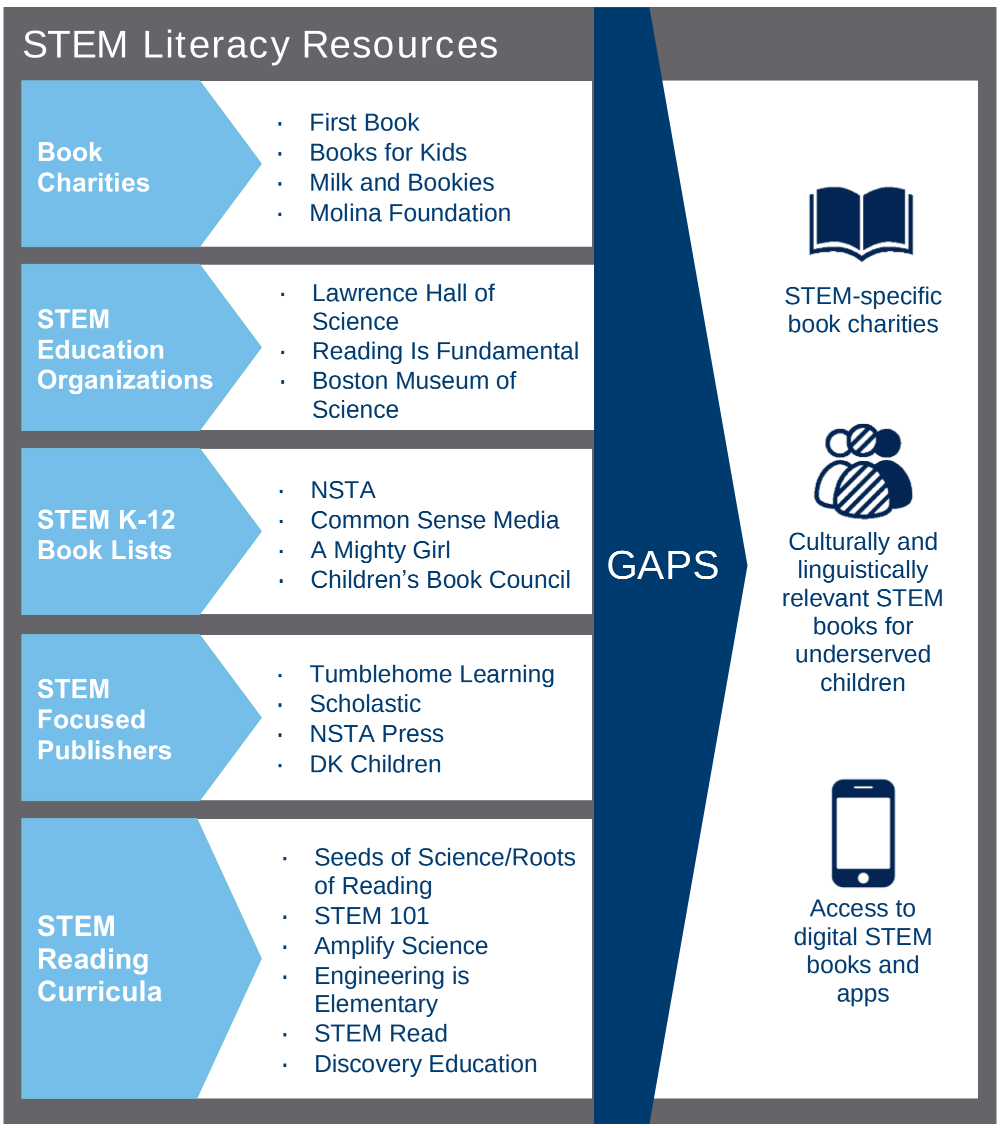
Literacy in STEM: Resources and Gaps

While there is currently a considerable amount of interest in integrating literacy into STEM education, there are still some gaps in available resources. The following bulleted list highlights the available resources and areas for growth in literacy in STEM:

- **Book Charities**: There are several nonprofit organizations dedicated to serving underrepresented populations through book donations (First Book, The Molina Foundation, Books for Kids, Milk and Bookies, etc.)
    - Area for growth: None of these organizations are STEM-specific.
- **STEM books that represent ethnic and gender diversity**: There is growth in the availability of STEM books featuring people of color and women as main characters (see book lists from A Mighty Girl for some examples - https://www.amightygirl.com/books).
    - Area for growth: There are no organizations that specifically distribute culturally and linguistically relevant STEM books to underserved communities.
- **Curated STEM Book Collections**: Both fiction and informational STEM books (in paper and digital formats) are widely available for all ages, and several organizations attempt to assess their educational value (such as the National Science Teacher's Association and the Children's Book Council's "Best STEM Books" selection, as well as numerous other lists compiled by booksellers, nonprofits, and educators).
    - Area for growth: There are far fewer digital books and reading apps accessible to underserved populations outside of the school day. Some research suggests that kids might prefer e-books to traditional books and that their built-in features, such as read-aloud narration and pop-up definitions, can support struggling readers (Jones & Brown, 2011). Other benefits include being able to store a large amount of books on digital devices, pride of ownership (especially for low-income children), or, in the case of more transient populations such as foster children, their portability.
    - Area for growth: There is an opportunity to leverage technology to develop resources that better integrate literacy with hands-on STEM learning. There are some apps (e.g., Bright Worlds) that blend science-focused texts with real world simulations through games and/or 3D exploration.

- **Literacy in STEM Curricula**: There are several organizations that have developed K-12 curricula integrating STEM and literacy. UC Berkeley's Lawrence Hall of Science curriculum, *Amplify Science*, is perhaps the most comprehensive, meeting all NGSS standards and many Common Core ELA and Math standards. It is designed to teach science through hands-on, literacy-rich activities and informational books.
  - Area for growth: The cost of most of the literacy in STEM curricula and books is too high for most afterschool settings.
  - Area for growth: There are still limited curricula available that specifically focus on teaching children how to read complex science material.

The graphic below outlines some of the most prominent literacy in STEM resources available and the main gaps (for a more complete list of literacy in STEM resources, please see the Appendices B, C, D, and E).



RECOMMENDATIONS BASED ON THE REVIEW AND SCAN

1. **Focus on distributing STEM-themed books that feature the work of people of color and/or women:** Although there has been a recent surge in the publication of STEM-themed books that feature scientists, engineers, and mathematicians who are women and people of color, there are few book charities that specifically focus on getting these books into the hands of children from underserved communities. The following lists can serve as excellent resources for selecting high-quality books for distribution:

    a. The National Science Teacher's Association and the Children's Book Council curates an annual list of the best STEM-themed books (http://www.cbcbooks.org/2017-best-stem-books/).

    b. Reading is Fundamental curates a STEM-themed multicultural book collection (http://www.rif.org/books-activities/booklists/multicultural-k-5/).

2. **Prioritize investing in educational programs that employ an integrated approach to STEM and literacy:** The strongest STEM educational programs in both formal and informal settings incorporate literacy-rich materials with hands-on investigation and experimentation. When exploring STEM programs, look for programs that include reading and/or writing opportunities. There is ample evidence that developing writing skills develops reading skills, and vice versa.

3. **Invest differently in formal school settings than you would in informal learning settings** (e.g., after-school programs, camps, museums): Formal learning environments are ideal for teaching literacy skills through the use of complex STEM-themed texts while informal learning environments are ideal for inspiring curiosity and motivation in STEM.

    a. **Formal School Setting**: The Lawrence Hall of Science's curricula (*Amplify Science* and *Seeds of Science/Roots of Reading*) are examples of research-based programs that use literacy as the vehicle for learning science.
    b. **Informal School Setting**: The Boston Museum of Science's free *Engineering is Elementary* curriculum for afterschool programs is research-based and designed with the afterschool environment in mind.

4. **Look for high-quality literacy in STEM programs that are available in a digital format:** Digital reading resources are not only cost-effective but many also contain interactive features that make them more engaging and accessible to struggling readers.

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APPENDIX A: CRITERIA FOR EVALUATING HIGH-QUALITY STEM READING PROGRAMS AND MATERIALS[2]

EVALUATION RUBRIC FOR STEM PROGRAMS AND CURRICULA		
GENERAL CRITERIA		
Is the program designed for school setting?	Yes ___ No ___	Comments:
Is the program designed for the after-school setting	Yes ___ No ___	Comments:
Is the material available in digital form?	Yes ___ No ___	Comments:
Is the material available in languages other than English?	Yes ___ No ___	Comments:

Does the material integrate Literacy and STEM?	5 Yes	4	3 Somewhat	2	1 No
Does the material target inclusion and equity? Does it feature diverse characters?	5 Yes	4	3 Somewhat	2	1 No
Is the material aligned with appropriate standards? (I.e. Common Core; Next Generation Science Standards.)	5 Yes	4	3 Somewhat	2	1 No
Does the program require mentorship?	5 No	4	3 Somewhat	2	1 Yes
What is the program's social & entertainment appeal? (e.g. enjoyable learning environment facilitates learner's interest and active participation)	5 Excellent	4	3	2	1 Poor
Is the material suitable for repeated use?	5 Yes	4	3 Somewhat	2	1 No
What is the program's ease of use? (reasonable in terms of set up time, space, timing per session, easily integrated into existing programs, etc.)	5 Excellent	4	3	2	1 Poor
What is the cost of the program?	5 Low	4	3	2	1 High
LITERACY CRITERIA					
Are the material's readability and interest level developmentally, intellectually, and age appropriate for its intended audience?	5 Yes	4	3 Somewhat	2	1 No
Does the material contain a vivid and interesting writing style that actively involves the reader?	5 Yes	4	3 Somewhat	2	1 No
Are the book's illustrations and graphics text-relevant, appealing, and representative of a child's perspective?	5	4	3	2	1

[2] The criteria are adapted from the National Science Teachers Association's criteria for their "Best STEM Books K-12" http://www.nsta.org/publications/stembooks/ and The Science Trade Book Evaluation Rubric (Atkinson et. al, 2009).

	Yes	Somewhat	No
SCIENCE CRITERIA			
Does the material contain substantial science content?	5 4 3 2 1 Yes Somewhat No		
Is the material's science content (text, scale, vocabulary, and graphics) accurate and current?	5 4 3 2 1 Yes Somewhat No		
Is the material's science content intellectually and developmentally appropriate for its audience?	5 4 3 2 1 Yes Somewhat No		
Is the material's science content presented "as an everyday endeavor" so that students can connect it with some of their own experiences?	5 4 3 2 1 Yes Somewhat No		
Does the material contain a hands-on element?	5 4 3 2 1 Yes Somewhat No		
Does the material address connections between STEM disciplines?	5 4 3 2 1 Yes Somewhat No		

FINAL REVIEW

Final reviewer evaluation:

1. Average the scores for this review related to General, Literacy, and Science Criteria.
2. Select values below based upon the average of scores. Round each score to a tenth of a point.

	5	4	3	2	1
Rating from a general perspective:	5 Superb	4 Recommended	3 Use with Caution	2 Marginal	1 Unacceptable
Rating from a literacy perspective:	5 Superb	4 Recommended	3 Use with Caution	2 Marginal	1 Unacceptable
Rating from a science perspective:	5 Superb	4 Recommended	3 Use with Caution	2 Marginal	1 Unacceptable

Comments:

To be considered for use, a program/curriculum should receive final average scores in the 4-5 range for all criteria.

APPENDIX B: BOOK CHARITIES

Name	Brief Description	STEM related?	Fiction vs Nonfiction	Reach	Link
First Book	Nonprofit social enterprise that provides new books, learning materials, and other essentials to children in need.	can search titles by STEM category	both	Distributed more than 160 million books and resources in 30 countries. They currently reach an average of 3 million children every year.	www.firstbook.org
Milk and Bookies	Milk and Bookies includes children in the process of bringing books to children in underserved sectors of their communities. This model not only helps to promote childhood literacy, but it also shows that kids can make a difference and encourages them to keep giving back to their communities.	no	Mostly fiction	438,879 books raised by 168,512 kids	www.milkandbookies.org
Molina Foundation Book Buddies	A nonprofit organization focused on reducing disparities in access to education and health that partners with preschool programs, clinics, schools, family service organizations, churches, and other civic organizations serving low-income and at-risk families.	no	Mostly fiction	The Molina Foundation has worked with more than 2,500 organizations and schools towards this end, donating over 4 million books and hosting workshops and programs for educators and families.	molinafoundation.org/programs/book-buddies
Books for Kids	The mission of the Books for Kids Foundation is to promote literacy among all children with a special emphasis on low-income and at-risk preschool-aged children. Books for Kids creates libraries, donates books, and implements literacy programs to develop the critical early foundation and skills which young children need to be successful in life.	no	both	2015-2016: 22,920 books donated, opened / renovated 6 libraries, and operated programming in 24 libraries throughout the US.	www.booksforkids.org

Name	Brief Description	STEM related?	Fiction vs Nonfiction	Reach	Link
Kids Need to Read	Kids Need to Read works to create a culture of reading for children by providing inspiring books to underfunded schools, libraries, and literacy programs across the United States, especially those serving disadvantaged children.	no	both	Information not available.	www.kidsneedtoread.org
Little Free Library	Nonprofit organization that inspires a love of reading, builds community, and sparks creativity by fostering neighborhood book exchanges around the world. They provide support to volunteer stewards by providing access to free or discounted books through their partners, free building instructions, online resources, etc.	no	both	50,000 + libraries, millions of books exchanged in over 70 countries.	littlefreelibrary.org
Project Night Night	Provides free Night Night Packages to homeless children from birth to pre-teen who need exposure to high-quality literacy materials during this time of upheaval. Each Night Night Package contains a new security blanket, an age-appropriate children's book, and a stuffed animal.	no	Mostly fiction	Donates over 25,000 Night Night Packages each year to homeless children 12 and under. 250,000 children's books have been donated since 2005.	www.projectnightnight.org
Worldreader	Delivers e-books to people in the developing world, uses e-readers, mobile phones and other digital technology.	no	both	Provided readers in 53 countries with a digital library of over 45,000 book titles. Since 2010, Worldreader has served over 5.4 million readers.	www.worldreader.org

Name	Brief Description	STEM related?	Fiction vs Nonfiction	Reach	Link
Bridge of Books	Provides books to New Jersey's underserved children by collecting books through book drives, individual donations, publisher overstocks and corporate donors, and by distributing books through various agencies, community events, schools and other venues.	no	both	Since 2005 facilitated the distribution of over a half million books to underserved children across New Jersey, both directly and through the agencies that serve them.	bridgeofbooksfoundation.org
Reader to Reader	Reader to Reader, Inc. is a 501(c)(3) public charity dedicated to bringing books, free of charge, to under-resourced school libraries and public libraries across the United States.	no	both	Over $50 million dollars worth of books and computers donated, with over 2 million books and computers shipped.	www.readertoreader.org
Better World Books	Book for Book program donates a book for each book purchased.	can search titles by STEM category	both	They have re-used or recycled over 216 million pounds of books and raised over $18 million for global literacy and local libraries.	www.betterworldbooks.com
The International Book Project	Focuses on individual requests for books from around the world. Since 1966, has sent small, customized shipments of books to partners based on their needs. Ships books to schools, libraries, churches, community organizations, and Peace Corps volunteers throughout the developing world and in the United States.	no	both	Sent more than 6 million books to over a 140 countries since their founding, including the USA.	www.intlbookproject.org

APPENDIX C: LITERACY IN STEM RESOURCES

Name	Category	Brief Description	Fiction vs Nonfiction	Publisher	Cost	Research available?	Common core / NGSS aligned?	Informal or Formal	Link
The Lawrence Hall of Science	books, curricula, apps	Investigate, create, and evaluate educational materials and methods, professional development programs, and hands-on learning experiences for our science center, schools, communities, and homes	both	various	varies	yes	yes	both	www.lawrencehallofscience.org
Science Readers: A Closer Look Series	books	Sets of illustrated children's books and instructional support for small-group reading and inquiry-based activities	Nonfiction	Teacher Created Materials	loan system	Evaluated by CASRC	not explicitly mentioned	Informal	www.teachercreatedmaterials.com/administrators/series/science-readers-a-closer-look-126
Max Axiom, Super Scientist: Graphic Science Interactive Collection	Activity Sets & Audiovisual Media	A collection of 18 science-based novels (comic-strip format)	Fiction	Capstone	loan system	Evaluated by CASRC	not explicitly mentioned	Informal	www.capstonepub.com/library/products/graphic-science-19

Name	Category	Brief Description	Fiction vs Nonfiction	Publisher	Cost	Research available?	Common core / NGSS aligned?	Informal or Formal	Link
STEM Read	books, videos, games	Live and online programs @ the NIU to inspire readers to learn more about the science, technology, engineering, and math concepts in popular fiction	Fiction	various	games and online content is free, book prices unknown	n/a	yes	Informal	www.stemread.com
Discovery Education / TECHBOOK	e-books	Blend of text and media, different reading levels and languages, and text-to-speech feature	Nonfiction	Discovery Education	available upon request / 60 day free trial	yes	yes	Formal	www.discoveryeducation.com/what-we-offer/techbook-digital-textbooks
eGFI: Dream Up the Future	print and digital magazine	From the interactive website to the colorful and inspiring print and digital magazine, there is something for everyone--students, K-12 teachers and informal educators, parents and guardians, etc.	Nonfiction	eGFI	free	n/a	not explicitly mentioned	Informal	students.egfi-k12.org/read-the-magazine.htm
Bright World	e-books	E-books on STEM (ocean forests and amazing amphibians)	Nonfiction	n/a	free	yes	not explicitly mentioned	Informal	brightworldadventures.com
Brightly	books	A resource to help raise lifelong readers. Launched in partnership with Penguin Random House, provides book recommendations from all publishers for every age and stage	both	various	varies	n/a	not explicitly mentioned	Informal	www.readbrightly.com/stem-books-for-kids

Name	Category	Brief Description	Fiction vs Nonfiction	Publisher	Cost	Research available?	Common core / NGSS aligned?	Informal or Formal	Link
Galactic Academy of Science book series	books with activity kit	GAS is designed to stimulate general interest in science & engineering and to encourage student participation in inquiry based STEM competitions through engagement in a fun and exciting adventure, mystery, CSI mission. Each book of the series has a corresponding kit, activity and/or game/software package that supplements the storyline and subject matter of the book.	Fiction	Tumblehome Learning	$9.95 per book + activity	no	yes	Informal	tumblehomelearning.com/g-a-s-products
National Science Digital Library (NSDL)	library	The NSDL offers many teacher resources, including lessons, content refreshers for teachers, and online (free) access to the science (STEM) literacy maps developed by the American Association for the Advancement of Science (AAAS)	Nonfiction	various	n/a	yes	not explicitly mentioned	Formal	www.nsdl.org

APPENDIX D: LITERACY IN STEM ORGANIZATIONS

Name	Research available?	Brief Description	Main function	Reach	Link
You for Youth	yes	Mission: To build a community of caring and competent afterschool professionals who nurture, motivate, and engage children and youth in 21st CCLC programs. (This program supports the creation of community learning centers that provide academic enrichment opportunities during non-school hours for children, particularly students who attend high-poverty and low-performing schools).	The Y4Y portal is filled with free resources from checklists for supervisors and principals to STEM activity guides, it's all there at your fingertips to help you reach your program and site goals. You will find resources that are featured in each course, as well as external links to lesson plans and research-based resources.	n/a	y4y.ed.gov
Reading Rockets	yes	The website includes an archive of articles, professional development webcasts, interviews with children's authors, a daily headline service, two blogs, and much more. The Reading Rockets project also encompasses programs produced for PBS, including A Tale of Two Schools and a series called Launching Young Readers.	Offers resources on how young kids learn to read, why so many struggle, and how caring adults can help.	n/a	www.readingrockets.org/teaching/commoncore
National Science Teachers Association	yes	The largest organization in the world committed to promoting excellence and innovation in science teaching and learning; provides resources, books, journals.	Association of science teachers	Current membership of more than 57,000 teachers, science supervisors, scientists, business and industry representatives, etc.	www.nsta.org

Name	Research available?	Brief Description	Main function	Reach	Link
The Campaign for Grade-Level Reading	yes	All-sector collaboration that focuses on an important predictor of school success and high school graduation — grade-level reading by the end of third grade (emphasis on low-income families)	(1) broad-based support for and investment in "on-track" child development, learning and literacy across the early years and early grades; (2) widespread community engagement, civic action and citizen service to find and implement community solutions to barriers to student success; and (3) local, state and federal policy reforms to strengthen, scale and sustain improved child outcomes and school success for children in low-income families	"140 communities are part of our Grade-Level Reading Communities Network, which is bringing together mayors, United Way agencies, chambers of commerce, schools, parents, and educators to substantially increase third grade reading proficiency in their cities and towns."	gradelevelreading.net
Books for Kids	yes	Aims to promote literacy among all children with a special emphasis on low-income and at-risk preschool-aged children.	Creates libraries, donates books, and implements literacy programs	Donated over 28,000 books and $30,000.00 to the public libraries and school districts	www.booksforkids.org
STEM Education Coalition	yes	Works aggressively to raise awareness 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.	Advocacy	n/a	www.stemedcoalition.org
A Mighty Girl	n/a	The world's largest collection of books, toys and movies for smart, confident, and courageous girls.	Curates books, purchase links to Amazon	n/a	www.amightygirl.com

Name	Research available?	Brief Description	Main function	Reach	Link
Common Sense Media	yes	Nonprofit organization dedicated to helping kids thrive in a world of media and technology.	Empower parents, teachers, and policymakers by providing unbiased information, trusted advice, and innovative tools (incl. curates books); advocacy	n/a	www.commonsensemedia.org
Boston Museum of Science	yes	Science museum and indoor zoo with a 18,000-volume collection covers a broad range of science, engineering, technology, and mathematics topics, including topic-specific trade books and storybooks appropriate for students in grades K – 12 and standards-based curriculum.	Science museum and indoor zoo	n/a	www.mos.org/educators
Reading Is Fundamental	yes	The largest non-profit children's literacy organization in the US, With the help of volunteers and local established chapters throughout the country in schools, Head Start programs, community centers, health clinics, migrant camps, and homeless shelters, we provide books and supporting literacy resources to reach children wherever they are in need.	Literacy resources: 3 free e-books, print book distribution, curates book lists (including multicultural themed ones)	Provides 4.5 million children with 15 million books and a growing number of literacy resources each year	www.rif.org
Assessment Tools in Informal Science	yes	The goal is to provide practitioners, evaluators, researchers and policy makers with the information to choose appropriate tools for assessing program quality and outcomes for children and youth.	A searchable website of assessment tools for informal science learning. The goal is to provide practitioners, evaluators, researchers and policy makers with the information to choose appropriate tools for assessing program quality and outcomes for children and youth.	n/a	pearweb.org

Name	Research available?	Brief Description	Main function	Reach	Link
Siemens Science day Leaning by Doing	yes	Introducing Siemens STEM Day: a refreshed and expanded version of the beloved Siemens Science Day, now intended to span the whole K-12 STEM experience! Siemens STEM Day offers a variety of tools and resources that will help you reinvent your STEM curriculum. You'll find new, original hands-on activities, a teacher support center, and our Possibility Grant Sweepstakes	Resource for hands-on STEM activities	The Siemens Foundation has invested more than $100 million in the United States to advance workforce development and education initiatives in science, technology, engineering and math.	www.siemensstemday.com
4-H	yes	A community of more than 100 public universities across the nation that provides experiences where young people learn by doing. Kids complete hands-on projects in areas like health, science, agriculture and citizenship.	Global network of youth organizations, working to advance four personal development areas of focus for the organization: head, heart, hands, and health.	"Through our community of 100 public universities, 4-H reaches kids in every corner of America - from urban neighborhoods to suburban schoolyards to rural farming communities. Our network of 500,000 volunteers and 3,500 4-H professionals provides caring and supportive mentoring to all 6 million 4-H'ers, helping them grow into true leaders today and in life."	4-h.org

Name	Research available?	Brief Description	Main function	Reach	Link
The Children's Book Council	yes	Trade association of children's book publishers, with NSTA's "Best STEM Books" list.	Nonprofit trade association of children's book publishers in North America, dedicated to supporting the industry and promoting children's books and reading.	n/a	www.cbcbooks.org/2017-best-stem-books

APPENDIX E: STEM CURRICULA

Name	Description	Designed specifically to integrate Literacy and STEM	Link
Seeds of Science/Roots of Reading	SS/RR units save teachers time by allowing them to teach science and literacy together. Classrooms using SS/RR experience increased student achievement in both literacy and science for a range of diverse students, including English language learners. The Do-it, Talk-it, Read-it, Write-it approach for grades 2-5 engages students in learning science concepts in depth, while increasing their skills in reading, writing, and discussing as scientists do. It can be used during science, literacy, or as supplementary instruction. The curriculum is informed by research, verified by rigorous evaluations, and field-tested in classrooms around the country.	Yes	scienceandliteracy.org
Amplify Science	Amplify Science is rooted in the Do-Talk-Read-Write-Visualize model of learning. Coupling this process with a suite of digital apps, including modeling tools, computerized simulations, and science practice apps, students step into the world of science and learn from within it. Educators who adopt Amplify Science receive a turnkey curriculum complete with detailed lesson plans, embedded formative assessments, hands-on activities, digital simulations, and a variety of effective teacher supports.	Yes	www.amplify.com
GEMS®	GEMS® Teacher's Guides provide teachers of grades PreK thru 8 with flexible, affordable, stand-alone units that can be used as enhancements for an existing curriculum, or, by combining units, provide a series that delivers comprehensive coverage of a topic. The units feature inquiry-driven activities that engage and excite the interest of students. With over two million books in print the GEMS® program is a recognized leader in standards-driven, inquiry-based science and mathematics education.	Yes	www.lawrencehallofscience.org/programs_for_schools/curriculum#gems

Name	Description	Designed specifically to integrate Literacy and STEM	Link
STEM 101	STEM 101's elementary education and STEM 101's middle grades repository represents a blended learning, project-based curriculum that is accessible from any Web-enabled device. Students are actively engaged in hands-on minds-on on activities through which they realize the application and relevance of their STEM education experience. The curriculum is based on national standards that correlate to individual state standards. STEM 101's middle grades repository includes career exploratory pathways for agriculture, architecture, aviation, biotechnology, coding, electronics, energy, engineering, design, food science, information technology, manufacturing, medical, sustainability, and transportation.	Yes	www.stem101.org
Engineering is Elementary by Boston Museum of Science	EiE is the nation's leading engineering curriculum for grades 1–5. This fun, flexible, inquiry-based curriculum integrates engineering with the science subjects. The EiE Curriculum consists of three components: a teacher guide, storybook and materials kit. It contains 20 cross-disciplinary units designed to fit with the most commonly taught Earth Science, Life Science, and Physical Science topics. EiE integrates with ELA and social studies lessons through engineering storybooks.	Yes	eie.org
FOSS (Full Option Science System)	FOSS (Full Option Science System) is a research-based science curriculum for grades K-8 developed at the Lawrence Hall of Science, University of California, Berkeley. FOSS has evolved from a philosophy of teaching and learning that has guided the development of successful active-learning science curricula for more than 40 years. The FOSS Program bridges research and practice by providing tools and strategies to engage students and teachers in enduring experiences that lead to deeper understanding of the natural and designed worlds.	Yes	www.fossweb.com

Name	Description	Designed specifically to integrate Literacy and STEM	Link
Insights: An Inquiry-Based Elementary School Science Curriculum	An Inquiry-Based Elementary School Science Curriculum is a K-6 curriculum designed to meet the needs of all children in grades K-6 while specifically addressing urban students. The curriculum and accompanying materials were developed by a coalition of science curriculum specialists and teams of innovative elementary school teachers from across the nation. Each module was pilot-tested by team teachers, revised, field-tested on a larger scale, and revised a second time before reaching the publication stage. Among other things, the curriculum materials are designed to integrate science with the rest of the curriculum, particularly with language arts and mathematics.	Yes	www.nsfresources.org
STC™	Each STC™ unit is based on a four-stage learning cycle that is grounded in educational research and practice: First, students focus on what they already know about a topic. Second, students explore a scientific phenomenon or concept, following a well-structured sequence of classroom investigations. Third, students reflect on their observations, record them in journals, draw conclusions, and share their findings with others. Finally, students apply their learning to real-life situations and to other areas of the curriculum. In addition to this basal science curriculum, we also offer the STC Literacy Series™ for grades K–6. This series balances the needs of emerging readers with states' science, math and social studies standards. Content is presented in a colorful, engaging, and age-appropriate manner ideal for reading time.	Yes	ssec.si.edu

Name	Description	Designed specifically to integrate Literacy and STEM	Link
Science Companion	The Science Companion curriculum, developed by the Chicago Science Group (CSG) is a hands-on learning program that takes advantage of children's extensive knowledge of – and curiosity about – how things work in the world. The purpose of the curriculum is not only to provide children with the opportunity to wonder about their world, but to teach them science processes as they explore, quantify, and interpret the world. The children are also given the time and encouragement to draw, write, discuss, and reflect upon what they have done. The program's approach to primary education balances discovery-based learning with teacher-directed instruction.	Yes	www.sciencecompanion.com
4-H	National 4-H Curriculum focuses on science, healthy living, and citizenship. 4-H curriculum promotes positive youth development through experiential learning. All of our curriculum products contain this element of experiential learning. All of the curriculum goes through a rigorous peer review process, ensuring the highest quality of all of our materials. Engaging STEM curriculum encourages youth of all ages to soar into outer space, construct robots, discover the power of wind, and experience the magic of electricity.	Yes	4-h.org
The Five Stars curriculum	The Five Stars curriculum includes six lesson plans that explore how light from the electromagnetic spectrum is used as a tool for learning about the Sun. Some activities were adapted from existing lesson plans, while others were newly created for the Five Stars project. All lessons were developed in collaboration with Girls Inc. program instructors, undergraduate and graduate students, and scientists. While this curriculum has a focus on heliophysics (sun science), the lessons explore the electromagnetic spectrum in general, since most physics and astronomy undergraduate and graduate students are familiar with the electromagnetic spectrum. The curriculum is designed for middle school participants in afterschool programs.	N/A	multiverse.ssl.berkeley.edu/FiveStars