ARTICLE

Harnessing the Power of STEM Education

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Whether you have been a school librarian for thirty years or three months, it is likely that you have heard educational buzzwords such as STEM, inquiry-based learning, and makerspaces. You may have already dived headfirst into learning and implementing within your library or you may be hesitant to dip your toes into such a foreign world. No matter where you are in the journey, harnessing the power of relevance through STEM education is at your fingertips!

Experts at the U.S. Department of Education believe that it is more important than ever that our nation's youth are prepared to bring knowledge and skills to solve problems, make sense of information, and know how to gather and evaluate evidence to make decisions (U.S. Dept. of Ed. n.d.). They believe these skills develop through exploring and learning about science, technology, engineering, and math, as well as computer science. In addition, *STEM Education for the Future: A Visioning Report* indicates,

> "Rapid technological advancements and societal changes are our daily reality. While the future of work, the economy, and society is uncertain, one thing is not: To maintain the nation's leadership in science and technology discovery, we must create an approach to science, technology, engineering, and math (STEM) education that prepares and advances the U.S. for this future." (National Science Foundation 2020, 7)

Educational standards at the state and federal level currently integrate STEM education components for students, whether explicitly stated or through technical and soft skill development. The International Society for Technology in Education (ISTE) has standards for constructing knowledge, innovative design, and computational thinking, among others (ISTE 2021). The AASL *National Standards for Learners, School Librarians, and School Libraries* have been crosswalked to both ISTE and Next Generation Science Standards (<standards.aasl.org/project/crosswalks>). Being an integral component to education today, the school library is in a prime position to support the growth and development of all students through integration of STEM education.

As a prior middle school science teacher and STEM junkie, I have experienced the power of connecting STEM to literacy in my new school librarian role. STEM fuels my library programming, and the excitement of learning is contagious. So how exactly do you get started? In what realistic ways can you make the largest impact on the students and staff at your school? Let's look at some potential ways to try STEM education in your school library.

Benefits of STEM Programming

Working in a school library affords many opportunities to design and provide authentic learning experiences for students. As a school librarian, you have the opportunity to work directly with teachers to provide quality instruction. STEM education, integrated within the school library, can bring life, depth, and excitement to learning! The benefits of incorporating STEM into the library program can be measured in multiple facets: educational achievement, discipline data, social skills, and emotional development.

STEM programming provides a clear pathway for cross-curricular learning experiences. STEM activities, by design, are relevant and tied to real-world applications. When designing STEM activities, you are able to take a cross-curricular approach by pulling into the lessons content standards from multiple sets of standards. By harnessing the power of a professional learning community (PLC), you can meet with classroom content-area teachers who are experts in their standards, and design activities that are authentic and powerful learning tools in multiple areas. Allow the standards to drive the planning. The time and energy your PLC puts forth will be worth the result of motivated students engaged in learning through inquiry.

STEM activities in the library (and classroom) target technical skills as well as soft skills, such as communication, collaboration, and critical thinking, all of which are core components to successful learning experiences. It is incredibly important to provide students opportunities to foster these skills. Employers frequently list teamwork, collaboration, and oral and written communication skills as highly valuable yet hard-to-find qualities in potential new hires (Jerald 2009). Integrated STEM education is student centered and has demonstrated potential for increasing content retention as well as promoting problem-solving and higher-level thinking skills (Stohlmann, Moore, and Roehrig 2012). It can be concluded that frequent opportunities to practice building these skills through inquiry-based learning is vital in education. In my experiences, my students are often hesitant to work within certain groupings. However, within just a few minutes into a STEM lesson or challenge, they are utilizing one another's strengths to find success. That is something I can't

teach without providing experiences for students to feel, see, and grow from. What a powerful message it sends to them each and every time. Students recognize that they all come to the table with different skillsets. They all have strengths and weaknesses. They all need each other to learn, succeed, and grow.

An engineering mindset builds a framework to tackle problems innovatively and creatively. STEM education challenges students to use a design-thinking framework, to develop and test ideas, to fail, adapt, and try again. In a 1973 document, Dr. Bernard Roth outlined a formal design process, describing how successful engineers go through a series of steps to critically think about the problem and, as a result, create alternative approaches for solutions (Hill-Cunningham, Mott, and Hunt 2018). In our school library we consistently follow Dr. Bernard Roth's Engineering Design Process: ask, imagine, plan, create, improve. STEM education has allowed my students to see that their failures are how they learn and that failures are encouraged. STEM for my students has also taught them the power of reflection and perseverance. They are willing to take risks. They are no longer afraid to fail. They want to try again. These environments are powerful learning opportunities!

Starting Small

Getting started can be overwhelming. It can be scary. It can also be exhilarating. You can take a big bite and start large, or you can start small. The most important part is that you take a risk and give integrating STEM a shot in your library. Let's look at some ideas that have been successful for my students; you may want to give them a try!

As a prior middle school science teacher, I spent eight years focused on STEM, project-based learning, and personalized learning for students. I have always had a passion for professional development and consistently sought new opportunities to gain knowledge, explore resources, and network with educators. Through attending conferences and workshops, I was able to invigorate my STEM activities with students. When I made the transition to school librarian, my role drastically shifted within the school building. I knew I needed to still find ways to incorporate my passion for STEM education into my new job responsibilities. I started small.

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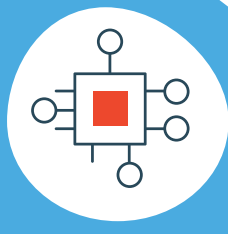

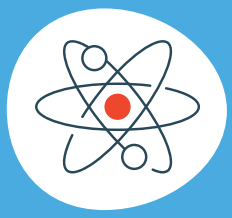

challenges into each lesson I did with students. Working at an elementary school, I have the opportunity to see classes on a flexible schedule. My time with a group of students includes: a book read-aloud with built-in literacy instructional components, a hands-on activity directly connected to the story, book checkout, and a STEM challenge. Because of the excitement for the STEM challenge, my students rarely show any inappropriate behavior. They are excited but focused and motivated to use design thinking together. Since my time with students is short, these STEM challenges are designed to take only ten to fifteen minutes.

One challenge my students love is tied to the picture book *Creepy Carrots* by Aaron Reynolds. For this challenge they are provided an image of a carrot patch on paper, four large popsicle sticks, and eight wooden clothespins. Learners are challenged to design and build a fence that will keep the creepy carrots detained. It's short, simple, requires very little in supplies—and provides an opportunity to pull in math with thinking about perimeter and area, as well as have discussions on fence designs and the engineering behind them.

Another challenge that my students have had great success with focuses on the fairy tale "The Gingerbread Man." Pick your favorite author's version! After reading the fairy tale aloud, students are challenged to design a raft that will allow the Gingerbread Man to cross the river to get away from the fox. Each student group is provided with the same consumable materials: straws, craft sticks, tape, and aluminum foil. I give my students a Gingerbread Man cutout that they get to color and tape onto a clothespin. This way, it provides some weight when placed in the raft. Students test their raft designs in a large tray of water. They are challenged to redesign their rafts after test runs for optimal success. You could expand this lesson by adding a fan to one side of your tray of water. With a timer, you could challenge students to design a raft that gets across the river the fastest! Scientific ideas of flotation and waterproof materials are easily investigated, along with data collection. Bump it up by graphing your data and analyzing your findings! STEM challenges can be a great way to engage your students for little cost, while you are gaining comfort and experience with STEM integration.

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Makerspaces have become extremely popular in libraries in recent years. A makerspace is a collaborative work space inside a school, library, or separate public/private facility for making, learning, exploring, and sharing through use of high-tech to no-tech tools (What Is a Makerspace 2021). Makerspaces provide students the resources to be innovative and creative while using critical thinking. Makerspaces often remove the parameters that STEM challenges set and allow students to interact, design, and grow in a less-structured environment. While there are costs associated with supplying a makerspace with consumable materials, materials for a makerspace in your school library can often be funded through grant opportunities. By planning with teachers, the school librarian can provide the makerspace area for students to utilize for classroom projects or for extensions of learning and enrichment. If you are worried about not having a dedicated space in your library, consider that many librarians have formulated solutions with portable makerspaces!

Another start-small project idea is to create Storybook STEM kits. As I was deciding on how I could best support the students and staff at my school, I recognized that teachers needed quick access to cross-curricular STEM materials that they could use in their classrooms. The idea of these Storybook STEM kits was developed. I secured a small local grant to purchase enough materials, including consumables, to build twenty kits. Each kit includes a hardcover library-bound picture book, STEM curriculum explicitly connected to grade-level standards across curriculum,

and all consumable materials needed for the activity. The kits also include a teacher's guide for easy implementation. I added the kits to my school library collection for teacher circulation. With the grant funding, I was able to purchase enough consumables to replenish the kits after classroom usage. They have been a huge hit!

If these ideas seem still too large or daunting, think about small-scale ideas that you could provide to your students, classroom teachers, or families. You could create STEM challenge videos and push them out through a learning management system, such as Google Classroom or Canvas. Teachers could use the videos within their classrooms or students could try them at home with their families. You could provide monthly STEM choice boards that include mini-challenges. You could even focus on collection development and buff up your library's STEM resources for circulation.

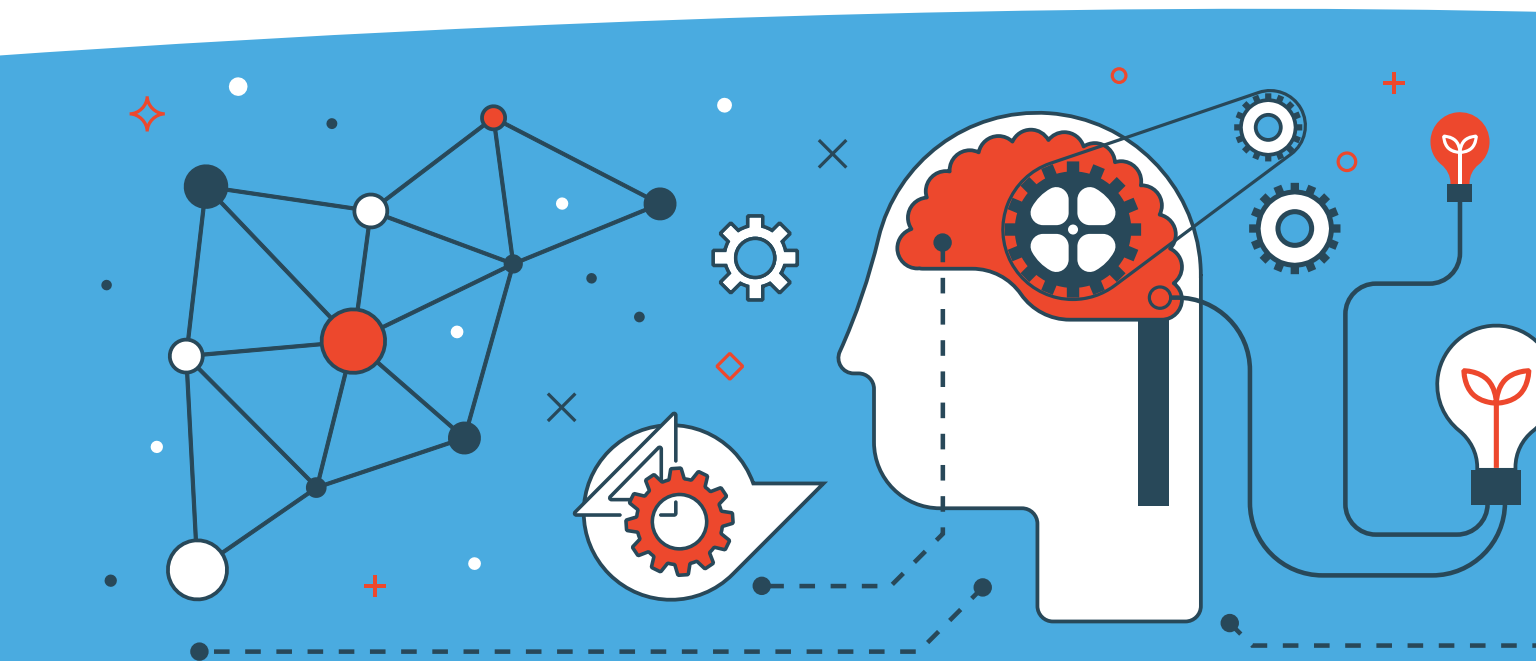
Diving Deep

Are you ready to tackle some large-scale STEM ideas? Consider having your students participate in competitions. Some options include Discovery Education 3M Young Scientist Competition, Google Science Fair, FIRST Robotics Competitions, Botball, Modeling the Future Challenge, SeaPerch, and Science Olympiad. Check out local universities and organizations to see what STEM opportunities they have for your K–12 students.

You may also consider designing a large-scale project within your library built on STEM principles. One example of this could be to ultimately build a raised garden for your school. You could set challenge parameters, such as the garden must fit within a certain area of the schoolyard, or it must be under a certain budget. Students could use the engineering design process to move through the phases of the project. You could work with a specific grade level, tying in their state standards across the curriculums. You could invite community members and experts to support your students' research, design ideas, and construction processes. You could showcase their work in a public ribbon-cutting ceremony! As a project-based learning teacher, I have had the opportunity to design yearlong cross-curricular STEM activities, all connected to the United Nations Sustainability Goals (UN n.d.). Depending on the age of the students, your large-scale project can have a rigid framework or allow students to work within parameters to choose ideas about which they are most passionate.

Professional Development

No matter how much experience you have with STEM education, professional development opportunities can always add new insights and resources to your toolkit. Many opportunities designed for groups of classroom teachers will also invite school librarians to participate. You can then apply your new knowledge to impact students directly or provide professional development to the staff of your building. A great way to find STEM professional development is to start local with your school district, as well as any local colleges or universities that have STEM education programs. Local science museums can also be another great resource. As a school librarian in eastern North



Carolina, I take part in opportunities from both North Carolina State University's Science House and University of North Carolina Wilmington's CESTEM program. Both have a technology loan program and scheduled workshops for educators at little or no cost.

Larger opportunities for educators to participate in STEM professional development exist, too. These programs often occur in the summer and include an application and selection process. Do not be intimidated that your job title or description may not exactly match their requirements. I have had great success in being selected for these programs as a school librarian. A key to acceptance is being able to articulate clearly how you will incorporate the learning into your library to support staff and students at your school and community. The U.S. Space & Rocket Center in Huntsville, Alabama, offers a Space Academy for Educators program. This used to be free but does now charge a tuition fee. Two free programs that I have found beneficial—and fun—are Air Camp for Educators in Dayton, Ohio, and Real World Science at the National World War II Museum in New Orleans, Louisiana. You can also join organizations such as the Civil Air Patrol as an Aerospace Education Member (AEM) for a one-time $35 fee. By being an AEM, you gain access to free aerospace/STEM educational materials and free STEM kits! You also get to participate in a free teacher-orientation flight at a local airport.

Harnessing the power of STEM education in the school library supports learners' skill development across curriculums. Do not be afraid to try it on! Take advantage of professional development, network and plan with your professional learning community, and implement with enthusiasm. No matter how big or small, your efforts will impact the students and staff of your school in a positive way.

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Resources to Jumpstart Your Transformation

Hess Toy Truck: STEM Curriculum Guide <https://hesstoytruck.com/stem>. Pro Tip: Apply for their STEM classroom kit giveaway each year. School librarians are eligible!

Oak Ridge Institute for Science and Education <https://orise.orau.gov/resources/k12/lesson-plans.html>

Science Buddies <www.sciencebuddies.org/>

Teach Engineering: STEM Curriculum for K–12 <www.teachengineering.org>

Teachers Pay Teachers <www.teacherspayteachers.com>. The power of this educational community is immense. Be selective and choose materials wisely. Adapt to match your comfort level!

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