STEM IMPLEMENTATION
IN THE SCHOOL LIBRARY

by

Jeffrey B. Harris

An Abstract
of a research paper submitted in partial fulfillment
of the requirements for the degree of
Master of Science in Library Science and Information Services
in the Department of Educational Leadership and Human Development
University of Central Missouri

July, 2015
ABSTRACT

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Jeffrey B. Harris

Schools across the United States are placing an increased emphasis on STEM (Science, Technology, Engineering, and Mathematics). School librarians, therefore, are working to discover ways of implementing STEM curricula in their libraries. This research paper is a review of the literature associated with this topic, which indicates that, in spite of challenges that librarians face in the process of STEM implementation, there are multiple reasons why it is an important mission to undertake. The paper concludes with specific methods that school librarians have taken to bring STEM into their libraries in meaningful new ways.
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UNIVERSITY OF CENTRAL MISSOURI
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CHAPTER 1
INTRODUCTION

Statement of the Problem

STEM (Science, Technology, Engineering, and Mathematics) has become one of the prevalent initiatives being pursued by schools across the United States; and due to this shift, school librarians are attempting to determine how best their libraries can make adjustments to include STEM in their spaces and curricula. The research in this paper serves to analyze recent literature on this topic and the implications it has for specific ways that school libraries can adapt to make STEM an integral part of their daily practices, which can prove to be a challenging task due to STEM integration’s existence as a relatively recent development in librarianship. The examples provided of STEM implementation methods, therefore, indicate practices that can be replicated in other school libraries.

Purpose of the Study

The purpose of this study is to review the literature to examine issues surrounding the impact of STEM subject areas on librarians’ roles within the school setting. It includes reasons that have been purported as evidence for STEM becoming an area of greater focus within school libraries, as well as difficulties that librarians have encountered in this process. Methods of implementation of STEM initiatives are also summarized to give a general picture of how these curricula are being infused into the everyday practices of librarianship. The study’s results indicate that there are clear courses of action that can be taken by librarians to include STEM in their work in meaningful new ways.
Research Questions

The research serves to examine the answers to several key questions:

1. Why has STEM been identified as an area of growing importance within schools and libraries?

2. What issues have librarians encountered when attempting to integrate STEM topics into their existing curricula?

3. What types of programs and initiatives could the school library take on to include STEM subjects in their work?

Limitations of the Study

This study was not without its limitations. These include the limited amount of time (five months) that was spent in the research process. Only readily available peer-reviewed journal articles in specific databases were consulted, which is compounded because STEM is a relatively new topic of study in terms of its relationship to school libraries. The data that were consulted tended to encompass the science, technology, and engineering components of STEM, with mathematics as only a minor focus of the articles found on the topic. Additionally, the examples of ways in which STEM can be implemented in school libraries are not able to be extended to all schools based on their own budgetary and technological limitations and restrictions.

Definition of Terms

Implementation – These are ways in which areas of the curriculum and particular techniques are put into practice.
Integrate/Integration – For the purposes of this paper, this term indicates ways in which librarians include particular areas of the curriculum into their lessons and units of study.

Librarianship – For this paper, this refers to the professional duties of a school librarian.

STEM – This is an acronym that stands for science, technology, engineering, and mathematics, which are four related areas of curriculum that are often combined as a central initiative of many schools.

Research Design

This research study was based on preexisting scholarly journal articles on the topic of STEM integration in school libraries. No original research was conducted on the part of the author. Literature was reviewed and analyzed to examine specific examples and trends of STEM inclusion in the library setting, and no permission was required to retrieve the sources that were consulted.

Articles that were used were located on these databases: Academic Search Complete, Education Research Complete, and Library Literature & Information Science Full Text, which were all retrieved through the Online Databases on the library website of the University of Central Missouri. The search terms that were used included “school libraries,” “librarianship,” “STEM,” “STEM in school libraries,” and “technology integration.”

Conclusion

This study consists of three chapters that indicate methods that have been used to integrate STEM curricula into school libraries. The second chapter is a review of existing literature on this topic. The third chapter analyzes conclusions that can be drawn
based on the previously established research questions, and specific recommendations and applications that can be made in light of the research literature that was consulted.
CHAPTER 2
REVIEW OF THE LITERATURE

This research paper focuses on how school librarians can connect library activities to the STEM components of school curriculum (Science, Technology, Engineering, and Mathematics). It analyzes this topic from three standpoints. First, the research will showcase reasons for increased focus on STEM curricula within the school library setting. Next, the research will examine challenges to creating these connections. Finally, the research will delve into specific ways in which librarians can implement STEM lessons, create STEM units of study, and utilize STEM resources and technologies.

**Reasons for Increased Focus on STEM in the School Library**

The need for an expanded focus on STEM in the school library has been analyzed in multiple journals and scholarly articles, many of which are discussed in this paper. It has been stated that in STEM-centric libraries, students gain a deeper knowledge and understanding of STEM-related topics (Mardis 253). Through the STEM curriculum, students also work to utilize technology more effectively to prepare themselves for global citizenship. To assist them in this process, librarians work to remain up-to-date on technology- and curriculum-related trends. The basis for this STEM shift is established on the foundation of previously established learning theories. These include constructivism, inquiry, and active engagement. In these libraries, students gain opportunities to take responsibility for their own learning. Students also take on the role of creators of new information and innovations in a variety of forms. There has been a decreasing student interest in STEM fields and a simultaneous increase in the need for
workers in related professions, which has served to spark curricula emphasis (Powell and Boyd 17). This section of the paper will explore real-world connections and problem-solving aptitudes that are explored through the use of STEM curricula.

In schools, students are working to obtain a greater understanding of all curricular areas associated with STEM. In one report, non-STEM students claimed that their understanding was only at a surface level, leading to an incomplete knowledge of the concepts being studied and difficulty memorizing what was being taught (Powell and Boyd 26). An increase in direct, hands-on practice, laboratory studies, and organic use of scientific information in context, it was claimed, were linked to greater achievement in understanding STEM content (Powell and Boyd 28, 38). Another way this is achieved is through students’ ongoing participation in digital media, which opens up new opportunities for connecting them to the world of information in ever-changing forms (Subramaniam, Ahn, Fleischmann, and Druin 162-163).

Students will become much more prepared for their roles as global citizens by learning how to use technology effectively, which is another area of study commonly addressed in school libraries. School libraries’ STEM emphasis, it is posited, can be enhanced through the library’s promotion of students’ participation in technology and online resources such as hybrid learning spaces, virtual worlds, and online learning communities (Subramaniam, Ahn, Fleischmann, and Druin 170, 175-176). Students’ willingness to engage in learning to become STEM literate and understanding of related issues serves to help them become more reflective, constructive, and motivated citizens by linking them to a global world of digital information (Kennedy and Odell 247). Moreover, in working to achieve fluent use of technology and information in
various forms, they will be given an authentic twenty-first century learning environment in their school library through which the librarians integrate these technologies in more effective ways (Sharkey and O’Connor 37). In this way, true hybrid learning spaces are formed in which students’ use of technology is made more relevant and meaningful connections between these resources and concepts and their applications to the world outside the classroom or library can be made (Subramaniam, Ahn, Fleischmann, and Druin 170).

To make this possible, librarians consistently strive to stay appraised of the latest developments in both curricula and technology. The increased technology focus within the greater context of STEM has led many educators to seek out opportunities to infuse these technological advancements into their curriculum. “When you see eSTEM, you are viewing a deliberate, integrated educational paradigm shift where digital, technology-focused STEM is the ‘driver’ of the curriculum. Even physical education teachers integrate STEM into their curriculum and shifting the focus from STEM to eSTEM makes it more relevant to 21st century learners” (Jaeger 11). Instead of viewing the rise of new STEM-related technologies as spelling the decline or eventual extinction of libraries, one author touts that librarians can remain relevant by remaining up-to-date on new STEM technologies and related skills so that their focus is on the future (Stephens 130).

The development of STEM curricula and its connections to learning in the library have been founded on pre-existing, established learning theories that include, but are not limited to, constructivism, active engagement, and more. Today’s libraries are described as places of freedom and relaxation where children can create, dream, and discover new
things through the process of authentic inquiry (Myers and Huss 41). This inquiry basis is infused throughout all content areas and it, along with blended, project-based learning, forms students into more active learners (Donovan 6). This is in direct contrast to older educational methods of rote memorization and subjects being taught in isolation (Peterson 8). Instead, by being actively engaged in their own learning process, students are said to more easily make meaning of the content under study (Capraro and Han xvi). “All of these theories are based on the concept of learning by doing and experiencing, which resonates with today’s learners who want to interact and connect with their professors, classmates, and learning environment” (Sharkey and O’Connor 37).

These environments enable students to take more easily the responsibility for their own learning. Integrating scientific methods into the studies occurring in school libraries push students to think more critically and deeply about their role as future designers and decision makers (Myers and Huss 42). This form of self-directed learning leads to increased student motivation, and allows the students themselves to direct their own learning process through their direct involvement in the explorations, reflections, and discoveries within the library (Stephens 130).

Additionally, throughout this process, the literature claims that students’ engagement in their own learning crafts them into information creators and innovators rather than passive users of information resources (Capraro and Han xvi). Librarians are encouraged to experiment with an array of different online media tools, such as social networking applications, virtual worlds, and more, which will allow them to connect learners to the technologies and concepts they are learning about. This in turn helps each student to form their identity as a learner of STEM topics specifically, and of all the
content being learned in general. Students learn to become more adaptive and to engage in extensive analysis, problem-solving, and critical thinking on a regular basis (Young, “Stemulation,” 20). As they develop these literacies, students may potentially create something that can influence others in the future (Marcoux 69).

Looking ahead to the future in store for these learners, it has been said that there has been a simultaneous decrease in students’ interest in STEM fields while a need for workers in those areas has only increased. “The National Science Foundation (NSF) estimates that 80 percent of the jobs created in the next decade will require some form of math and science skills” (Young, “STEM: Sparking Innovation,” 14). Technicians, researchers, and qualified experts in the maths and sciences are also said to be critical to advancing present-day economies (Kennedy and Odell 248). In order to enable these future positions and careers to be filled, one author states, it is suggested that American schools need to establish a more focused and direct approach to STEM-related learning (Powell and Boyd 17).

At the center of all of these developments is an ongoing quest for librarians and their fellow educators to help students make real-world connections between areas of study and to become active problem-solvers. In including the technology and engineering components of STEM, students gain greater experience and confidence to analytically assess problems under scrutiny, offer prospective solutions, and create inventions that have not yet been conceived of, let alone utilized (Spellman, Jones, and Katsioloudis 30). In order to find the solutions they are seeking, students are immersed, in STEM libraries, into an environment that is student-driven, exploration-focused, and
full of actively engaged learners who work together to solve problems in new and powerful ways (Young, “STEM: Sparking Innovation,” 14).

**Challenges to Creating STEM Connections in the School Library**

Despite the reasons previously established for increasing the presence of STEM curricula in school libraries, the literature has established several challenges and threats to making these changes a reality. Some school librarians lack confidence in teaching this area of the curriculum. Many lack formal education in STEM disciplines as well. Some teachers resist STEM-related collaboration due to the lack of time to cover the necessary curriculum, the increased emphasis on high-stakes testing, and the lack of confidence on the part of STEM teachers in the librarian’s ability to contribute to the teaching on these subjects. Additionally, some students may initially be reluctant to take part in STEM activities in the library because of unfamiliarity with the methods being used. Gender, racial, and socioeconomic gaps in STEM involvement were cited as problematic as well. One last issue discussed is that collection materials in school libraries can become rapidly outdated in STEM areas with increased expansion of scientific knowledge and innovation.

One common obstacle to infusing STEM curriculum in the library can be due to the librarian’s own lack of confidence in effectively teaching the material being presented. This can lead them to become less apt to attempt to establish connections with teachers of STEM content areas. In return, this can be further compounded by the inability to purchase all of the resources librarians might wish to use to enhance these connections, especially if they do not feel as comfortable in broaching these content areas in the first place (Mardis 252). This lack of perceived expertise may be viewed by some
librarians as being truly problematic, but it certainly is not the only problem that they may face in this integration process (Subramaniam 16).

The inferred deficit in skill may be directly linked to a lack of formal education in STEM disciplines on the part of the school librarian. Instead, librarians usually have undergraduate degrees in language arts and social sciences, which is stated to be a contributing factor to their discomfort in teaching in these content areas (Subramaniam 16). Subsequently, STEM teachers themselves in turn sometimes do not view their school librarians as valid partners in instruction in these content areas. Without an extensive level of experience in STEM fields, it may be more difficult for librarians to make decisions as to how to better build the science and technology components of their collection as well (Mardis 252).

Another challenge from the perspective of the content area teachers comes with a perceived lack of time deemed available to spend on the curriculum itself, and the increased focus on high-stakes testing, which makes some teachers more reluctant to engage in ongoing partnerships with the school librarian. District, state, and national standards must be met, and exams must be taken, which are valid points (Herreid and Schiller 62). Additionally, “With heavily packed lectures and laboratory sessions, instructors in the sciences, engineering, and technology may be particularly reluctant to ‘sacrifice valuable instructional time’ to accommodate library instruction” (Rose-Wiles 397).

Students, too, may initially be reticent to attempt new strategies and techniques if they are unfamiliar to them. The work that they do may involve methods that they have not used in the past, and can involve work outside of the classroom, perhaps even outside
of the school in general. The lessons created must be composed carefully for students to be adequately prepared for these new learning experiences (Herreid and Schiller 63).

Certain subpopulations within the student body are further challenged due to gender, racial, and socioeconomic gaps. “Recent national analysis finds that gender, socioeconomic status, and race continue to define gaps in STEM participation. Young women and those from lower socioeconomic backgrounds are less likely to pursue STEM majors in college. Furthermore, white young people are more likely to complete STEM degrees than their black or Hispanic peers” (Subramaniam, Ahn, Fleischmann, and Druin 164). Previous experiences, family lifestyles, and demographic backgrounds impact student motivation to learn STEM content and pursue STEM careers (165) Educators may have lower expectations about the potential of certain student subpopulations, or have previously established stereotypes that are difficult to change (Williams 24).

Even the library’s collection itself can become a barrier at times due to materials becoming rapidly outdated in lieu of the expansion of scientific studies and knowledge. These items must be continually reviewed to determine which should be deselected to ensure the collection’s currency (Anderton 45). Books about technology that have been published within the last ten years can be out of date, as there could be significant changes that have occurred in those areas of invention within a relatively short period of time (Hopwood 55). Science-related books typically remain useful for only 3-5 years, and computer resources become obsolete even more quickly (Harris 16). Supplementing one’s collection with e-books, online tools, links to related sites, and apps on tablets and e-readers can improve the collection, without the need for physical expansion (Young, “Stemulation,” 20).
Implementation of STEM in the School Library

Librarians contribute to the implementation of STEM curricula and lessons in a variety of ways in the school library setting. One manner in which this is achieved is through the provision of collections, resources, and content related to STEM, which can involve changes in library resource organization. Librarians work to build collaborative partnerships with STEM teachers. They also create connections between the components of STEM and the resources used through integrative units of study. Activities involved in STEM-emphasizing libraries include those that challenge students to innovate and invent. Makerspaces provide one specific opportunity for such innovations to take shape. Technology is utilized to link students to real and virtual worlds. The flipped classroom method provides another opportunity. Grants and outside resources are available to enrich STEM offerings and bring in the outside world, not just through monetary gains but also through expanded resources and enhanced learning experiences. In all of these examples, the librarian serves the role of a mentor and guide to colleagues and students alike.

One way that librarians bring STEM into their school library is through providing print and multimedia resources, collection materials, and more that are related to these content areas. According to one writer, STEM should be an organic part of our entire library collection, and promoting nonfiction materials is a strategy that introduces readers to the materials that are available in this genre (Hopwood 54). Careful analysis of one’s collection allows the librarian to determine which areas can be bolstered with additional resources (Braun 60). Digital and electronic STEM media is also needed to be up-to-date (Young, “STEM: Sparking Innovation,” 15). Subscription STEM databases offer one
opportunity for providing quality resources (Harris 16). It is posited that librarians working closely with STEM teachers improves the quality of the library’s STEM collection in all forms and draws teachers’ attention to what is available (Mardis 259).

The organization of the library itself and the materials within it can also be shifted as a result of changes in STEM resources being offered. Embracing changes, new ideas, and technologies necessitates these alterations. Library spaces with a STEM emphasis can include green screen technology, Hexbugs (a brand of small, creature-like toy automatons) and Lego robotics, iMovie centers, and various collaborative stations where students can create, explore, and discover (Steele 12). Engaging displays, primary resources, and the provision of a wide variety of hands-on activities and electronic resources are additional ways that the environment of the library can be transformed (Young, “Stemulation,” 22). Online content is sometimes organized within a STEM context as well, through the use of applications such as LiveBinders and other online guides (Braun 60). Through these materials and the way they are organized, librarians begin to demonstrate their ability to connect to STEM areas of the curriculum, building connections to classroom teachers.

Collaborative partnerships are being built between librarians and STEM teachers. Teaming up with fellow educators helps to create change and influence students to pursue STEM careers (Dow 15). Using their extensive training in curating content, curriculum, resources, and instructing students in how to utilize information effectively, librarians can work more closely with teachers and show their connection to STEM areas of instruction (Duff 24). Duff suggests librarians seek additional assistance from their peers to discover quality resources (Duff 25). In their role as instructional
partner and change agent, school librarians have the opportunity to implement these changes in instruction and to connect with other educators throughout the entire school (Subramaniam, Ahn, Fleischmann, and Druin 168-169). Two researchers on the subject of librarianship and collaboration with STEM teachers claim that “In schools where the school librarian collaborated with STEM teachers, there was a significant, positive relationship with student achievement and that strong STEM connections were the key to building relationships with STEM learners. When the STEM teacher and the school librarian provided learning opportunities with digital content to students, those students mastered course content and sustained interest in the STEM topic” (Mardis 253).

These connections can be further extended through the use of more extensive, integrative units of study. An author states that STEM curricula can cut across the various content areas and thereby invites interdisciplinary method of teaching STEM content. Technology can then similarly be integrated across all of these curricular areas to impact teaching strategies and techniques, as well as student learning (Kennedy and Odell 253-255). The collaborative partnerships that librarians develop with classroom teachers serve to increase the infusion of different literacy practices and establish connections between students’ needs of information for research purposes, curricular areas being studied, desired learning goals, and resources in many forms. In these ways, librarians are supporting the overall educational community within their schools (Subramaniam, Ahn, Fleischmann, and Druin 173). In so doing, librarians and teachers provide their students with multiple perspectives, alternative viewpoints, and global opportunities that enhance their ability to think critically, and make meaningful
applications of the concepts students have learned to their lives in general (Kennedy and Odell 256).

Another method that librarians can use to incorporate STEM into their libraries is by providing activities that challenge students to innovate, invent, and create. At the elementary level, students’ curiosity is piqued through dynamic additions to the library environment, such as terrariums, ant farms, or other stations, and they are also enabled to create their own science materials, like bird watching and weather journals, leaf-rubbing kits, and similar tools that they can take home (Koester 23). Librarians are encouraged to create hands-on learning opportunities through labs, models, simulations, and student-created digital booktalks. More extensive creative opportunities include bringing in exhibits from museums in the surrounding area and hosting invention conventions for students to participate in (Myers and Huss 41-42). Fabrication workshops are just one more method that can be utilized in school libraries, using 3D printers and CAD software through which students can learn the art of creation (Vengersammy and Collins 6). Donovan advocates organizing STEAM fairs (the “A” stands for the arts, which are sometimes grouped with the other STEM subjects), as well as starting up technology-related clubs (8). Students’ roles as authors and creators of new information are cultivated through these methods when they are given chances to engage in interactive activities (Harris 16). In these examples, there is “an emphasis of play, experimentation, and social interaction with other learners as part of the program. A focus on play, innovation, and experimentation is needed for twenty-first century learning success” (Stephens 131).
To take these creative opportunities to the next level, librarians establish full-fledged Makerspaces within the library. These types of spaces invite learners to engage in innovative uses of technology and connect to many areas of literacy, such as digital literacy, reading comprehension strategies, and the ability to navigate a variety of different resources effectively (Bowler 58). Librarians’ roles in these areas are as hosts and guides to the resources, activities, and opportunities that are available (Donovan 6). More than simple play, students in these Makerspaces are able to construct, experiment, invent, and design their ideas, which builds their excitement in STEM areas of the curriculum (Loertscher 45).

Science concepts can be further taught through the ways that technology can connect students to both real and virtual worlds. Librarians and teachers alike are given increased chances to craft research projects with their students. Students in turn have more opportunities to work with scientific resources and equipment that would not be available outside of the classroom, as lectures, homework, etc. occur outside of school, so that creating, making, and doing happen inside of classrooms and libraries (Herreid and Schiller 62).

Students can learn media skills and scientific content through their interaction with digital media, as well as link STEM concepts to what they have already experienced firsthand through librarians’ collaboration with classroom teachers to provide meaningful, technology-enhanced instruction on these skills (Subramaniam, Ahn, Fleischmann, and Druin 162-166). Whether a librarian is using social networking tools, video games, or other hybrid types of learning spaces and activities, all of these are used
to connect students to STEM curriculum and help them establish their identities as science learners (Subramaniam, Ahn, Fleischmann, and Druin 175-176).

The outside world is brought in by librarians in tangible ways as well through librarians’ attempts to search for outside resources and pursue STEM-related grants. Community groups, STEM-centric businesses, and educational departments of scientific institutions can be contacted and partnered with to receive financial support and a variety of resources (Hopwood 54). There are many funding opportunities that are available to enable librarians to find sources that are just right for them (Braun 60). Starting simple with a single grant or program and then building on those experiences from there is suggested for librarians who are new to such initiatives (Anderton 46). Seeking guest speakers, finding touring opportunities in local businesses, and contacting museums for traveling materials are all advocated as further methods through which librarians can connect students with STEM resources that are accessible within the larger community (Myers and Huss 42). In all of these examples, the librarian is working to infuse STEM curricula and resources in meaningful new ways.

The final method in which librarians can infuse STEM into their daily practices is as mentors and guides to their students. In one particular study, students interested in STEM areas talked about how they had previously been mentored by science teachers who were interested in what they were teaching and helped pull learners into their world of creativity and exploration (Powell and Boyd 30). Librarians, like other educators, in their relationship to students as coaches, serve to encourage students, enhance their learning, and apply what they are teaching to the real world and solving problems (Jaeger 12). Science, technology, engineering, and mathematics instruction, in summary, can be
enhanced by STEM teachers and librarians who interact with their students with enthusiasm, offer meaningful learning opportunities, curate STEM content and resources, and collaborate to provide integrative instruction across the curriculum (Powell and Boyd 38).
As indicated by research, many school librarians are following the educational shift to an increased emphasis on science, technology, engineering, and mathematics (STEM) content and curriculum. In spite of the challenges and obstacles that may be faced in the process of embracing STEM initiatives, there are many different ways that this content can be integrated into the curriculum of school libraries. When considering this change towards a greater STEM presence in the library, several questions may be raised. First, why are STEM content areas being addressed in the library setting? Secondly, what initial problems have librarians encountered that are related to this transformation, and how can these challenges be overcome? Finally, what have been some successful applications of STEM in school libraries that have already embraced these initiatives? The answers to these questions have been addressed in the previous section of the paper, but will be answered directly in the paragraphs below, which are followed by a conclusion that connects the concepts discussed.

**STEM Is a Growing Area of Emphasis in School Libraries**

Students in today’s schools, it is posited, are going to require a greater understanding of STEM content areas in order to be prepared for their future professions, and to be digitally literate in a world where proficiency in a variety of technology skills and math and science related concepts is key (Subramanian, Ahn, Fleischmann, and Druin 170). There will be a continuously growing need for professions that require a greater level of expertise in the maths and sciences, as well as the use of technology,
which has led to schools pursuing methods through which students can achieve increased mastery of these curricula (Kennedy and Odell 248).

The school librarian can create an environment where these skills are taught and reinforced in authentic, meaningful ways in a setting where a myriad of resources exist that can provide direct linkages to the areas of STEM content under study. In the process, students also gain a deeper and broader understanding of the technological tools utilized to foment this growth in achievement and understanding. (Sharkey and O’Connor 37).

Another reason that STEM content is being focused on in school libraries is that it develops critical thinking skills in the students that are learning about these content areas through integrative, hands-on, demonstrative projects and tools (Myers and Huss 42). Learners develop persistence in their motivation to grasp new STEM concepts, and can, therefore, apply these new understandings in settings outside the library, and outside the school itself (Young, “Stemulation,” 20). In so doing, students are molded into more creative, innovative thinkers who tackle issues needing to be solved with determination and logical problem-solving methods (Bowler 59). Through the use of the trial and error process of experimentation, students gain a clearer view of how STEM concepts work as well as an understanding of themselves as STEM learners (Koester 24).

**Overcoming Obstacles to STEM Integration in the Library**

Librarians encounter several difficulties when in the early stages of adopting STEM initiatives. Some librarians find themselves out of their comfort zone, having typically experienced a greater level of formalized instruction in language arts, social studies, and other related subjects (Mardis 252). Attempting to integrate STEM content
into the library, therefore, is at times a new and disquieting journey that may make some librarians feel unprepared (Subramaniam 16). In spite of what may initially be viewed as professional deficits, however, the literature states that library staff do not necessarily have to be experts in STEM content areas in order to be effective educators of these concepts. This is achieved through the establishment of collaborative partnerships with other educators (18). Librarians are further assisted in their self-belief as STEM educators when they provide many print and digital resources that offer students opportunities to explore STEM subjects in creative, empowering ways (Koester 22).

At times, the resources available in the library’s collection have been viewed as a hindrance rather than a help in the STEM integration process. This is due to the way in which print items in the collection related to STEM content areas quickly become out of date in the presence of new discoveries and innovations in these fields (Harris 16). In order to maintain an empowering, up to date, and vibrant collection, the librarian reviews library materials in a timely manner to examine which resources may be weeded, and which sections of the collection require new purchases that provide students with current, accurate information about scientific and technological fields of study (Hopwood 55). The provision of online resources, digital databases, and other technological tools in addition to or in place of some print resources also leads to the maintenance of a well rounded, empowering collection that will be of service to librarians, teachers, and students alike (Young, “Stemulation,” 20).

Other staff members may be reticent to accept the librarian as an effective STEM partner. This can be related to STEM teachers’ view of librarians as being less inclined to have an advanced understanding of science and math concepts (Mardis 252). It can
also be a matter of teachers’ unwillingness to allot more time outside the classroom for students’ exploration of STEM lessons in the library when there are already many pressures placed on fitting in all the necessary learning objectives in a relatively short amount of time (Rose-Wiles 397). Librarians, therefore, must continuously demonstrate their capability as instructional partners who can substantially increase student levels of achievement through their cooperative efforts with fellow teachers (Mardis 253).

**Successful STEM Methods in School Libraries**

The research has demonstrated that there are numerous ways in which STEM curricula can be embedded in the school library setting, one of which is the use of an extensive set of resources related to these content areas. The previously mentioned analysis of the library collection can be an indicator of areas that could benefit from new STEM additions (Braun 60). STEM teachers can be utilized as local experts who can offer suggestions as to possible materials that could be purchased as well (Mardis 259). Librarians must also maintain an array of online resources and technological tools and databases that serve STEM teachers and students as ably and effectively as the print collection (Harris 16).

Lessons and activities are similarly examined to find opportunities to enhance student learning through activities involving creation, innovation, and exploration. One method through which this is achieved is through the use of technology themed clubs and organizations whose meetings take place in the library media center (Vengersammy and Collins 8). Another involves giving students the chance to create scientific tools through which they can carry out their own experiments (Koester 24). Software programs, games, and Web resources that challenge students to design their own inventions,
models, and structures gives students freedom to exercise their imaginations as well as their understanding of STEM content (Myers and Huss 42). This use of digital media helps students establish clear, conceptual links between scientific concepts and real-world applications (Subramaniam, Ahn, Fleischmann, and Druin 163).

No matter which specific tools or techniques are used to bring STEM into the school library, the literature promotes the librarian’s role of mentorship within their students’ educational journey. Librarians become guides for students in navigating the information being learned and the technology being used in STEM content areas, and in leading them to integrate their studies into their day to day lives (Sharkey and O’Connor 37). As positive, energetic educators, librarians can, through their interactions with students, help them to perceive themselves as STEM learners, and to discover possible STEM career paths that they may wish to pursue (Powell and Boyd 38). It is posited that when librarians work closely with STEM teachers in this mentoring role, students’ enthusiasm about the content under study and their understanding of the concepts being taught is both maintained and enhanced (Mardis 253). Through these methods, students are encouraged and enabled to meet new challenges and discover new applications of their learning experiences and problem-solving techniques to environments that extend beyond the school setting (Jaeger 12).

**Conclusion**

Librarians across the country are beginning to partner with teachers and students to bring STEM curricula into their school libraries. Due to an increasing emphasis on STEM concepts in many career fields, and a need for students to increase understanding of these subjects, librarians have begun to take on this challenge in order to better prepare
their students for the world that they will encounter outside of their school experiences. In the process, librarians may run into difficulties, be they barriers to collaboration due to teachers’ perceived lack of time to address the content, a lack of confidence on both librarians’ and teachers’ parts as to librarians’ grasp of STEM concepts, racial, gender, and socioeconomic differences between student subpopulations, or even deficits within the library collection itself. In spite of these obstacles, librarians are discovering ways to infuse STEM into what they teach and how they teach it. Through the creation of learning environments that offer inquiry-based activities that allow students to experiment and innovate, the crafting of continuously updated collections of current print and online STEM resources, and the cultivation of collaborative partnerships with their fellow educators, the librarian can transform the library into a place where STEM learning is empowered in new and meaningful ways. In this process, librarians are serving to guide learners to become confident, capable, and cooperative innovators who will gain the content knowledge, persistence, problem-solving aptitudes, and overall understanding to take what they have learned and apply it to their lives for years to come.
WORKS CITED


