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Implementing Effective STEM Programming in Public Libraries: Eight Recommendations

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Executive Summary

Public libraries are becoming an important place for informal science, technology, engineering and mathematics (STEM) education for K-12 students and their families, as well as for adult education activities that support STEM workforce development. This report provides public librarians, administrators and collaborating organizations a brief background on the role that libraries can play in fostering a healthy STEM education ecosystem, as well as promising practices for implementing effective STEM programs in public libraries.

Garmer (2014) suggests there is a need for STEM learning in communities and that public libraries are a key place for that learning to occur. By offering their services for free, libraries serve as a "public square," where members of a community can gather for information, education programming, and policy discussions (American Library Association, 2013; Garmer, 2014). Increasingly, libraries' missions, initiatives, and services reflect their role in improving scientific literacy and supporting STEM learning and education standards (Anderton, 2012; Braun, 2011; Institute of Museum and Library Services [IMLS], 2009), especially for those underrepresented in STEM fields (IMLS, 2014). Patron attendance for STEM programs supports the popularity of this trend (Koester, 2014).

Public Libraries Engage Underrepresented Populations in STEM

Public libraries are particularly ideal for reaching underserved and underrepresented people and regions. Public libraries serve people of all races, ages and socio-economic backgrounds. In 2013, the Pew Research Center (PRC) conducted a survey of over 6,200 Americans to learn how people utilized public library services. The PRC survey found that 91% of Americans ages 16 and older believe public libraries are important to their communities. Seventy-six percent reported that libraries are an important education resource for them and their families. Furthermore, African Americans (60%) and Hispanics (55%) were more likely to say that libraries are "very important" to them and their families as compared to Caucasian families (41%).

Promising Practices for Public Libraries

While there are some promising practices for informal STEM education and programming in public libraries, the novel and innovative nature of STEM programming in these settings means that there is still much to learn. Informal STEM education programs typically have three goals: 1) cultivating students' interest in STEM; 2) building capacity to engage with STEM subjects; and 3) emphasizing the value of STEM learning. Program elements found successful by public library STEM programs include engaging youth, integrating youth feedback, involving caring mentors, offering a good physical location and providing professional development opportunities for librarians.

Further, based on promising practices found in the current literature, the following activities are recommended for public libraries:

1. Collaborate with STEM stakeholders that include educators, after-school staff

and/or experts in informal STEM institutions;
2. Form partnerships with organizations that serve youth;
3. Target K-12 youth historically underrepresented in STEM and their families;
4. Make STEM programs accessible to and equitable for all youth;
5. Develop strong, lasting and caring adult-youth relationships;
6. Provide training and professional development opportunities to librarians that focus on STEM facilitation strategies;
7. Evaluate STEM programs, and monitor and track outcomes; and
8. Share results with stakeholders

Public libraries have a unique opportunity to begin innovative STEM programs that support underrepresented youth through effective informal education programs and increase their community support and involvement. While best practices still need to be tested and explored for STEM programming in public libraries, librarians and library professionals can utilize these recommendations as a guide to begin developing, implementing and improving STEM programs.

The Need for STEM in Public Libraries

While STEM (Science, Technology, Engineering, Mathematics) careers are expected to grow faster than other areas of employment, many K-12 students in the United States are disengaging from STEM due to educational barriers. This has increasingly made STEM education and programming a priority for the United States, including for public libraries.

Public libraries are a long-standing and promising environment for informal education opportunities. Several national organizations support informal STEM education and programming in public libraries by providing research findings, resources and support to the library community. For example, as part of the Space Science Institute's National Center for Interactive Learning, the STAR (Science-Technology Activities and Resources) Library Education Network (*STAR_Net*) team is supporting public libraries in developing and implementing STEM education programming (Dusenbery, 2014b).

STEM professionals credit formal and informal experiences for their interest and motivation in STEM (National Research Council [NRC], 2009). Ballard (2015) found that nearly half (48%) of students pursuing STEM careers did not complete high school calculus, a popular indicator of STEM achievement. More research is needed to discern the path students take to pursue STEM careers (Cannady, Greenwald, & Harris, 2014). According to Ballard (2015), such research should consider the impacts of student opportunity, identity development and career decision-making criteria. However, the President's Council of Advisors on Science and Technology (2010) identified improved coordination and more effective teaching as the greatest areas of need in STEM education facing the U.S.

Minority students, girls, and those with low socioeconomic status or disabilities face barriers to engaging in STEM education, ultimately decreasing their opportunities to enter the STEM workforce. Students may be in multiple groups (e.g., an African-American girl living in poverty), which increases the barriers they face to STEM education.

Several barriers prevent girls from engaging in higher STEM education and aspiring to STEM careers, including negative gender-based stereotypes (Hanson, 2007) and girls' self-concepts of lower abilities in STEM (Grossman & Porche, 2014). This persists despite performance equal to or greater than that of boys in STEM subjects (McCreedy & Dierking, 2013).

Ethnic groups, specifically Hispanics and African-Americans, face cultural (e.g., social expectations), structural (e.g., historical laws and regulations) and institutional barriers (e.g., discriminatory policies and practices) to participation in STEM (Tsui, 2007). Both external negative stereotypes questioning the intelligence of Hispanic or African-American students (Fisher, Wallace, & Fenton, 2000) and internal perceptions of fewer career opportunities within these groups (Fouad & Byars-Winton, 2005) have been found to

influence STEM engagement. Further, students with disabilities are less likely than their peers to take advanced science or mathematics courses and pursue higher education (Fancsali, 2002). Each of these populations face barriers to STEM education that can be addressed in informal education settings.

This report is a summary of a comprehensive literature review developed as part of the *STAR_Net* project (Shtivelband, Wallander-Roberts, & Jakubowski, 2016). It was developed to give librarians, library administrators and collaborating organizations insight into promising practices for STEM library programs, as well as strategies to implement these innovative programs. This report provides a definition of the ecological model of STEM education, discusses inequities in STEM education, presents public libraries as a solution to this problem and provides eight recommendations for STEM education and programming in libraries.

An Ecological Model of STEM Education

Recent research uses a new lens to view successful STEM education through the STEM ecosystem model. This research views the "ecosystem" as an interconnected network with multiple sites of STEM learning support that come together to further a specific goal. According to several recent studies, STEM enrichment with the greatest amount of student interest takes place not in formal academic settings, but in informal settings such as zoos, museums, aquariums and afterschool activities (Falk, et al., 2015; Falk et al., 2016; Traphagen & Traill, 2014). These researchers suggest that STEM "ecosystem" connections provide the best means for engaging students and reinforcing learning. In fact, according to Semmel (2015), to achieve long-term change in STEM ecosystems, the best route is to look to the collective impact of multiple organizations. Indeed, improvements to the lack of enduring STEM education programs would reinforce learning for youth and help the community's overall ecosystem to flourish (Traphagen & Traill, 2014).

Put another way, when all learning environments functioning as STEM inputs (e.g., schools, afterschool activities, community organizations and social networks) come together as partners in the equation of youth STEM learning, more enduring lessons and skills are successfully imparted to youth. Best practices of innovative programs are then shared across settings and modified to fit the community, thus providing solutions for otherwise entrenched obstacles to access and efficacy of informal STEM programs (Traphagen & Traill, 2014).

Youth STEM learning activities in library. Retrieved from http://www.starnetlibraries.org/

The Importance of Informal Education

Informal STEM education environments promote and facilitate STEM programming outside of formal education settings. In fact, programs can take place in a variety of informal education institutions (e.g., public libraries, zoos, museums, aquariums, community settings, summer programs and science centers), and can be structured or semi-structured, such as afterschool programs (Shtivelband et al., 2016; Traphagen & Traill, 2014). Together, these informal venues constitute a STEM learning ecosystem, where the strengths and holes in a community's STEM learning offerings are understood through a shared vision (Traphagen & Traill, 2014).

NRC (2009) concluded that learning experiences across informal environments positively influence science learning in school, attitudes toward science and pursuit of science-related occupations. Moreover, less than 20% of K-12 student time is spent in formal learning environments, which provides potential for learning in out-of-school-time (OST) spaces (Banks et al., 2007). Furthermore, most science is learned outside of school, with the average American spending less than five percent of their life in classrooms (Falk & Dierking, 2010). There is considerable research about the positive role that OST experiences can play in student achievement (Afterschool Alliance, 2014; National Research Council [NRC], 2015). According to Falk and colleagues (2016), in order to be able to have a science-engaged public:

> *…we need to connect learning experiences across settings; leverage and customize community resources and partnerships; and broker additional science-learning opportunities across individuals' lives that connect to their family, cultural practices and community (p. 8-9).*

In a review of STEM education literature, Jakubowski et al., (2011) identified OST activities as essential to increasing achievement and diversity within the STEM disciplines. Demand for and participation in OST programming among low-income households is greater than with higher-income students. OST programs are especially well-positioned to help close the opportunity gap that many children and youth from underserved and underrepresented communities face (Afterschool Alliance, 2014; NRC, 2015). Of the 8.4 million children in OST programs, ethnic minority children are more likely than others to participate; for instance, 60% of African-American students and 57% of Hispanic youth would participate in afterschool programming if possible (Afterschool Alliance, 2014). Unfortunately, barriers such as cost, safety concerns getting to and from afterschool programs and lack of afterschool programs prevent low-income African-American and Hispanic families from enrolling their children in afterschool programs.

While the STEM movement is gaining momentum in public libraries, only select programs report evaluation data on their level of success. Examples of success include the implementation of makerspaces by informal education institutions nationwide, *STAR_Net*, a science-

technology activity and resource program for public libraries, and YOUmedia Learning Labs in libraries and museums. Below, these programs are described in greater detail, along with their initial impacts or benefits.

Public libraries make informal STEM education accessible. Retrieved from https://images.nasa.gov/#/

Public Libraries - A Promising Direction for STEM Equity and Access

Public libraries are uniquely positioned to address inequalities in formal STEM education. In recent years, there has been a movement toward offering STEM programs in public libraries. For example, many libraries have begun to include STEM activities in their existing youth and adult programming (e.g., Anderton, 2012; Braun, 2011; Dusenbery, 2014a; Roberson, 2015). Results from *STAR_Net's* national library survey document that STEM programming is offered regularly in public libraries (Hakala, MacCarthy, Dewaele, & Wells, 2016). Specifically, of the 455 responding libraries, 29% offer STEM programming "frequently" (more than once per month) and 26% offer STEM programming "monthly." When asked what age groups they would like to reach with STEM programming, 89% said elementary students, 85% said middle school students, 73% reported pre-K and 71% wanted to reach high school students.

Therefore, it is not surprising that numerous researchers (e.g., Baek, 2013; Koester, 2014) argue that public libraries can engage their communities in STEM learning. Public libraries provide a "third space" beyond the formal classroom and home that can unite schools and communities around STEM education and complete the community's STEM learning ecosystem (Baek, 2013; Traphagen & Traill, 2014). They are accessible, provide existing resources (e.g., access to materials and the internet free of charge, assistance of library staff) and are positioned in communities as a place of learning (Baek, 2013). The following list highlights the benefits of STEM programs in public libraries.

Public Libraries Are Accessible

With well over 17,000 nationwide (Swan et al., 2013), public libraries are more accessible than other informal education settings (Dusenbery & Curtis, 2012). Unlike other informal education settings (e.g., museums, zoos), public libraries offer services to families at no cost and are closer to their homes (Dusenbery & Curtis, 2012). Public libraries are also critical spaces for minority and underrepresented populations to engage in learning. For example, the Pew

Research Center (2013) found that these groups rated the services that public libraries provide (e.g., books and media, safe space, youth programs) as very important. Similarly, the American Library Association (2013) found that high percentages of families and underrepresented minority groups utilized public libraries. Public libraries can use their existing connections to underrepresented communities to increase informal STEM education and encourage STEM interests and aspirations for these and other populations.

Public Libraries Are Places for Community Learning

Public libraries are known for providing a place for people of all ages to pursue their interests, have meaningful experiences and gain expertise (Association of Science - Technology Centers & Urban Libraries Council, 2014). These institutions support life-long learning that can enhance the personal development of their patrons by providing free and easy-to-access information, resources, and a safe and welcoming environment (Durrance & Fisher, 2003). As public libraries allow lifelong, life-wide, and life-deep learning experiences (NRC, 2009), they are a great place to offer informal STEM education programs.

Public libraries can also provide the opportunity to learn STEM free of judgment and grade pressure, allowing youth to make mistakes and participate in hands-on activities of their own volition (National Research Agenda, 2011). Spencer and Huss (2013) describe public libraries as an ideal environment that can supplement formal education and provide a relaxed place for youth to discover, dream, create and invent. These aspects of learning can support youth engagement in public library STEM programs and increase their interest in STEM subjects.

Public libraries make provide a place for community learning. Retrieved from pexels.com

STEM Programs Can Increase Community Support and Funding

Incorporating STEM into programming for youth benefits public libraries, particularly through increasing funding opportunities, partnerships and support from the community (Hopwood, 2012). Various STEM initiatives are being supported through grants, including federal and state government grants (e.g., Institute of Museum and Library Services, National Science Foundation), as well as grants from foundations and nonprofits (e.g., Change the Equation Organization, Iridescent).

Libraries providing informal STEM education increase their access to these funding opportunities, which can be used to implement, sustain or grow library programs. Another benefit to public libraries offering STEM education and programming is increased partnership opportunities. Partnering with STEM stakeholders can provide public libraries with additional

resources to which they otherwise would not have access, including funding, programming resources and additional volunteers. These partnerships and STEM programs also strengthen the role public libraries have in their communities as institutions of education (Hopwood, 2012). Fun, innovative and educational STEM programs can increase the visibility of public libraries, help them to better engage with community members and support achievement of their overall goals.

Promising Practices for STEM in Libraries

Public libraries have the opportunity to encourage the development of STEM interests, values and career aspirations in youth. Using best and promising practices, as well as significant resources available, libraries can develop and implement STEM programming. The NRC (2009) recommends that OST environments do not restrict themselves to purely academic goals or subjective learning outcomes. The NRC (2009) suggests that outcomes are best defined by learners in OST settings. The following describes effective STEM learning in OST settings:

- Experience excitement, interest and motivation to learn about phenomena in the natural and physical world;
- Generate, understand, remember and use concepts, explanations, arguments, models and facts related to science;
- Manipulate, test, explore, predict, question, observe and make sense of the natural and physical world;
- Reflect on science as a way of knowing; on processes, concepts, and institutions of science; and on their own process of learning about phenomena;
- Participate in scientific activities and learning practices with others, including using scientific language and tools, and
- Think about themselves as science learners, and develop an identity as someone who knows about, uses, and sometimes contributes to science.

To better understand how public libraries can meet these goals, the following section provides best and promising practices for informal STEM education in public libraries, as well as best practices for engaging underrepresented populations in STEM education. Examples of STEM programs in public libraries are provided to show the range of styles in STEM programming, as well as successes and resources for developing STEM programs.

STAR Library Education Network.

STAR_Net is a national informal education program that has developed STEM-related exhibitions, education and outreach programs (http://www.starnetlibraries.org) for library settings (Dusenbery, 2014b). This program builds capacity for public libraries to provide informal STEM education through resources (e.g. exhibitions) and program activities, in addition to professional development and training for librarians. Summative evaluation of

STAR_Net programs indicates that this project made positive impacts on host library communities (Evaluation and Research Associates, 2013).

Specifically, the following trends were observed:

- An increase in libraries hosting STEM-related programming or activities in the six months following the *STAR_Net* programs and;
- An increase in the interest, knowledge and engagement of library patrons in the STEM exhibit topics of Discover Earth and Tech (Evaluation and Research Associates, 2013).

These results indicate the potential for long-term impact of initiatives like *STAR_Net*. Public libraries can work with *STAR_Net* to launch their STEM programs, as *STAR_Net's* STEM exhibits allow public libraries to gain STEM program experience before developing and investing in independent programs. Public libraries can also utilize the resources (e.g., blogging community, social network, newsletters) and learning opportunities (e.g., conferences, online forums) provided by *STAR_Net* to learn more about and connect with other library that implement STEM programs.

Evaluation of demonstrated promising practices for STEM programming in public libraries is presently limited, as existing programs are relatively new and not enough time has passed to evaluate their value and scalability. However, public library STEM programs have found success when they: 1) engage youth; 2) include youth feedback; 3) involve caring mentors; 4) offer a good physical location; and 5) provide professional development opportunities for librarians (Fancsali, 2002; Lyon, Jafri, & St. Louis, 2012; Spielberger & Whalen, 2002). Professional development for librarians is particularly important to successful STEM programming, as many librarians feel concerned about their abilities and competency to provide STEM programming (Baek, 2013).

Additionally, Hopwood (2012) offered suggestions to support STEM programs in public libraries, including: 1) hosting open-book trivia contests with STEM content; 2) creating STEM displays; 3) offering LEGO activities; 4) providing family science nights; 5) offering STEM-related story times; 6) providing video gaming technology; 7) hosting cooking programs; 8) providing sports activities that integrate statistics; and 9) showcasing technology so patrons can utilize tablets, e-readers and cameras. In addition to each of these program elements, Anderton (2012) made the following recommendations to integrate STEM into public libraries:

1. Promote STEM programs to educators and parents;
2. Create STEM booklists and include STEM–related items in general booklists;
3. Advertise STEM resources on blogs or other social media tools;
4. Apply for funding from local and national organizations;
5. Involve others in your community;

6. Host a STEM program (e.g., facilitate gaming sessions or create digital content);
7. Build slowly; and
8. Ask teens to help.

These innovative ideas, recommendations for implementation and successful program elements provide direction for public libraries to incorporate STEM. As libraries are already engaging populations underrepresented in the STEM workforce, it is important to consider best practices to overcoming barriers in STEM education for these groups.

Make learning fun! Retrieved from pexels.com

YOUmedia Learning Lab (YOUmedia).

YOUmedia provides informal education spaces in libraries and museums that provide STEM-related experiences for middle school and high school students through digital media and technology. Though YOUmedia is unique to its setting, all aim to support students in "hanging out," "messing around," and "geeking out" in their areas of interest with peers and supportive mentors (Association of Science-Technology Centers & Urban Libraries Council, 2014). These programs are based on principles of "connected learning," which initial evaluations indicate help students gain exposure to various interests, develop expertise in areas of interest and connect interests to academic and career paths. YOUmedia builds learning ecosystems that engage teens, provide mentors and offer physical space for a successful program (Association of Science-Technology Centers & Urban Libraries Council, 2014). The YOUmedia Network Community of Practice (http://community.youmedia.org/home), helps public libraries connect to discussion forums and resources with other organizations offering STEM programming.

Engaging Underrepresented Populations in STEM

Several strategies for overcoming barriers specific to and engaging with populations underrepresented in STEM fields have been developed and used by public libraries. SciGirls (2016) recommends the following strategies to help girls overcome barriers to engaging in STEM:

1. Focus on collaboration, especially when girls can participate and communicate fairly;
2. Provide projects girls will find personally relevant and meaningful;
3. Provide hands-on, open-ended projects and investigations;
4. Allow girls to approach projects in their own way, applying their creativity, unique talents and preferred learning styles;

5. Provide positive feedback on things girls can control, such as effort, strategies and behaviors, which will improve girls' confidence and performance;
6. Encourage girls to think critically to gain confidence and trust in their own reasoning; and
7. Encourage relations with role models and mentors.

Chicago City of Learning. The Chicago City of Learning (CCOL) provides another approach to STEM learning opportunities for diverse youth by bridging the gap between traditional academic learning in school and informal out-of-school learning in innovative ways (Chicago City of Learning [CCOL], 2016). CCOL seeks to "break down false barriers" between these two settings and leverage the city's many STEM-related resources and visible organizations (CCOL, 2016). Participating youth are recognized via digital "badges" displaying their learning milestones. Offshoots of the CCOL program are also available in other cities across the country (e.g., Columbus, Dallas, Los Angeles, Pittsburgh and Washington, D.C., with more to be launched). The concept of collective impact builds on these principles to bring various interdependent community organizations together to demonstrate they make a "real difference" in STEM education needs (Semmel, 2015).

Inspire excitement, interest and motivation to learn about the natural and physical world. Retrieved from https://images.nasa.gov/#/

Recommendations for STEM Programs in Public Libraries

Based on an extensive review of the literature (http://www.nc4il.org/papers.html) the following recommendations were developed for public library professionals, staff, administrators and collaborators to create, integrate and strengthen STEM programs and activities. These eight recommendations provide the public library community promising tools and resources that may help sustain informal STEM education and programming in their institutions.

1. Collaborate with STEM Stakeholders

STEM education has begun to be seen as a learning "ecosystem." A learning ecosystem considers schools, community settings such as after-school programs, science centers and museums, public libraries and other informal experiences at home as places of learning and development for children and youth. The goal of the ecosystem is to engage young people, promote knowledge and become skilled in the STEM disciplines as they grow (Traphagen & Traill, 2014).

STEM stakeholders are part of the learning "ecosystem" and include STEM professionals and community leaders, as well as community-based organizations, schools and universities that provide STEM education. STEM stakeholders can provide innovative ideas and opportunities for programming, as well as help public libraries develop a bridge between research and practice. These collaborations can build the capacity of public libraries to deliver effective STEM programming while providing opportunities for STEM stakeholders to engage in community programs.

2. Form Partnerships with Organizations that Serve Youth

In addition to collaborating with STEM stakeholders, public libraries implementing STEM programs can also form partnerships with organizations that directly serve youth (e.g., Boys & Girls Clubs, 4-H, afterschool programs), especially the historically underrepresented. These partnerships can strengthen public libraries' capacity to serve youth and mitigate barriers that they may face engaging in STEM. Additionally, public libraries can benefit from youth organizations' experience in positive youth development programming, which has shown to increase program effectiveness. In this context, youth development programming refers to an asset-based theoretical framework that encourages youth-centered, knowledge-centered and community-centered experiences (McLaughlin, 2000). The framework aims to achieve target outcomes that reflect successful positive youth development efforts, including competence, confidence, connection and contribution (Lerner, 2005; Luke, Stein, Kessler, & Dierking, 2007).

3. Target Historically Underrepresented K-12 Youth

Public libraries may also see their programs make greater impacts on STEM engagement by targeting populations underrepresented in STEM, including girls, ethnic/racial minorities, students of low socioeconomic status and students with disabilities. Public libraries are already serving these groups by providing them with a safe, trusted and welcoming environment, which may increase their effectiveness at addressing disengagement than other informal education settings. Therefore, public libraries should take advantage of their unique opportunity to engage underrepresented youth in STEM education and programming.

4. Make STEM Programs Accessible to and Equitable for All Youth

In addition to targeting underrepresented populations in STEM fields, public libraries should ensure STEM programs are as accessible and equitable as possible for all youth, including those with disabilities. To accomplish this, public libraries can continue offering free programs and services, provide a welcoming atmosphere, and employ friendly and knowledgeable staff. Public libraries can also implement services to make transportation easier for youth (e.g., a voucher system), inform parents and caregivers of STEM programs and engage them when possible to support youth enrollment in programs, offer STEM

materials in other languages represented in the community (e.g., Spanish), and share knowledge gained from STEM program implementation with other public libraries. Additionally, the Research + Practice Collaboratory developed four recommendations for structuring out-of-school staff efforts to support equity-oriented STEM learning (Bevan, Ryoo, & Shea, 2015). These recommendations include "seeing, hearing and honoring" youth ideas shaped by their culture; building in required time for reflection on teaching, learning and equity; focusing on asset-based professional development approaches; and explicitly discussing political and historical inequities as they relate to youth and shaping STEM program activities (Bevan, Ryoo, & Shea, 2015).

Host a STEM LEGO activity. Retrieved from https://images.nasa.gov/#/

5. Develop Strong, Lasting, Caring Adult-Youth Relationships

Strong, lasting and caring relationships with adults are critical for youth development across formal and informal education and programming. Public libraries have an opportunity to foster the development of these relationships by providing a consistent and enduring network of adults who youth can trust and engage with during STEM programming. Adults can include individuals such as librarians, STEM program staff, STEM mentors, parents, volunteers and even students from collaborating high schools or colleges. For example, Techbridge's (2016) Role Models Matter Initiative provides online training toolkits to STEM professionals to conduct activities that engage girls and underrepresented youth in STEM. This program concluded that it is vital for staff working with youth to develop skills to effectively engage and inspire them (Techbridge, 2014). Techbridge has developed several approachable formats for effective training, ranging from hour-long lunch and learn trainings on-site and community full-day outreach events, to online training modules for distance learning and refresher courses (Techbridge, 2014). These relationships can provide youth with the guidance, support and mentoring they need to engage and persist in the STEM ecosystem.

6. Provide Training Opportunities to Librarians

Librarians need to feel equipped with the skills and confidence to implement STEM programming, as many believe they are unable to offer this type of service to youth. Providing librarians with professional development and training can increase their ability to provide successful STEM programming. These opportunities should include information on youth development and programs, as well as STEM-specific activities and programming facilitation. Librarians need to feel empowered to provide STEM education and programs, partner with STEM stakeholders and direct

students to STEM resources. Creating a high-quality public library staff is a best and promising practice for successful library programs; therefore, investing in training for library staff and Library and Information Science students is critical for developing, implementing and improving STEM programs.

7. Evaluate STEM Programs and Monitor and Track Outcomes

Although evaluation for STEM programming in public libraries needs further development, public libraries should strive to track program data and evaluate their outcomes. This can be accomplished through identifying how library resources and activities contribute to educational outcomes for library patrons. Additionally, public libraries can partner with evaluators and academics with expertise in evaluation to increase their library's evaluation capacity. Specifically, by evaluating programs, libraries can identify successful tactics and areas for improvement, increase funding opportunities by showing effectiveness of programs, and share lessons learned and ideas that work with other public libraries looking to implement STEM programming.

8. Share Results with Stakeholders

As public libraries implement and evaluate STEM programs, they should share their results with stakeholders to show their impact to the larger community. Not only will sharing information encourage evaluation efforts of STEM programs, but it may also increase community support, visibility and, potentially, partnerships. These benefits can be realized by public libraries sharing program successes and other public libraries looking to garner support to begin STEM programming.

Conclusion

Public libraries are increasingly becoming a place for informal STEM education in the U.S., addressing inequities and issues facing STEM fields. As this movement continues, public libraries can utilize these best and promising practices and recommendations to develop, implement and improve STEM programming in their libraries, effectively addressing issues affecting the STEM workforce. Public libraries have the unique opportunity to engage youth in fun, exciting, and educational STEM programs; further develop the skills and knowledge base of their librarians; partner and collaborate within the community; and increase their support in the community, all while providing necessary informal education opportunities to support STEM fields. While STEM programs in public libraries are still new, there are already significant resources available to encourage the development, implementation and improvement of STEM programs in public libraries.

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