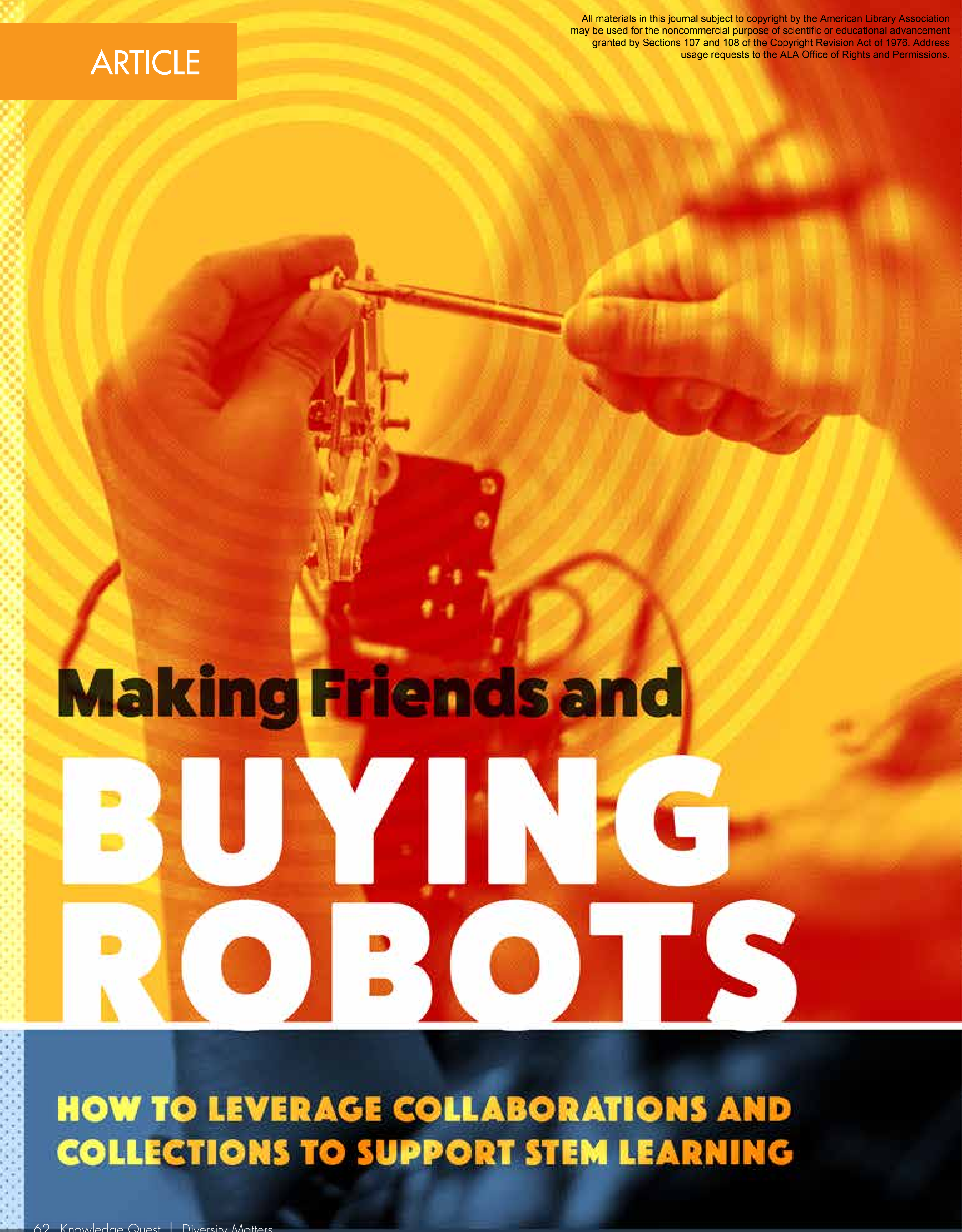
ARTICLE



Making Friends and BUYING ROBOTS

HOW TO LEVERAGE COLLABORATIONS AND COLLECTIONS TO SUPPORT STEM LEARNING

Cassandra Kvenild
ckvenild@uwyo.edu

Craig E. Shepherd
cshephe6@uwyo.edu

Shannon M. Smith
ssmit147@uwyo.edu

Emma Thielk
ethielk@uwyo.edu

In a climate of increased interest in science, technology, engineering, and math (STEM), school libraries have unique opportunities to grow collections and cultivate partnerships in the sciences. At the federal level and in many states, STEM initiatives encourage hands-on exposure to technologies and open the door for student-led discovery of tools related to robotics, coding, programming, and electronics. Influenced by local STEM initiatives, the Learning Resource Center (LRC) at the University of Wyoming Lab School decided to create a circulating collection of STEM kits. (The UW Lab School is a tuition-free charter school with a diverse population selected by lottery.) This school library also partnered with Lab School teachers to explore these STEM collections and to develop programming and a curriculum to teach digital literacies and STEM skills to students in kindergarten through ninth grade.

Because the Learning Resource Center did not have enough square footage for a dedicated makerspace and because the collection budget was more robust than the equipment budget, the school librarians decided to purchase STEM kits and materials with collection funds and circulate them. This decision generated excitement around the collections but also created new challenges related to collection development, acquisition, and circulation. Once those challenges had been addressed, the collection became available for exciting experiments, programs, and other instructional opportunities.

Practicalities

Buying and Prepping the Resources

The STEM kits and materials of high interest were not available from any of the library's contracted vendors. To select these materials, librarians participated in the online makerspace conversation through websites, Twitter, blogs, and more. Teachers and professors recommended several items for purchase, and students also made suggestions. Selection criteria included designated age range, positive reviews, size, cost, number of parts, and the presence of consumable parts. The librarians favored purchase of items small enough (in their original packaging) to fit on standard library shelves and those that did not have consumable parts that required regular replacement (with the exception of batteries, which patrons are expected to provide). Kits with a higher cost or a large number of parts were considered on a case-by-case basis and sometimes added to the collection.

Once items had been identified for acquisition, they were ordered a la carte from websites and paid for using a credit card. (See the sidebar for URLs of suggested vendors.) Once the purchased materials arrived at the library, the processing required was significantly different from that of most acquisitions. The library already owned a small and growing collection of kits and games, and staff adapted the specialized workflow for those items when processing the new STEM collections. This workflow involves inventorying all parts and pieces of the kit for the benefit of circulation staff and patrons, photographing the items, and including the photographs and inventory in the online catalog (Butler and Kvenild 2014).

Circulating

Staff training and active policy refinement were required to circulate these materials. Many STEM kits include consumable or easily lost components, such as conductive thread, batteries, SD cards, specialized tools, or small LED lights. The school librarians had to decide whether to circulate consumable parts. When those parts circulated, we had to decide whether to charge patrons for missing components, or to accept a certain level of loss and pay the replacement costs from the library budget. Clear communication with patrons about expectations for what must be returned and what can be used up proved to be important when circulating this collection. Parts and pieces of a kit are counted at the points of check-out and check-in to ensure all parts are present and the kit will still function, a process that can slow the pace of work at the circulation desk.

Circulating the STEM materials can impact instruction and planning. Because of the popularity of the collection, librarians who want to use the resources are careful to check out kits in advance of programs. After an initial decision to circulate the STEM kits for a full loan period, the school librarians decided to shorten loan periods on all kits and games. This change increased availability of the collection for a larger number of patrons and helped make sure that kits were returned to the library in time to be used in the Lab School library's own programming and instruction.

Learning How to Use the Resources

The acquisition of STEM materials also led to a different type of challenge: how best to use these new resources in support of student learning. Librarians are accustomed to learning the ins and outs of a new database or reading and recommending books. In many cases, librarians have been trained to provide critical insights and guidance about how to use purchased materials. In the case of these cutting-edge STEM collections, Lab School librarians had less experience on which to draw when testing the kits, but the results of their investigations and hands-on explorations proved rewarding.

One of the first significant purchases for the STEM collection included Raspberry Pi computer kits. The school librarians knew when they selected these kits that they could not be circulated in the condition in which they had been received because the hardware would be unassembled and untested. The choice was made to offer a nine-week program open to sixth- through ninth-grade students at the Lab School to build and secure these kits for circulation (see figure 1). When these kits arrived, librarians initially felt somewhat out of their depth. Lack of instructions, lack of experience working with small computer components, and lack of teaching background in STEM fields increased their uncertainty. Most collections do not require subject expertise to use or circulate, and most kits arrive with clear instructions or lesson plans. The STEM collections did not match the librarians' prior experience with other circulating kits.

To remedy this situation, librarians approached science teachers from the Lab School and asked for help. One teacher was fascinated by the kits and offered to cohost the program. Not only did this teacher bring years of STEM experience to the project, she also had access to soldering irons, safety eyewear, and a science lab with heat-protected workstations. Thus, students were able to practice soldering skills prior to building the mini-computers. The burden of safety and subject expertise became shared when the school librarians partnered with a science teacher.

The burden of safety and subject expertise became shared when the school librarians partnered with a science teacher.

Working with a classroom teacher increased the richness of resources for previously existing STEM opportunities in the school; the new resources provided a unique way for librarians to reach out to science and math teachers.

With this support, the program helped students conceptualize and discuss what constitutes a computer, and culminated in students building five Raspberry Pi computers, uploading a Linux-based operating system, and programming the machines using both Scratch and Minecraft (see figure 2).

Through this experience, the Lab School librarians realized that identifying and developing units of instruction while simultaneously gaining familiarity with technology-rich tools (many of which require assembly and software training) can be a daunting task. However, they also realized they were not alone in these endeavors and were reenergized about the work they had begun. Working with a classroom teacher increased the richness of resources for previously existing STEM opportunities in the school; the new resources provided a unique way for librarians to reach out to science and math teachers. From that point forward, partnerships were actively sought to reduce anxiety, brainstorm ideas, distribute learning goals, share resources, and divide classroom applications. Partnerships have included the groups described in the following sections.

Current Teachers

Teachers have a wealth of knowledge to support STEM activities, are easily accessible, and often share interests in purchased (and desired) resources. As the school librarians have encouraged engagement with these materials, they have discovered interested teachers in a variety of disciplines, including science, mathematics, and art. Additionally, teacher partnerships have allowed librarians to access resources not traditionally held in their collections that facilitate and enhance program offerings (e.g., art supplies, safety goggles, sinks, lab tables). The division of classroom-management responsibilities also allows for the focus to be on leveraging STEM-based activities and engagement with students.

Students

Students gravitate toward these circulating STEM materials. Soon after receiving kits, student interest is piqued as they examine the new resources in programs offered by librarians. Students can gain considerable experience with technologies that match their interests and become useful mentors to others, including librarians and other partners. Fortunately, most students are flattered when given an opportunity to share their skills with others, particularly adults. Leveraging students' expertise can generate ideas, facilitate instruction, engage other students, and foster student-directed learning.

At the UW Lab School, librarians have found that students are also essential partners in programs relating to STEM initiatives. Their enthusiasm is contagious and propels those around them to think about technology in new and innovative ways. Often, students research new collection materials and make suggestions for add-ons or additional kits that will allow them to deepen their STEM exploration. The school librarians find that students generally have strong opinions about purchases of STEM materials and are happy to share why they believe additional purchases are important. This process generates both a strong collection and program ideas that are student-driven. Librarians are now working to develop a formal student-led purchasing program with a dedicated portion of the collections budget.

Part-Time Support Staff

Additionally, school librarians lean on the interests and motivations of their support staff to encourage hands-on and web-based exploration and to report best practices. Because STEM resources are in library circulation, staff members are encouraged to check out materials, test them at home, share them with friends and family, and note their observations. This approach not only helps the school librarians identify websites and videos devoted to supporting STEM technologies, but also to identify potential lessons, activities, and assessments for learning.

Local Enthusiasts

Several faculty members at the university near the school are interested in Pre-K–12 technology integration and have historically partnered with local schools to help pre-service teachers gain technology skills (Shepherd et al.

Figure 1. A UW Lab School student assembles a Raspberry Pi kit.

Figure 2. UW Lab School students program Raspberry Pi computers.

2015). Thus, librarians approached these faculty members to see if they would like to get involved in learning about and supporting STEM-based circulation materials. A few volunteered. This partnership began with awareness sessions for pre-service teachers. Every semester these faculty members now bring pre-service teachers to the Lab School library to learn how school librarians support instruction and to examine circulating technology resources (see figure 3).

As the STEM programs and curricula developed by the school library continue to grow, the librarians consult and partner with still more local experts and enthusiasts. The librarians reached out to the local robotics club to share information and software. One librarian now volunteers with the robotics club to gain knowledge for the Lab School library's programs while providing valuable mentoring to children in the club, as well as a female presence in the volunteer cohort. Programming software developed by leaders of the robotics club is now installed on all library workstations for use by students learning to code. The librarians developed relationships with other local makerspaces and with the 3-D visualization cave on the university campus for additional support and for field trip experiences. And, of course, other school librarians and public librarians are incredibly valuable resources and partners for sharing and learning about STEM resources and developing new approaches to implementation of STEM programs.

Sphero Robotics: An Example

Here's a detailed example of a recent program to demonstrate how partnerships, along with circulating materials, have engaged students in STEM. When building the robotics collection of STEM kits, the library purchased and circulated several robots (e.g., Dash and Dot, Sphero, Ollie, Bee-Bots). During the 2015–2016 school year the library staff decided to purchase twelve additional Sphero devices (see figure 4) because they are compact, durable, waterproof, inexpensive, support free and portable programming options, lack small parts to lose, and were found to be more approachable than Lego Robotics. Fortunately, a university professor, a middle school science teacher, and a part-time library employee volunteered to help librarians develop and teach a nine-week course at the Lab School. In the course students explored robotics, programming, and art with this technology, even though none of the adult facilitators had much (if any) experience using Sphero robots.

Prior to instruction, all of these instructional partners met to discuss what goals and objectives they wanted to accomplish. They determined that students would learn how the robot moved and how they could interact with its various sensors using the SPRK Lightning Lab app for Android and iOS devices. The instructional partners wanted to teach basic programming that included key concepts such as loops, variables, sensors, and events. Achieving this goal required additional study for all instructors. While each had explored rudimentary Sphero programming for course-preparation purposes, they were not deeply familiar with many of these concepts and spent time learning off-hours. Teachers and librarians nurtured a culture of open communication to share their discoveries with each other and support one another's successes.

To accomplish the daunting project of planning a new course with technology that was brand-new to us, tasks were divided among the team members. The part-time employee located web-based resources regarding the internal components of Sphero and how they worked. Librarians found ideas on Pinterest and other blogs about using Sphero robots with finger paints. The Learning Labs site associated with the robot included resources about using slow-shutter-speed cameras to draw light-based pictures (SPRK Lightning Lab n.d.). All partners learned how to program the robot using various examples provided in the app used to control the Sphero devices. Through these explorations, the team developed a solid curriculum. (See the sidebar for links to our website.)

Initially, fifteen seventh- through ninth-graders enrolled in this program, meeting for forty-five minutes a week in the heart of the library. During these sessions, students learned how to drive their robots using app-enabled navigation controls and how to program a Sphero to change colors, move in basic shapes (e.g., squares, triangles), play Sphero hot-potato games, and auto drive (automatically altering directions when the Sphero

Teachers and librarians nurtured a culture of open communication to share their discoveries with each other and support one another's successes.

bumps into objects). The program culminated in an activity in which students programmed their robots to paint shapes with fingerpaints on giant strips of craft paper.

Although this program ran smoothly, instructors realized they had not leveraged student interest and expertise sufficiently. They revised their approach to better introduce difficult concepts like variables and sensors, and offered the course to a new group of students. During this implementation, students were encouraged to check out the robots, experiment with them at home, and report their findings during class. They were also asked more frequently to teach others, including the instructors and other adults. These changes resulted in more complex programs (e.g., heart shapes, stars, spiraling squares, circles), personalized hot-potato games, and more. Giving student partners a leadership role in this STEM program fostered greater depth and breadth in their robotics programming than would have otherwise been taught.

Getting Started at Your Library

If you want to reinforce STEM skills at your library, materials that will be the most popular and useful are those that can be used in numerous ways. Selecting versatile kits will allow for more program creation and offer a low-cost approach to getting started with STEM in your school library. Talking to other librarians and teachers to learn what kits they know about and what they'd be interested in using can provide valuable inspiration for purchases. Many of these kits are not reviewed in traditional sources, so partners will become your best reviewers and recommenders.

Figure 3. UW faculty members and pre-service teachers explore kits containing electronic components.

Figure 4. Lab School students discover how to control a Sphero robot.

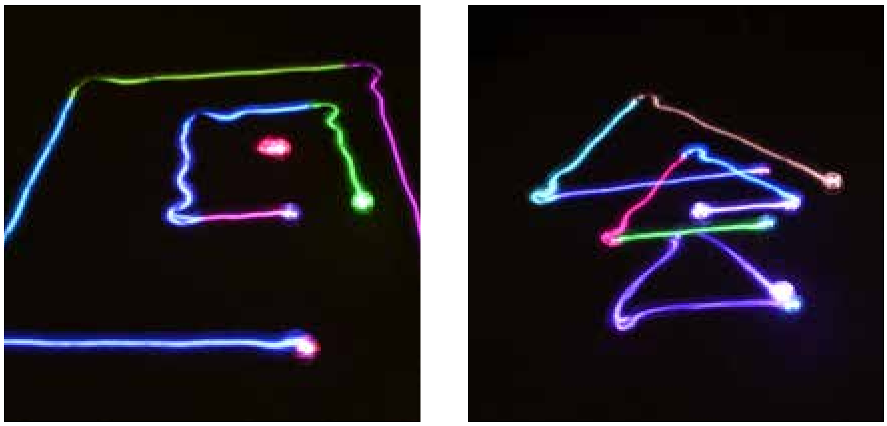


Figure 5. Examples of "light painting" with Sphero robots and a slow-shutter-speed camera.

Figure 6. Student "painting" by controlling Sphero robots.

If you want to reinforce STEM skills at your library, materials that will be the most popular and useful are those that can be used in numerous ways.

The next step after selecting materials for purchase and circulation is understanding how to use the technology. This step does not need to be intimidating, especially if you keep the following points in mind as you begin your STEM journey.

Remember, no one has to be an expert to learn. Developing expertise just takes some time and a willingness to play with the technology yourself. Blogs of librarians like Andy Plemmons, reports from maker fairs, as well as websites of STEM resource vendors and manufacturers are great ways to learn more about how the materials work and how to start teaching about and with them.

Provide a framework of support for you and your students. Consider adding books to your collection that directly correspond to the kits you selected for purchase. Being able to check out these books to read at home will allow students to delve deeper into understanding technologies and reinforce concepts.

Stimulate your students' interests by aligning tasks or challenges in your programs with pop culture references that are popular in that moment.

Seek out partners in your community by identifying groups and individuals with specialized STEM interests. These enthusiasts and experts can help you find new ways to create and present programs for your library.

Encourage student input by asking them what they want in the collection. Polls, questionnaires, and advisory groups are all ways to give students a voice in purchasing decisions. Consulting students also ensures popularity of purchased materials.

Document your successes by tracking what resources have proven useful and what approaches ignite the students' creativity. Incorporate formative assessments into programs to improve the experience as you go. Try to take photographs of every program and activity to capture and share what was successful.

Conclusions

Powerful learning moments occur when school librarians remember to step out of the role of teacher and into the role of fellow participant. Students working through problems on their own have been overheard making unprompted pronouncements about their learning experience, such as "I'm more comfortable programming this [robot] than driving it," and "Guys, we're doing a lot of geometry right now!" Learning connections to science and math were made without instructor input

SUGGESTED RESOURCES

For lesson plans, inspiration, and ideas:

Barrow Media Center Blog: <https://expectmiraculous.com>

Geek Gurl Diaries: <www.youtube.com/user/GeekGurlDiaries>

Learning Resource Center Blog: <http://uwlibblogs.uwyo.edu/learning>

Learning Resource Center STEM Curriculum Materials Site: <http://libguides.uwyo.edu/lrcstem>

Raspberry Pi: <www.raspberrypi.org/resources>

Scratch: <https://scratch.mit.edu>

Sphero: <www.sphero.com/education>

For purchasing STEM materials:

Bee-Bot: <www.bee-bot.us>

Dash and Dot: <www.makewonder.com>

Little Bits: <http://littlebits.cc>

Maker Shed: <www.makershed.com>

Makey Shop: <http://shop.makeymakey.com>

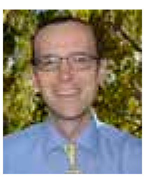
Sparkfun Electronics: <www.sparkfun.com>

Sphero: <www.sphero.com>

and resulted in students' continued engagement with the library programming. The confidence with which students have tested and developed new technology skills, and then taught them to adults, has offered an authentic assessment of students' burgeoning STEM interest and skills. Working with the hands-on resources also fostered a participatory culture in the library. School librarian Andy Plemmons has suggested that librarians "just need to be willing to offer the space for students to develop their expertise and pass that learning onto others" (2012). In the case of the Sphero program, his advice proved more true than librarians had imagined.

At the UW Lab School librarians have cultivated an interest in emerging technologies, a commitment to diverse community partnerships, and a willingness to let students be the classroom experts. They've learned that students sometimes go farther in thirty minutes of engagement with these kits than the librarians did in several hours of work! Now, the participating librarians come to their programs with a belief in offering guidance (via videos, books, websites, and other materials) and support to the students, and an open approach to exploring STEM alongside the students. The librarians are now part of the journey; together all of the library's partners model for students how to ask questions of each other and how to share their discoveries. Together they have overcome initial anxieties around creating compelling STEM programs and have opened the door to STEM success.

Cassandra Kvenild *is head of the Learning Resource Center (the Lab School library), part of the University of Wyoming Libraries. In 2015 she and Melissa Bowles-Terry coauthored the book* Classroom Assessment Techniques for Librarians *(ACRL 2015). A member of the Association of College and Research Libraries (ACRL), AASL, and the Library Information Technology Association, Cassandra is the current chair of the ACRL/EBSS Research Committee and a member of the ACRL Publications Coordinating Committee.*



Craig E. Shepherd *is an associate professor of instructional technology at the University of Wyoming. His research interests include technology use to facilitate learner-centered informal and formal learning environments, electronic portfolios and other tools to document and examine professional practice, and distance education.*

Shannon M. Smith *is the library specialist at the Learning Resource Center (the Lab School library), part of the University of Wyoming Libraries. Shannon provides weekly technology instruction at the UW Lab School to K–9 students, including popular student-centered electives for middle school students. In 2015 she was recipient of the Wyoming Library Association's Milstead Award in recognition of her leadership in technology with schools in Wyoming. She blogs at <http://uwlibblogs.uwyo.edu/learning>.*

Emma Thielk *is the instructional technology intern at the Learning Resource Center (the Lab School library) of the University of Wyoming Libraries. At the University of Wyoming she is majoring in American Studies with a minor in Museum Studies. She loves working with diverse technologies among students of all ages. Emma is excited about the options to incorporate her experiences with technology into her future work with museums.*

Works Cited:

Butler, Marcia, and Cassandra Kvenild. 2014. "Enhancing Catalog Records with Photographs for a Curriculum Materials Center." *Technical Services Quarterly* 31 (2): 122–38.

Plemmons, Andy. 2012. "Opening the Space: Making the School Library a Place of Participatory Culture." *Knowledge Quest* 41 (1): 8–14. <www.ala.org/aasl/sites/ala.org.aasl/files/content/aaslpubsandjournals/knowledgequest/docs/KNOW_41_1_OpeningtheSpace.pdf> (accessed October 8, 2016).

Shepherd, Craig E., et al. 2015. "Fostering Technology-Rich Serving Learning Experiences between School Librarians and Teacher Education Programs." *Knowledge Quest* 44 (2): 44–52.

SPRK Lightning Lab. n.d. "Light Painting." <https://sprk.sphero.com/cwists/preview/78-> (accessed October 8, 2016).