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THE UNSPACE CASE: DEVELOPING A MAKER MOVEMENT IN A MULTIPURPOSE, FLEXIBLE SPACE, LIBRARY SETTING

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This paper presents the ongoing design, development, and implementation of a K-16 maker movement centered around a joint public school/university library whose minimal dedicated space has expanded opportunities for public participation, partnerships, and shared resources. As the library sought to circulate STEM resources for K-9 teachers and students in 2011, University instructors were seeking opportunities for preservice teachers to interact meaningfully with authentic, technology-rich environments. These separate endeavors coalesced over time to form a robust community of various school, university, and public stakeholders focused on mathematics and science learning. Because the space was not bound to a single physical location, proponents were able to leverage various resources, mobile tools, and settings to explore and apply STEM knowledge, construct products, and attract new and returning users. This design case articulates how the maker movement provides curricular programming while maintaining a playful atmosphere that encourages personal exploration regardless of age and ability.

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LEARNING RESOURCE CENTER

The University of Wyoming (UW) Libraries system houses a center in the College of Education for the instructional and research needs of college faculty, pre-service teachers, and other university students. This branch library, the Learning Resource Center (LRC), collects and circulates children's and young adult literature, juvenile nonfiction, graphic novels, textbooks, and kits. Somewhat unusual for a curriculum materials center, the LRC also serves as a school library for the UW Lab School co-located in the Education Building. Lab School students in grades K-9 regularly visit the LRC for library and technology instruction, research, and media check out.

The 6,200 square feet LRC includes a large shelving footprint for the collection, computer lab with 24 seats, free-form presentation area with couch and LCD display, study tables, story area, meeting room, and three staff offices. All public areas can be reserved by the University and Lab School and are heavily used. Because the facility is used by various groups, all public areas are designed to be flexible and easily reconfigured. Furniture includes adjustable height computer tables, LCD displays, rolling tables, and lounge furniture with data and power support.

STEM MATERIAL PURCHASES

In 2011, the LRC began to offer weekly technology learning sessions for Elementary Lab School students. This instruction was aligned to standards for digital learning defined by the International Society for Technology in Education (ISTE, 2007).

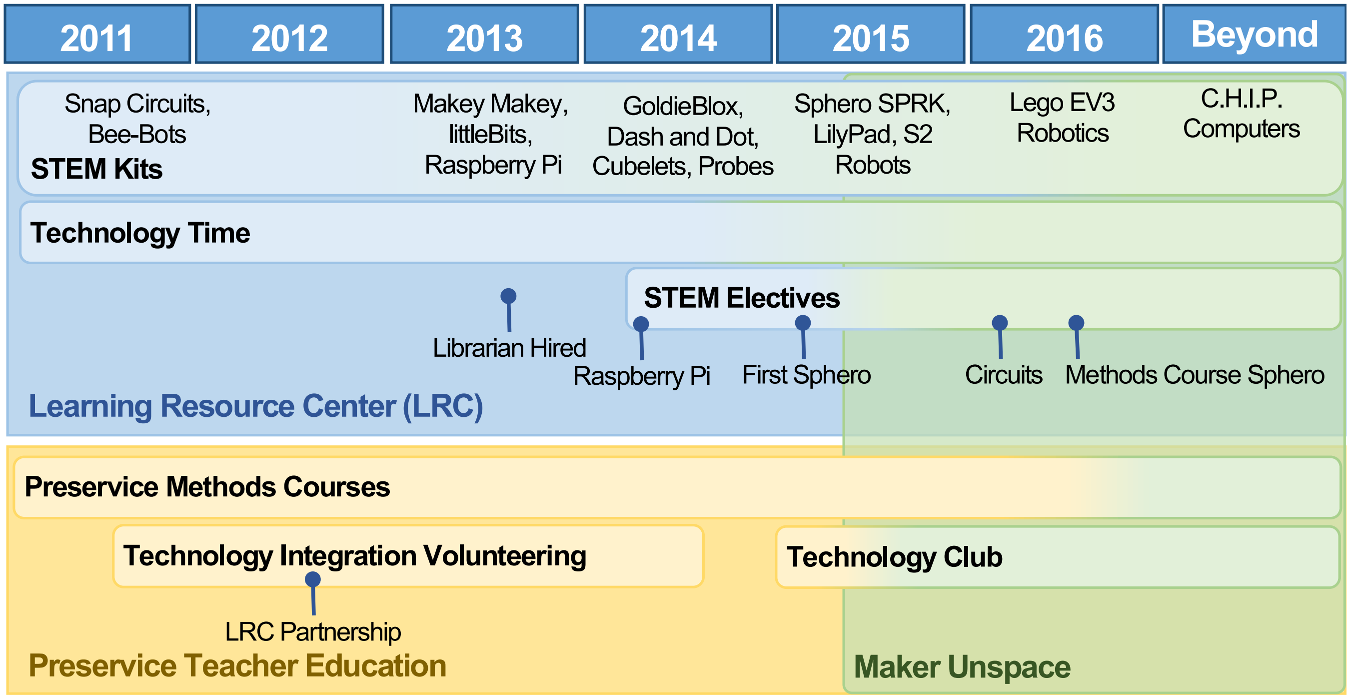

FIGURE 1. UnSpace Maker Movement Timeline.

In conjunction with this instructional focus, the head of the LRC began to purchase STEM-related items for the circulating collection (see Figure 1). Early purchases included Bee-Bot robots and Snap Circuits kits. Within a short time, the new collections were checked out regularly by education professors to demonstrate educational technology and math and science teaching concepts as well as by teachers at the Lab School.

In 2012, the head librarian at the LRC noted the popularity of the nascent STEM collection and began to actively grow STEM holdings. Due to space constraints and the purpose of the collection in supporting both off-site university teaching and learning as well as K-9 learning in the school, the head librarian decided to collect small, portable, circulating STEM materials rather than develop a devoted makerspace. This allowed the use of the LRC's relatively robust collection budget to purchase circulating materials instead of straining smaller supply or facilities budgets. The price point for many of these STEM materials was commensurate with the cost of academic library books ($40 - $200), which made loss or damage manageable under the existing library circulation policy, and allowed the library to acquire a wide variety of materials. However, specialized items such as circuit kits posed challenges for inventory control and circulation. Therefore, a new workflow was developed to accommodate the circulation of multi-part kits and games (Butler & Kvenild, 2014).

The second wave of purchases included littleBits, Raspberry Pi kits, Makey Makey kits, and computational board games. The collection continued to grow as library users requested additional STEM materials and robotics kits. The growth in the STEM collection also mirrored increased interest described in the literature about how access to STEM materials promotes a "maker mindset." For instance, the founder of MAKE Magazine, Dale Dougherty, recommended that educators, "identify, develop, and share a broad framework of projects and kits, based on a wide range of tools and materials, that connect to student's interest in and out of school." (Dougherty, 2013, p. 10). The LRC put this recommendation into practice, and in 2014-2015 purchased Sphero, S2, and Dash and Dot robots, GoldieBlox, Squish Circuits, Cubelets, wearable circuits, Arduino Inventor kits, breadboards, science probes, and related guidebooks.

LRC STEM CURRICULA

Elementary grade technology time sessions were popular among K-5 teachers and students but challenging to maintain for two librarians with occasional College of Education volunteers. In 2013, an additional librarian was hired to develop digital literacy curricula for elementary and middle grades and increase partnerships with educational stakeholders. Initially, she focused on curriculum alignment with classroom teachers during weekly technology times. Later, she diversified LRC "tech time" experiences to include circulation purchases.

During these experiences, young students worked with GoldieBlox to build logic skills, block coding was integrated

FIGURE 2. Elementary school students use GoldieBlox during TechTime.

FIGURE 3. Students practicing block coding in the e-classroom.

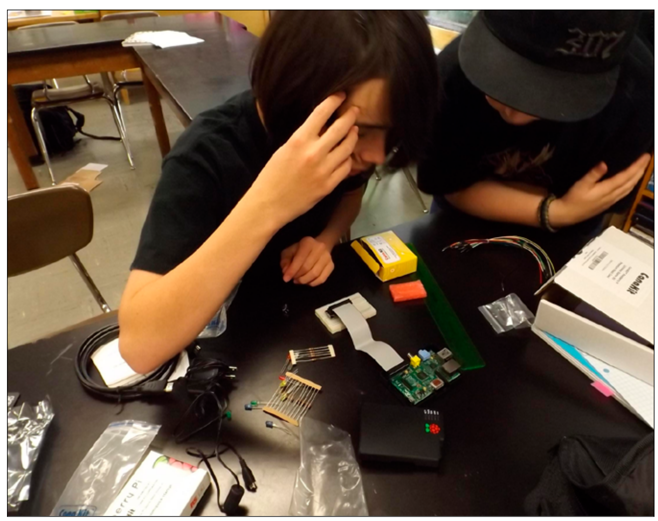

FIGURE 4. Middle school students assembling Raspberry Pi computers in the Science Lab.

across all grades, and students explored various robotics and circuits materials (see Figure 2). Additionally, the new librarian piloted weekly one-hour elective courses for middle grades. Teachers and librarians in the Lab School offered these nine-week elective courses using an ungraded, open, and exploratory approach—as required by the school. Friday electives increased contact hours with librarians and middle school students and were aligned with technology standards and growing STEM curriculum interests in the library collections.

Initial electives centered on the e-classroom in the LRC and explored online gaming/coding options (see Figure 3). After additional STEM purchases, a distinctive shift occurred. Work with technology moved from computer screens toward hands-on exposure that required full use of the LRC flexible space. During the first hands-on elective, students built five Raspberry Pi computers to enter circulation. Each computer needed assembly, cases, and operating systems. Organizers planned to use the LRC to support this elective. However, it became apparent that the space lacked necessary safety facilities. Some librarians also felt unsure of their technical expertise. A partnership was needed. This partnership was found with a female Lab School science teacher who shared her circuitry knowledge, soldering and safety supplies, and science lab. In this new location, organizers were able to complete tasks without compromising safety (see Figure 4). They accomplished goals without the need for additional equipment. Thus began the roots of a collaborative, flexible, and portable maker movement centered around LRC goals as opposed to physical spaces.

The elective revealed several lessons that guided future maker movement decisions. First, organizers learned that the best location for conducting activities could be anywhere, leading to the idea of an "unspace" makerspace. Library tables were not conducive for soldering, grounding, and other electronics activities. Being aware of locations surrounding the LRC--often within the same building--helped librarians select the best venue to accomplish outcomes. Second, they learned to step outside of their typical role as singular experts. They found that others nearby often were interested in similar projects and had skill sets and resources that when combined, resulted in successful experiences. When ideas were shared to the broader community, organizers obtained leads from patrons, parents, teachers, and university faculty regarding who would help them accomplish their goals. Additionally, partnering distributed workloads and allowed all parties to explore and learn together. Lastly, Raspberry Pi computers came without guidance or instructions, requiring librarians to spend considerable resources to determine how to assemble the computers for circulation. To minimize preparation time, librarians ensured that future purchases came with instructional materials.

PRESERVICE TEACHERS

While the LRC explored technology-rich electives, the College of Education required a technology integration course for all preservice teachers. Preservice teachers developed technology-rich lesson plans to meet specific curricular goals, considered distance education approaches, and fostered information literacy and lifelong learning (Ottenbreit-Leftwich, Glazewski, & Newby, 2010; Wepner, Bowes, & Serotkin, 2007). Yet, the course was offered as a prerequisite to those declaring an education major. This meant that preservice teachers lacked sufficient content and pedagogy skills to consider effective technology integration (Mishra & Koehler, 2006). Additionally, the course mixed all majors together—requiring instructors to focus on early childhood education while simultaneously covering approaches for high school courses. Given these constraints, instructors sought approaches to supplement coursework and provide authentic experiences for technology integration (Dawson & Dana, 2007; Meagher, Özgün-Koca, & Edwards, 2011).

In 2011, one male instructor added a field experience to the course where preservice teachers helped instructors at local schools implement technology-rich lessons. Prior to that time, preservice teachers often harbored dated or inaccurate views of technology integration that could not be clarified through traditional classroom experiences. By visiting local schools, preservice teachers observed and explored technology-rich lessons to reconsider prior beliefs (Brush et al., 2003; Dawson & Dana, 2007). Within a year, the experience was extended to all course sections. For three years, the course partnered with the LRC and other PK-12 venues to support technology times and after school clubs. Many venues used the circulating LRC STEM resources (Shepherd, Dousay, Kvenild, & Meredith, 2015).

Yet, challenges remained. Locating sufficient technology-savvy teachers within the rural community proved difficult. Preservice teacher involvement also varied (Brush et al., 2003). Some observed classrooms for six weeks while others co-planned and implemented lessons. Despite consistent, positive reviews from pre and inservice teachers, field experiences ended in 2014.

Instead, preservice teachers relied on content-specific pedagogy courses taken during their senior year for further technology integration experience. Some of these courses integrated technology as recommended by Meagher et al. (2011) and Ottenbreit-Leftwich et al. (2010). Emphasis was placed on meaningful uses of technology to enhance content learning, problem-solving, and computational thinking (Ashburn & Floden, 2006; Barr, Harrison & Conery, 2011; Mishra & Koehler, 2006; Papert, 1980). However, preservice teachers often wondered why they could not obtain more technology exposure prior to field experiences and student teaching. Additionally, the instructional technology program lacked funding, storage space, resources, and time to amass, distribute, track, and help preservice teachers inquire into current practices. With so many resources available commercially, preservice teachers lacked avenues to maintain awareness and familiarity. A partnership and additional materials were needed.

TECHNOLOGY CLUB

In March 2015, a male methods course instructor, male and female technology integration instructors, and female LRC librarian met to discuss how the Unspace maker design could aid in the formation of a weekly technology club to address the need for additional preservice teacher experiences. Through conversation, they decided to focus the club on technology "awareness and perceptions of use," "gains in competency," and the development and amalgamation of tutorials and curricular resources for STEM materials (Shepherd, 2015a). Wanting to differentiate the club from formal instruction and lacking personal exposure to some circulating STEM materials, the organizers decided to structure the club around LRC STEM resources and to plan session locations based on the materials being used. They also wanted to promote an environment of joint exploration as tools and approaches were considered for curriculum development. However, organizers knew that university students often lacked time for additional extra-curricular activities (Nathan, 2005). Thus, they wanted to create an atmosphere where participants could enter or exit the Unspace at any point without feeling guilty that they were falling behind (Oldenburg, 1989). This required an open, participant-centered curriculum.

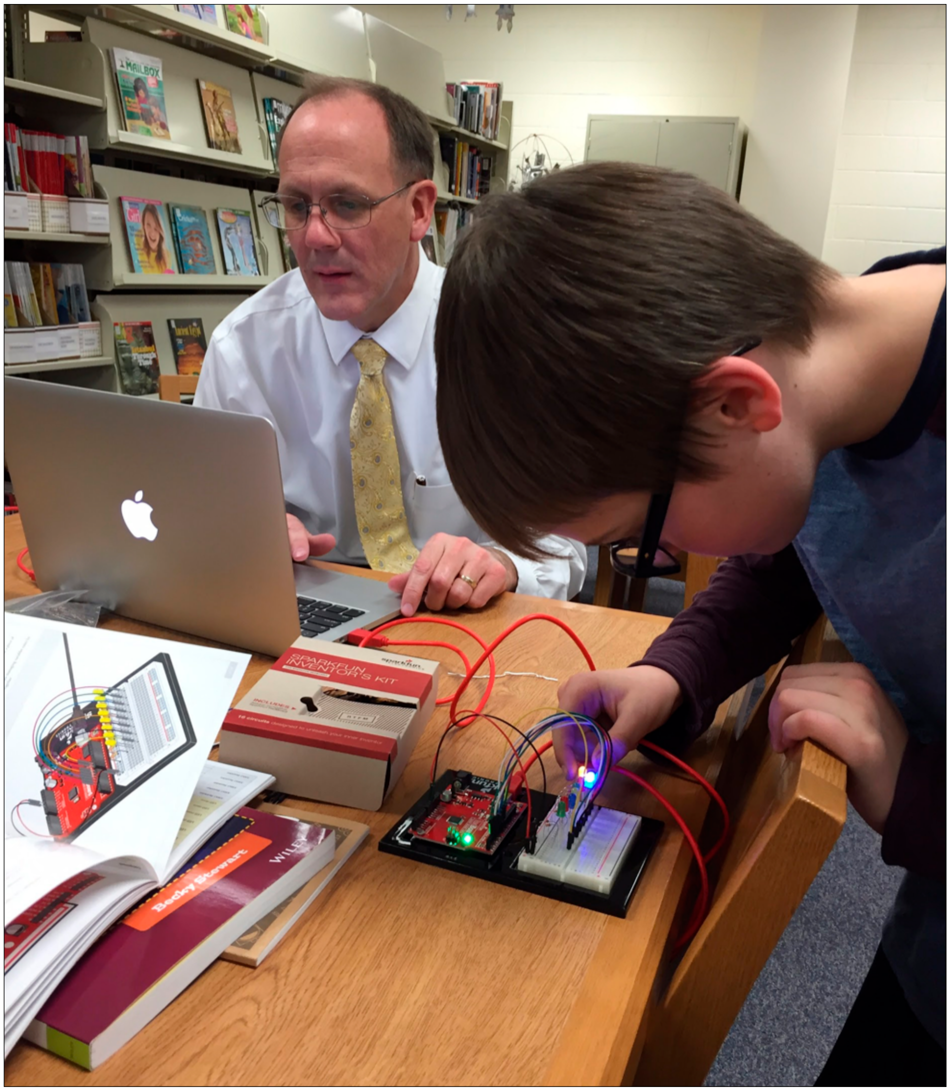

FIGURE 5. Unspace club members working through STEM guidebooks.

After a few meetings, organizers decided to loosely structure the Unspace club around topical areas (e.g., basic circuits, robotics, Hour of Code) so preservice teachers would know what to expect upon arrival. Topics rotated on a monthly basis, and each lasted three weeks--allowing a flexible week for further exploration, guest speakers, or field trips. Aligned with the participant-centered curriculum, organizers developed loose goals for exploration and proposed them for ratification, modification, or abandonment. Individuals who attended during later weeks could either begin at week one (using resources housed in an open learning management system), join an existing exploration, or pursue their own goals. As per the Unspace design, multi-purpose spaces in the LRC were initially used to support the club. Organizers hoped the club would allow preservice teachers and faculty to explore and learn together without fear of ignorance or failure (Oldenburg, 1989). In this sense, preservice teachers would learn how professional learning communities work in teaching settings.

UNSPACE DESIGN REFINEMENT

Organizing faculty members within the College of Education promoted the Unspace club, yet few preservice teachers attended. Eventually, technology integration instructors awarded three points of extra credit for each session attended. In a course with over 350 total points, instructors rationalized that an extra hour of technology exploration each week was worth three points of potential credit. As expected, attendance increased. Preservice teachers often stayed longer than the scheduled hour.

The Unspace club members initially decided to explore electronics kits because they included manuals with various

FIGURE 6. University professors, librarians, preservice teachers and students paint with Sphero robots outdoors.

activities (see Figure 5). However, following two weeks of free exploration, it became apparent that additional structure was needed to maintain interest. Free play, while initially inviting, provided minimal attachment. Preservice teachers did not invest anything in the experience, nor were they given ownership of their creations. While activities allowed them to spin motors and light LED bulbs, "the whole concept of circuits through these kits seemed like a black box that couldn't be deciphered without additional instruction" (Shepherd, 2015b). Students enjoyed the projects but did not understand how they worked. Technology awareness was insufficient to spark imagination and foster sustained inquiry.

Ironically, while initial Unspace clubs struggled, several K-9 teachers, students, and librarians observed the activities in passing and wanted to join. Not wanting to offend and recognizing the club had ample equipment, newcomers were welcomed. Introducing these groups instantly improved the experience. Preservice teachers were awed by the abilities of elementary and middle school students. They also enjoyed discussing integration ideas and techniques with practicing teachers and librarians. Soon, all LRC librarians along with Lab School teachers and a handful of Lab School students were invited to attend (Shepherd, 2015c).

While a playful atmosphere was desired, Unspace club organizers realized that members needed additional support to establish a knowledge foundation that sparked personal exploration, inquiry, and inventiveness. During the third club meeting, organizers took a new approach where participants were asked to complete a simple circuit and explain the underlying science (Shepherd, 2015b). As challenges arose (e.g., misunderstandings, open circuits, shorts) members searched YouTube, online documentation, and other resources to explain concepts. Effective resources were stored in an open-source learning management system. Eventually, all members could differentiate between series and parallel circuits and identify shorted circuits. More importantly, members seemed interested in science concepts and eager to move beyond manuals and experiment with their own ideas and constructions.

Providing overview instruction to stimulate investigation became routine practice. So, too, did invitations to teachers, university faculty, preservice teachers, students, and librarians. Program organizers planned initial activities to anticipate questions and provide guidance. In subsequent sessions, organizer roles diminished as members explored together, listened to guest speakers, conducted field trips, and discussed implementation and integration techniques in K-12 classrooms.

Because LRC STEM kits were small and portable, club organizers determined the best locations to leverage resources. For example, using robots to paint made more sense on public sidewalks or along hallways within close proximity to sinks than within the carpeted library space (see Figure 6). Selecting varied locations increased access to LRC resources, highlighted their flexibility and ease of transport, and made the club more visible to newcomers—further expanding the design of the Unspace.

Organizers often met and discussed potential locations to convene the main Unspace club sessions outside the LRC due to low visibility and space constraints. They considered common areas near preservice teacher classrooms to increase club exposure, gymnasiums for increased room, science labs for plug outlets, sinks, and safety equipment, and established maker spaces on the university campus for access to additional resources and support. Each location met needs of particular goals and activities but fell short on others. Club meetings began in the LRC for consistency and marketing purposes but relocated as needed. Activities and the nature of the STEM materials drove space requirements.

CONVERGENCE

For about six months, the technology club and LRC electives remained separate. Overlapping and diverse teams of university faculty members, librarians, and K-9 teachers devoted time and resources to each group but discussed them as separate entities. During early Fall, 2015, club participants explored uses of Sphero robotics for painting and programming (Shepherd, 2015c). Based on the success of these sessions, a librarian, university faculty member, and Lab School science teacher decided to offer a Sphero robotics elective running from the end of October 2015 through mid-January, 2016. Students in 7-9 grade were invited to participate and 15 males enrolled. Meanwhile, the technology club switched topics to Internet-based programming.

While the course ran smoothly, instructors noticed several challenges. Although instructors had experience working with robotics (e.g., Lego robotics, Dash and Dot), they introduced the curriculum with little Sphero robotics experience. This required them to devote considerable time familiarizing themselves with device-specific concepts. Lack of experience resulted in lessons that only minimally focused on student interests and expertise. Students were presented with programming concepts and given challenges to solve, but provided little input into course directions or techniques (see Figure 7). Additionally, no females enrolled in the elective, though several showed interest in these technologies on other occasions. This gendered response prompted organizers to consider how the space was promoted and used.

The gender makeup of students in the elective did not mirror that of the organizers. The university professor was male, but the science teacher and librarian were female. Additionally, organizers realized that they were not the gatekeepers of the course. Students were given lists of available electives and ranked their preferences, but decisions were made by school officials who took student preference and seniority (grade level) into account. Students who selected the technology elective as their first choice are largely male. However, female students also indicated interest (though more likely as their second choice).

Following the Sphero robotics elective, organizers met several times to consider next steps. They decided to rerun the elective but allow only females to join. This allowed female students to investigate their interests in STEM programming. Organizers also wanted to restructure the course and include more student-centered goals. Because the technology club had not started that semester, organizers decided to use the after-school group for additional planning and hands-on exploration. These sessions allowed members to more deeply explore robotics, attempt new programs and commands, and experiment while brainstorming curricular ideas. More time was devoted to curricular planning during existing time commitments.

One of the key tenets of the Unspace design is that STEM resources are in library circulation and can be checked out by students for further exploration. Thus, elective students

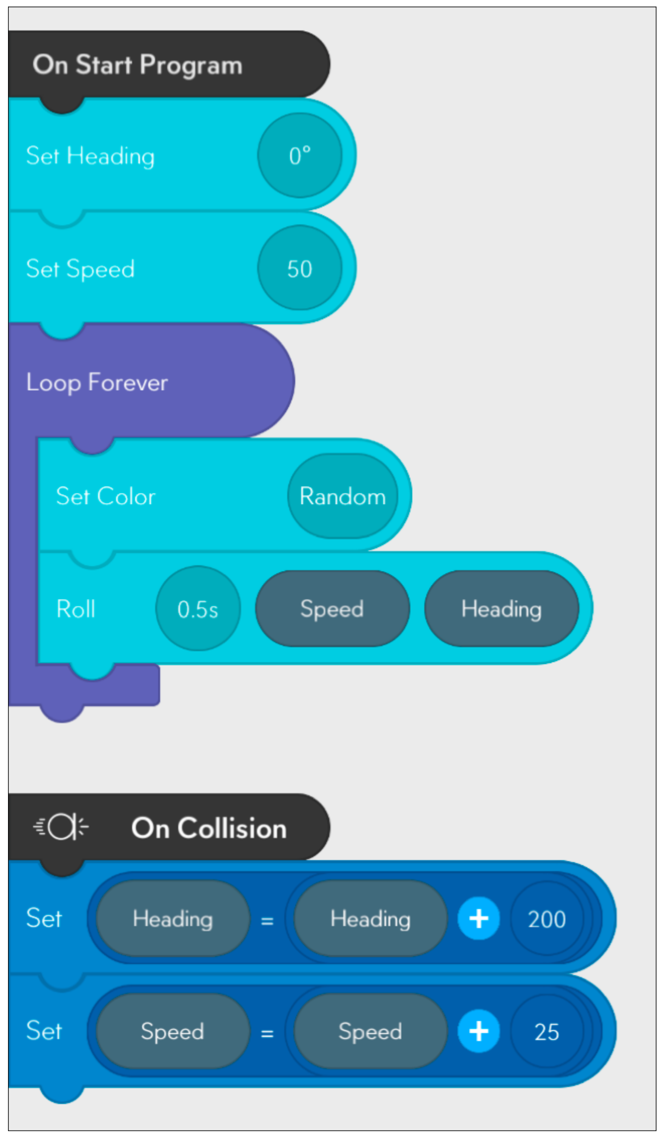

FIGURE 7. Sample Sphero robotics program using the Sphero Edu app.

were encouraged to take robots home over the weekend, try new programs and commands, return them midweek (to ensure they were charged for the Friday elective), and share their learning at the beginning of each class. This design decision significantly increased student exposure to LRC materials and simultaneously enhanced caregiver awareness. However, organizers learned that the home environment was utilized best when specific challenges were introduced. Challenges provided an impetus for further exploration, established a common purpose, and encouraged student communication and competition.

Extending elective locations to home settings and inviting students to assume co-teaching roles based on their discoveries surprised students. When asked about explored techniques, they thought instructors were feigning ignorance to begin a conversation. Only when students realized the instructors were learning too and valued student comments, did they assume teaching roles and explain their discoveries fully. These moments personalized the course, established greater commitment among all participants, and resulted in deeper learning. They also expanded the maker movement to home-based locations.

Although LRC space and elective course time facilitated programming lessons, they were once again insufficient to meet learning needs.

Organizers needed additional time to explore (obtained through the alignment of technology club activities). Students also needed more time to interact with STEM resources, but their schedules did not allow for repurposed activities. Leveraging additional time and space at home (afforded through the Unspace design principles) met their needs. Organizers also used science labs (with tile floors, sinks, and paper towels) to conduct painting activities and facilitate cleanup. Shared goals blurred the lines of the space and partnerships furthered the movement.

Organizers believed the female-only course was more successful than the previous offering. They also learned that while curriculum provided structure to STEM activities, students needed playtime to freely explore resources. Too much playtime diluted learning activities and too much structure stifled creativity and personal exploration. Allowing students to bring the space home, show-off skills to parents and siblings, and experiment together enlivened the experience. Home play, coupled with instructor play (afforded through technology club times and circulating equipment), enlivened the curriculum. Access to science labs and other venues facilitated it. These realizations prompted organizers to wonder if Unspace club and elective settings could co-exist and serve converging purposes. Implementing curricular resources in the technology club might provide the foundation needed to spark further investigation among members while simultaneously improving elective course offerings. Ideas generated by the club also found a venue for authentic K-9 implementation and evaluation--potentially making experiences more meaningful for pre and inservice teachers, university faculty, and librarians.

CURRENT PRACTICE

Based on these ideas, another elective course was scheduled in late Spring 2016 for 5th-9th-grade students involving basic circuits. Students began using Snap Circuits and littleBits to explore the differences and similarities of loads arranged in series and parallel. Once basic circuit terminology and ideas were defined and explored, students developed electronic collages and circuit origami using paper, aluminum foil, transparent tape, batteries, and LED lights. Afterwards, they transitioned to fabric-based circuits with LilyPad kits. As these activities occurred over the nine-week curriculum, the technology club explored the same concepts--trying to stay a few weeks ahead of the course but leveraging open-ended exploration. Club exploration resulted in curriculum modifications. More time was provided for circuit construction when working with layers of paper and fabric because origami folds might short unprotected circuits that functioned in two dimensions and fabric layers could get in the way of desired connections.

During this time, additional partners were identified and asked to participate, including a middle-aged, Lab School paraprofessional who was an excellent seamstress and a patient teacher. The College of Education provided LilyPad circuits, batteries, and conductive thread. Lab School teachers provided needles, thimbles, and basic sewing skills. Because students constructed fabric-based circuits over several weeks, organizers reserved an LRC meeting room as the design space. To avoid waste, students developed paper-based protocols prior to receiving materials.

Organizers and students enjoyed this elective for several reasons. Students retained many of the projects they completed: Finished circuit collages, origami, and sewing projects became student property (see Figure 8). The prospect of keeping completed projects increased student engagement. Several volunteered lunch hours to work on their projects, troubleshoot problems, and support others. Additionally, circuit collages and origami projects used common classroom items and inexpensive electronic components (e.g., batteries and LED lights).

However, this circuit course introduced a new challenge: how to secure and resupply consumables. The library collections budget could account for lost or damaged items but had little precedent for items intended to be consumed. Prior to this elective, LRC STEM kits were purchased for circulation. They were meant to be reused several times in multiple locations. Student products were captured through displayed items (later disassembled), photographs,

FIGURE 8. Students worked on individual sewing projects and kept the circuits they made.

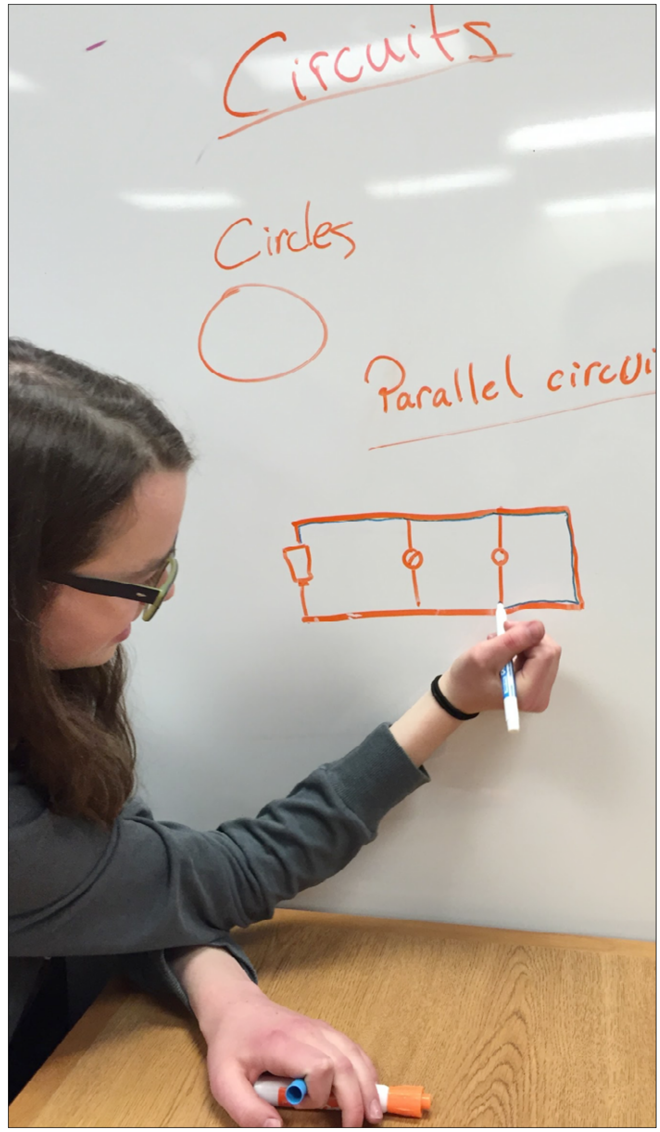

FIGURE 9. A student diagrams a parallel circuit to others.

art projects, and electronic documents (e.g., design plans, coding programs). Conductive thread, sewable LED lights, and battery packs lacked reusability. Fortunately, partners supported the endeavor. The LRC provided space, Snap Circuits, littleBits, scissors, tape, and paper (see Figure 9). The College of Education provided circuit components, and a diverse team provided training. Costs, time, and activities were distributed among various partners.

Another ongoing challenge stemmed from balancing general circulation with curricular needs. Because electives lasted a minimum of nine weeks, classroom sets of circulation materials were needed for extended periods of time. This prevented others from using these materials. Finding the proper balance between curricular use and circulation is an ongoing point of discussion within the maker movement.

This discussion is compounded by the number of parts associated with STEM kits. Although most materials are purchased because they contain minimal parts (or include large, child-friendly parts), there are exceptions. Arduino Inventor kits and Lego Robotics, for example, contain a number of small components, wires, and resistors that can be misplaced easily. Who is responsible when components are misplaced or broken in an environment that encourages exploration and seeks to minimize fear of failure or lack of knowledge?

Additionally, organizers discussed how they could increase interest beyond established regulars, particularly among female students, local university professors, pre and inservice teachers, and eventually teachers and librarians throughout the state via an interlibrary loan, shared curriculum, field experiences, and other options.

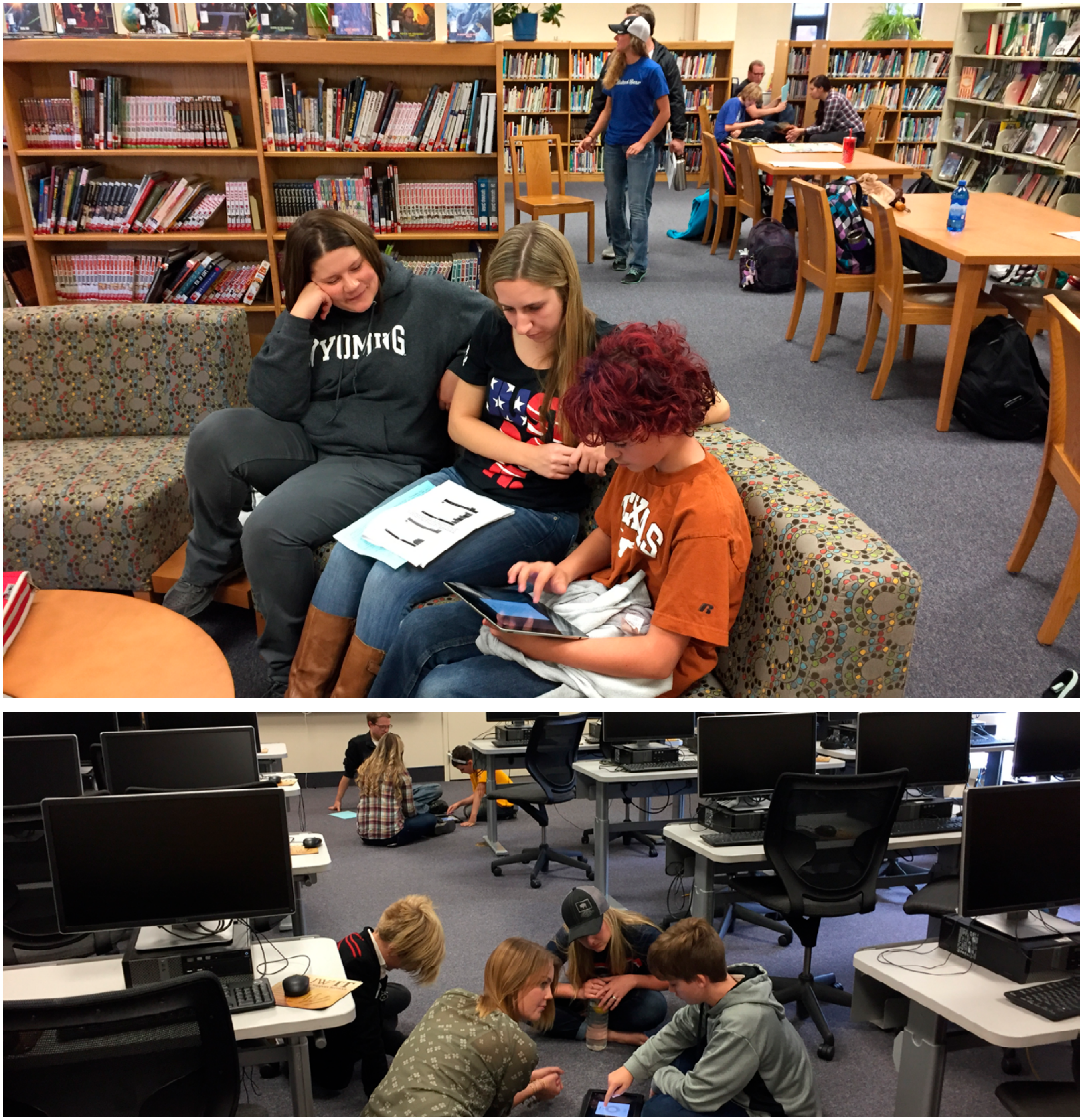

FIGURE 10. Preservice teachers work with middle school student in LRC gathering space on programming.

MOVING FORWARD

Partnership Expansion

Although several, diverse partners currently participate in the LRC Unspace maker movement, additional members (e.g., faculty, graduate and undergraduate students from multiple colleges, parents, community partners) are being recruited. Electives are available to all students in grades 5-9, but some students have previously committed to theater and music which meet during the same time. One particular interest is to foster female students' interests in STEM disciplines, and ensure that they feel welcomed and supported in the maker movement. Fortunately, several organizers serve as role models for women in STEM fields, but additional efforts are needed. While the movement strives to provide an atmosphere of playful exploration and productive struggle in a relaxed, supportive environment, more attention is needed to improve female perceptions of the movement and how it

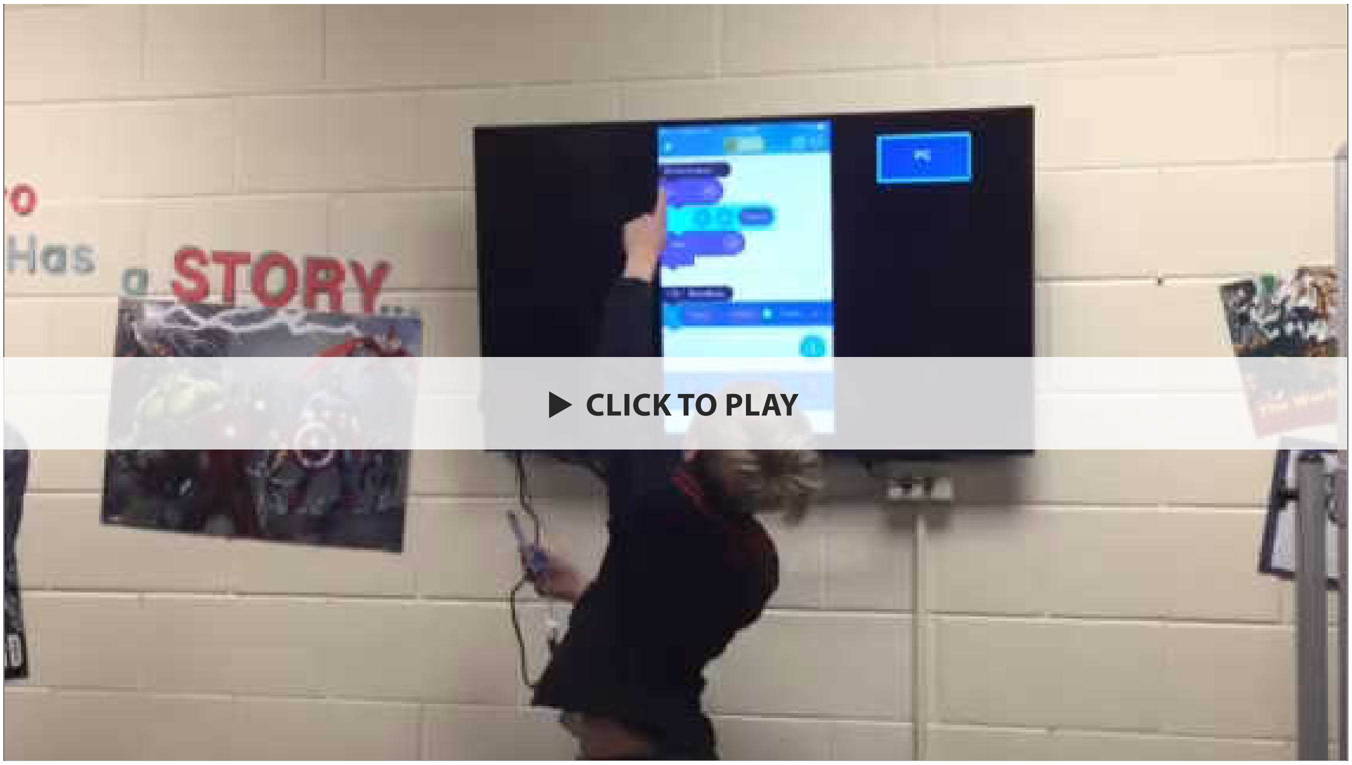

FIGURE 11. Video of student demonstrating use of variables and random commands to alter robot motion.

aligns with social image, personal identity, and expectations (Newcombe et al., 2009).

Additionally, organizers would like to increase participation among inservice teachers and K-12 students within the Lab School and across the district. Current meetings are limited to elective courses and one weekly, after school meeting. To increase access and grow membership, additional accommodations are needed. These could be distributed across the various spaces and stakeholders that comprise the maker movement--spreading increased workloads across a larger group. Organizers leveraged past participant email lists, course announcements, and personal invitations to remind university faculty, school librarians, pre and inservice teachers, and students about maker events. This has increased the movement footprint within the local community and expanded it beyond the physical space of the LRC.

For example, at the beginning of the Fall 2016 semester, 25 students in the Elementary Mathematics and Science methods course decided to collaborate with the maker movement to deliver a course on robotics. To give preservice teachers time to become familiar with the robots and programming environment, including troubleshooting strategies, organizers focused on Sphero robots (where initial lesson plans were already developed and could be modified and expanded by preservice teachers). The methods course was slightly altered to focus on how mathematics could be learned using robotics and programming--expanding the maker movement into the college classroom. Furthermore, preservice teachers developed challenge activities based on Common Core State Standards for Mathematics and performance-based assessment rubrics. In groups of two or three, preservice teachers mentored 15 middle school students at the end of September 2016-- scattered throughout the LRC to make the best use of available space (see Figure 10). During that time, students also shared their discoveries as they interacted with robots throughout the course and at home (see Figure 11).

DISSEMINATING IDEAS

Organizers have a desire to expand statewide outreach and increase partnerships among community colleges, neighboring districts, and public libraries through curriculum sharing and professional development. When the technology club was initiated, all resources were posted on an open access learning management system for dissemination purposes. Additionally, lesson plans for elective courses and various pictures of completed activities are housed on an LRC blog (see http://uwlibblogs.uwyo.edu/learning/) and library guides (see http://libguides.uwyo.edu/lrcstem). These provide some dissemination options for this maker movement. Information is also disseminated through regional and national conferences.

Consumables

As the use of circulating STEM kits continues to increase, questions arise about how to manage the collection for the future. Participants in maker activities express interest in keeping items to take home, such as origami circuits and conductive sewing projects. Other kits have small parts that wear out or go missing regularly. After making the choice to create a circulating collection, the LRC staff must now decide how to approach consumable parts. A 2016 survey of five public libraries in Illinois that circulate STEM kits revealed a mixed approach to consumable parts, with policies ranging from charging library patrons for replacements, circulating kits without the missing parts, and replacing parts from the library budget (Fisher, Sedik, & Zhao, 2016). The Claremont Colleges Library circulates STEM materials with clear instructions on what parts must be returned with the kit and what parts can be missing and replaced by the library at no cost (Cook, 2015). In 2016, small amounts of funding were secured from the College of Education, the Lab School parent group, and the University of Wyoming Libraries to purchase consumables for non-circulating STEM projects. Whether that pool of funding will be available in the future is unknown.

In addition to funds for consumable parts, the maker movement at the LRC actively seeks to diversify funding for all materials. The cost to purchase classroom sets of some STEM items (e.g., most robotics) exceeds the annual collection budget of the LRC. In 2016, a university professor secured fellowship funding to purchase additional Sphero robots and LilyPad kits, C.H.I.P computers, multimeters, and other circuitry components for the LRC. Next steps include pursuing grant funds and private donors to continue to grow STEM offerings for the maker movement. This funding would improve one-to-one equipment use and allow the LRC to circulate more STEM materials to individuals while maintaining enough items for curricular programming.

CONCLUSION

Through converging events that spanned several years, university faculty, LRC librarians, Lab School teachers, and K-9 students leveraged vibrant and varied spaces to support an Unspace maker movement. Organizers learned that partnerships are essential and relatively easy to identify. Community members share STEM interests and want to get involved. They bring knowledge, resources, and original ideas to the movement, are often willing to share their spaces, and mutually benefit from the experience. These collaborations allow members of the maker movement to accomplish tasks that would otherwise not be possible in the minimal space provided at the LRC. Leveraging varied spaces and circulating materials also makes the movement more visible, increases membership, and encourages exploration.

Additionally, providing resources encourages creativity and exploration but is insufficient to sustain the movement. True exploration requires users to move beyond awareness, struggle with relevant concepts, and persevere until desired outcomes are reached. Exploration and creation require users to gain a knowledge baseline that they can use to make conjectures, test ideas, and refine procedures. This requires a safe space for individuals of all ages to meet, wherever that might be.

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