The Maker Movement and Learning in School Libraries

Kimberly Hirsh

University of North Carolina at Chapel Hill

Introduction

Makerspaces and making activities are proliferating in school libraries. The practitioner literature is replete with books (Preddy, 2013b), blog posts (Hamilton, 2012a, 2012b), conference papers (Houston, 2013), and articles (Buerkett, 2014; Canino-Fluit, 2014; Craddock, 2015; Daley & Child, 2015; Graves, 2014; Houston, 2013; Kurti, Kurti, & Fleming, 2014a, 2014b; Loertscher, 2012, 2014, 2015, 2015; Moorefield-Lang, 2015a, 2015b; Preddy, 2013a; Range & Schmidt, 2014; Thompson, 2014) describing how school librarians can leverage the “Maker Movement” to increase engagement, enhance inquiry-driven learning, and build community in their school libraries. While this abundance of practitioner literature indicates that there is a bottom-up demand for information about how to make the most of school library makerspaces, there is also a top-down push for creating these spaces for learning. This emphasis is evident in President Obama’s Educate to Innovate program (“Educate to Innovate,” n.d.) and its collaboration with the Maker Education Initiative, the Institute of Museum and Library Services Learning Labs in Libraries and Museums program (Association of Science-Technology Centers & Urban Libraries Council, 2014), and the Young Adult Library Services Association’s creation of a *Making in the Library Toolkit* (Young Adult Library Services Association, 2014). In one survey of youth-oriented makerspaces, 39% of respondents indicated that their makerspaces were located in schools (Peppler, Maltese, Keune, Chang, & Regalla, 2015a). Litts (2015) points out that, while there is both popular demand and institutional support for makerspaces, “Researchers and practitioners are co-opting making as a learning activity without fully understanding the communities and cultures in which [it is] practiced” (p. 54). An emerging body of empirical literature has begun to address this disconnect; this literature review and the proposed study contribute to this body of literature by investigating whether school library makerspaces are rooted in the community and culture of the larger Maker Movement.

Defining the Maker Movement: Making, Makers, and Makerspaces

“The *maker movement* refers broadly to the growing number of people who are engaged in the creative production of artifacts in their daily lives and who find physical and digital forums to share their processes and products with others” (Halverson & Sheridan, 2014, p. 496). While the origins of the Maker Movement extend back to traditional handcrafts and the dawn of the digital age, the term “Maker Movement” and the movement as currently conceived were first popularized by the magazine *Make*: in 2005 and the associated Maker Faire in 2006. *Make*: is a magazine that focuses primarily on step-by-step explication of Do-It-Yourself (DIY) projects featuring both digital methods, such as computing, and traditional methods, such as woodworking. A Maker Faire is “an all-ages gathering of tech enthusiasts, crafters, educators, tinkerers, hobbyists, engineers, science clubs, authors, artists, students, and commercial exhibitors” (“About Maker Faire,” n.d.) featuring demonstrations and hands-on activities. While the movement was not explicitly conceived as an educational movement, educators quickly saw its potential for transforming student learning. The Maker Education Initiative was founded in 2012 with the mission of creating “more opportunities for all young people to develop confidence, creativity, and interest in science, technology, engineering, math, art, and learning as a whole through making” (Maker Education Initiative, 2015).

In their overview of the Maker Movement and its potential for transforming education, Halverson and Sheridan (2014) identify three pillars of the movement that can serve as a

framework for empirical analysis: making, makers, and makerspaces. Making refers to the set of activities involved in the movement. Makers refers to identities of participation in the movement. Makerspaces refers to communities of practice in which makers undertake making activities. This is a valuable framework for research on the Maker Movement as a whole. Because this literature review and prospectus focus on the school library setting in particular, and the school library practitioner literature thus far has focused more on creating makerspaces than on making activities or the construction of the maker identity, this literature review will focus primarily on makerspaces. Discussion of making activities and maker identities will be woven throughout the discussion of makerspace communities.

While there is no universally accepted definition of a makerspace and each makerspace will look different depending on the needs of the community it serves, many researchers have put forth definitions for use in their own work. Abbas and Koh (2015) describe both learning labs, which are devoted to media production, and makerspaces, which focus more on the production of physical artifacts, as “transformative library places... informal learning spaces where young people explore both traditional and digital media, interact with mentors and peers, and engage in expressive and creative projects” (p. 2). They emphasize that a makerspace is a dedicated physical space and that the activities that take place within that space are student-centered and project-based; they also specifically mention that this activity grows out of the traditional apprenticeship model of learning in which experts teach novices through hands-on experience.

Bowler (2014) defines a makerspace as “a physical place in the library where informal, collaborative learning can happen through hands-on creation, using any combination of technology, industrial arts, and fine arts that is not readily available for home use” (p. 59), describing the learning that takes place in such a space as “hands-on, iterative, and experimental” (p. 59). According to Brahms (2014), makerspaces are “places where people blend digital and physical technologies to explore ideas, learn technical skills, and create new products” (p. 2). Drawing on the work of Britton (2012) and Preddy (2013b), Moorefield-Lang (2014) asserts that a makerspace is a “is a location where students and patrons can create, craft, solve problems, and develop new skills...learn through experimentation and play... [and] come together to share, collaborate, and explore” (p. 584). The Institute of Museum and Library Services (2012) answers the question “What are makerspaces?” by saying, “Makerspaces are part of a growing movement of hands-on, mentor-led learning environments to make and remake the physical and digital worlds. They foster experimentation, invention, creation, exploration, and STEM learning” (p. 1).

Martin (2015) defines makerspaces by defining making: makerspaces are places where makers engage in making, “a class of activities focused on designing, building, modifying, and/or repurposing material objects, for playful or useful ends, oriented toward making a ‘product’ of some sort that can be used, interacted with, or demonstrated” (p. 31). According to Martin, three critical aspects of the Maker Movement are digital tools, community infrastructure, and the Maker Mindset. A makerspace might provide digital physical tools, such as 3D printers and laser cutters, or digital logic tools, such as microcontrollers. The Maker Movement supports community infrastructure face-to-face in makerspaces and at events such as Maker Faires and online through forums, videos, and tutorial websites. Martin identifies four elements that make up the Maker Mindset: it is playful, asset- and growth-oriented, failure-positive, and collaborative.

Focusing on makerspaces as learning environments, Litts (2015) defines them as “places where *making* happens in *community*” (p. 1) and identifies the three key features of a makerspace

as community, space, and tools. According to Norris (2014), makerspaces are “locales where individuals conceptualize and build designs” (p. 63). Describing school library makerspaces in particular, Koh (2015) states, “A Makerspace is a place for students to explore low and high technologies, interact with mentors and peers, and engage in creative projects” (p. 1).

While none of these definitions are widely accepted, they do have several features in common. Incorporating these common features and focusing on the school library environment, this literature review and the proposed study use the following definition: A school library makerspace is a dedicated space, either stationary or mobile, provided as part of a school library program in a K-12 formal education environment, for the purpose of students engaging in hands-on inquiry-driven learning through making activities, collaboratively or in community with both peers and adult mentors.

The Makerspace Landscape

While the body of practitioner literature regarding school library makerspaces is rich, empirical studies have thus far primarily focused on makerspaces in other settings including museums, public libraries, and community centers, as well as freestanding makerspaces. Since 2013, the research literature on this subject has expanded greatly.

Describing Makerspaces Broadly

Two surveys have addressed makerspaces very broadly. Burke (2013) conducted a survey of makerspaces in libraries, soliciting participation from members of library email discussion lists, Twitter, and Facebook. Of the 143 librarians surveyed, 109 (77%) indicated that they either currently had a makerspace in their library or planned to implement one in the future. Of these librarians, 51% worked in public libraries, 36% in academic libraries, and only 9% in school libraries. Most makerspaces had been established in the previous two years. They were funded from a variety of sources, including library budgets, grants, and donations. Many makerspaces intended to charge for supplies or equipment use. The most popular tools offered in the makerspaces were either digital or supplies for arts and crafts. Workshops in the library makerspaces were most frequently taught by library staff or volunteers.

Peppler, Maltese, Keune, Chang, and Regalla (2015a, 2015b, 2015c) undertook a survey of youth-focused makerspaces. Of the 51 respondents, 39% were located in schools; 2% were in homeschools, 6% in charter schools, 16% in independent schools, and 16% in public schools. As in Burke’s survey (2013), they indicated that digital tools and arts and crafts supplies were the most-used tools in their spaces. An important component of programming in these spaces was the opportunity for young makers to share the results of their work; they did this both privately and publicly, both on-site and at events outside the makerspace such as Maker Faires.

Making Makerspaces Work

The surveys described above provide a broad overview of the makerspace landscape, but two studies examine closely what is happening in specific makerspaces. Abbas and Koh (2015) interviewed professionals working in museum and public library learning labs and makerspaces using a structured interview framework of questions that asked about challenges, achievements, evaluation, and goals. This framework is also useful for exploring the results of Slatter and Howard’s study (2013) of the “issues and challenges of creating makerspaces within Australian

public libraries” (p. 275). Like Abbas and Koh, they performed qualitative interviews with professionals working in makerspaces.

Challenges. The first challenge Abbas and Koh (2015) identified as a theme across their interviews was personnel. The professionals interviewed found it difficult to identify personnel who had technical skills to work with the tools in the makerspace, an understanding of how to facilitate others’ learning, and the ability to work with teenagers, who were the primary audience of the spaces included in the study. They expressed a need for personnel to simultaneously be familiar with youth culture and be able to maintain an air of professionalism while working in the space. Potential personnel might have one or two of these qualities, but it was rare to find all of them in one individual.

Funding was a challenge for the makerspaces in both studies (Abbas & Koh, 2015; Slatter & Howard, 2013). Regardless of the amount of funding available, the digital tools necessary to ensure that makerspaces are cutting edge are expensive; makerspace professionals had to take great care to ensure they were careful stewards of allotted funds, making the most of the money available. Many spaces were initially funded by grants, but these were not sustaining. After the end of the original grant term, makerspace professionals had to seek funding from other sources or make a case to administrators for in-house continued funding of the makerspace. If they sought funding from new grants, the new grants might have goals attached that did not match their original goals for the makerspace, requiring them to shift directions every time they partnered with a new funder.

Related to difficulties with funding, professionals identified “mission creep” as a potential risk for makerspaces (Abbas & Koh, 2015). With the vagaries of funding, makerspaces might have to regularly alter their mission. On the other end of the spectrum, makerspace professionals noted that selecting a focus for their makerspace in the first place presented a challenge; because of the array of tools and techniques available for use in makerspaces, it could be difficult to identify a particular focus for the space. Professionals recommended selecting one focus when establishing the space, and expanding over time. For example, one makerspace might focus on digital fabrication using 3D printing, another might focus on e-textiles, while still another might focus on low-tech tools such as Legos.

Makerspaces located in public libraries and museums often face perceptions that they are faddish or not spaces where rigorous learning takes place (Abbas & Koh, 2015). Professionals working in these spaces felt that the best way to alter this perception was to advocate for the makerspace to be incorporated into the culture of the larger organization, rather than being seen as separate from its mission. Participants in Slatter and Howard’s study (2013) also faced difficulties with perceptions of their makerspaces. In the case of the Australian public libraries, it was the novelty of the makerspace as a concept that presented a problem. Library staff or administration might be reluctant to make the radical changes necessary in the library to support a makerspace, not understanding the value of providing such a program.

In Australian public libraries, concerns arose over the ownership of collaboratively-created projects and liability for both intellectual property and safety issues (Slatter & Howard, 2013). Because of how new the technology used in makerspaces is, Australian law does not address questions such as whether a library would be responsible if a patron used their makerspace to fabricate a weapon, or the specifics of how digital fabrication might facilitate copyright infringement.

Makerspace professionals had difficulty ensuring their space was accessible to patrons (Abbas & Koh, 2015). Limited personnel availability might limit hours; makerspaces might be

located somewhere that was difficult for patrons to reach. Teen patrons in particular might not have transportation to get themselves to the space and might rely on limited public transportation.

Achievements. Makerspace professionals noted that teens and other patrons were engaging with their institutions more fully after the establishment of the makerspace (Abbas & Koh, 2015; Slatter & Howard, 2013). They developed maker identities and, over time, took ownership of the space. While it was difficult to find personnel who had all the qualities necessary to work in makerspaces, makerspace professionals found that their role gave them the opportunity to and, in fact, required them to be lifelong learners, pursuing their own growth through networking and independent research. The new technologies available in the makerspaces also provided new opportunities for patrons to interact with technology to which they might not otherwise have access (Slatter & Howard, 2013). Although they identified perceptions of makerspaces as faddish and separate from the organization's main mission (Abbas & Koh, 2015), makerspace professionals found that, over time, they were able to change those perceptions. In some cases, makerspace professionals even felt they were future-proofing their libraries, ensuring their relevance in a time when it is often questioned (Slatter & Howard, 2013).

Evaluation approaches. While makerspace professionals found that output measures such as attendance at programs and statistics on the use of the space were valuable methods of evaluating their efforts, they found outcome measures to be more powerful (Abbas & Koh, 2015). They observed the growth and increased engagement of the teens visiting their spaces, informally assessing their programs based on changes they witnessed in the teens. When advocating for their spaces, they found stories and anecdotes particularly effective. They also collected feedback directly from the teens themselves.

Goals. Because every makerspace is different, each makerspace professional had different specific goals, but there were some themes common across the interviews (Abbas & Koh, 2015). Sustainability was a key goal. As mentioned earlier, many spaces were funded initially with grant monies and would need additional support to continue. Makerspace professionals sought ways to continue their work even after initial investments had been used up. These might include seeking further grants, requesting institutional support, and establishing partnerships with other organizations. Another goal was for the makerspaces to scale, spread, and expand. Makerspace professionals wanted to reach larger audiences and tackle new types of projects. They also wanted to share their own experiences and best practices to serve as mentor spaces for makerspaces currently in development. Finally, makerspace professionals had goals not only for the makerspaces in which they worked, but for themselves. They wanted to learn more about particular techniques and share their own expertise via publications and presentations.

Participants in Slatter and Howard's study (2013) suggested strategies that might help makerspace professionals achieve the goals articulated by participants and Abbas and Koh's study (2015). These include forging partnerships with outside organizations to find additional support, researching community needs in order to appeal to more members of the community, finding ways to articulate the benefits the makerspace affords the community, and "creating a blueprint of a successful makerspace for others to use" (p. 279).

Directions for future study. In a study in which she interviewed twelve librarians working in makerspaces, Moorefield-Lang (2015a) found similar results to Abbas and Koh (2015) and Slatter and Howard (2013). Based on these results, Moorefield-Lang suggests that the following themes surrounding makerspaces merit further research: rationales for implementing

makerspaces, staffing challenges in makerspaces, staff training for makerspaces, and patron training in makerspaces.

Investigating Specific Issues in Makerspaces

While Burke (2013) and Peppler and colleagues (2015a, 2015b, 2015c) provide an overview of makerspace settings, tools, and programming and Abbas and Koh (2015) and Slatter and Howard (2013) consider a variety of issues affecting a small selection of makerspaces, Moorefield-Lang explores specific issues related to makerspaces in depth, including the use of 3D printers (2014), makerspace user agreements (2015c), and mobile makerspaces (2015d). Moorefield-Lang completed case studies of six makerspaces that had incorporated 3D printers, interviewing the librarians who worked in these spaces. Two were in school libraries, two in public libraries, and two in academic libraries. Key considerations for all of the librarians interviewed were staff and faculty training for how to work with the 3D printer, patron education in the appropriate use of the 3D printer, acquiring funding for the printer itself and replenishable 3D printing supplies, and planning for the implementation of the 3D printer. Of particular interest to the current literature review and proposed study are the issues addressed by the school librarians interviewed. One of them expressed a firm commitment to integrating the use of the 3D printer into the school's curriculum, rather than treating it as an isolated activity. The same librarian indicated that making time to help students use the 3D printer was a challenge, due to the school only having one librarian. The other indicated that the popularity of the 3D printer was a challenge, as it was impossible to meet the demand for its use with a single 3D printer. Despite these challenges, both librarians felt that their implementations of the 3D printers in their schools had been successful and had benefitted their students.

Moorefield-Lang (2015c) examined the user agreements of 24 makerspaces from public and academic libraries in the United States, performing a qualitative content analysis to identify shared themes. Most user agreements required patrons to sign the agreement or provide identification to use the makerspace. They often specified what types of patrons could use the space, for example, whether children under 13 had to be accompanied by a parent or the space was limited to only teen patrons. Some described appropriate uses of the space, specifying that technology in the space was for creative use, not general e-mail checking or web browsing, or that it should be used primarily for library-sponsored activities. Several agreements described the specific technology available for use in the makerspace. Many addressed issues of neatness and maintaining the makerspace as a user. Those that charged for supplies or equipment use tended to address this in the user agreement. User agreements frequently addressed safety and liability issues, indicating that patrons took responsibility for themselves and would not hold the library responsible for injury. Finally, the use of digital fabrication tools in particular raises intellectual property concerns, so many user agreements require patrons to own the copyrights to or have permission to use the designs they use with 3D printers, laser cutters, and other digital fabrication tools.

Moorefield-Lang (2015d) also investigated the implementation of mobile makerspaces, interviewing six librarians and educators. These makerspaces are still dedicated spaces for making, but rather than being stationed in a library or other permanent space, they travel via cart, bus, or truck. This promotes accessibility to patrons who might not be able to come to the library and allows sharing of resources between different organizations. Librarians and educators working with mobile makerspaces identified three primary challenges to their work: demand, funding, and training. In most cases, word of mouth led to increased demand for visits from the

mobile makerspaces, but visits were limited by staff availability and only having one mobile makerspace. Funding was also a concern; while mobile makerspaces don't require a dedicated physical space in a building, buses and trucks require fuel and maintenance. Finally, training was a challenge; few makerspace staff members had received any formal training, and as most mobile makerspaces were staffed by only one staff member, they did not have colleagues to assist them in learning. Mobile makerspace staff members had to do a lot of independent research and networking to learn how to best serve their patrons.

Competencies for Working in Makerspaces

Abbas and Koh (2015) and Moorefield-Lang (2014, 2015d) note the difficulty of finding personnel who have all of the competencies and skills necessary for working in a makerspace and the importance of training for makerspace staff. Koh and Abbas (2015) interviewed information professionals working in library and museum makerspaces, asking them what competencies and skills they believed were necessary for working in a makerspace. The most important competencies they identified were "(1) ability to learn, (2) ability to adapt to changing situations, (3) ability to collaborate, (4) ability to advocate for the Learning Lab or Makerspace, and (5) ability to serve diverse people" (p. 119). The most important skills were "(1) management, (2) program development, (3) grant writing and fund raising, (4) technology literacy, and (5) facilitating learning based on learning theories and user behaviors" (p. 121). Participants identified the following ways to obtain these competencies and skills: "(1) networking (e.g., conferences and conversations with professionals in different Labs), (2) learning by doing on the job, (3) self-education (e.g., online training resources, reading articles, and reflection), and (4) formal education" (p. 122). When asked whether their higher education had prepared them to work in makerspaces, four of the nine participants said that it had. One pointed out that, while it had not prepared him for this work explicitly, it had prepared him to be a lifelong learner, which was key to obtaining necessary competencies and skills.

Koh and Abbas (2015) compared the competencies identified by participants to those identified by the American Library Association and its divisions. They found some overlap, but with the exception of the American Association of School Librarians (AASL), none of these sets of competencies included facilitating learning, focusing instead on the provision of services and resources. Participants consistently identified the ability to facilitate learning as a key skill, going so far as to indicate that their own professional identities had shifted to include "educators, learning facilitators, and mentors" (p. 124). In addition, none of the professional organization competencies included flexibility, adaptability, or a disposition for lifelong learning, all of which participants felt were necessary for working in makerspaces. Koh and Abbas suggest that both professional competencies and library and information science graduate school curricula should be updated to include the competencies and skills necessary for working in makerspaces.

Youth Conceptions of the Maker Movement

Abbas and Koh (2015), Moorefield-Lang (2014, 2015d), and Slatter and Howard (2013) investigate the perceptions of information professionals working in makerspaces. The activity that occurs in makerspaces, however, is user-driven. It is important to understand the perspectives of users when considering the potential impact of the Maker Movement. Martin and Dixon (2013) explored the conceptions of youth ages 12 to 18 participating in an out-of-school maker club, interviewing the youth themselves, their parents, and their adult mentors, as well as observing youth in the maker club. Three themes emerged from their analysis of their interviews

and observations. First, youth had a narrow conception of the maker identity. While they felt that the maker community allowed for many “forms of activity and many modes of participation” (p. 3), they felt that to be considered a maker, one must be consistently active both in making as an activity and in the maker community. Second, youth considered making to be atypical behavior, contrasting it with everyday consumer behaviors; it is unusual to prefer creation to consumption. Finally, youth experiences with making were integrated with and generalizable to their other life experiences; for example, one participant was a guitar player and as he engaged with making began to consider modifications he could make to his guitar to improve his playing.

Makerspaces and Learning

As learning scientists and educators have begun to recognize the powerful learning that happens in makerspaces, a body of empirical literature surrounding makerspaces as learning environments has emerged. This literature is grounded in constructivist learning theories and ranges from studies that seek to address whether students are learning at all in makerspaces to studies that go in depth to discover how making as an activity demonstrates learning.

Makerspaces and Learning Theories

In her exploration of makerspaces as learning environments, Litts (2015) draws on “constructivist-based situative-cognitive and sociocultural learning theories” (p. 14). While the empirical literature on makerspaces is not extensive, much of it connects makerspaces and making with these theories. Piaget (1953) suggests that learners build understanding through personally meaningful experiences; learning is not solely internal, but is influenced by the learner’s interactions with the external world. Vygotsky (1978) proposes that learning is socially and culturally constructed; learners grow beyond their current limits with assistance from mentors and peers. Piaget’s theory aligns well with the maker identity component of the Maker Movement, while Vygotsky’s is reflected in the community-oriented aspect of the movement.

Both of these theories of learning inform Papert’s (1991) theory of constructionism, the learning theory that most closely reflects how learning happens in makerspaces. Building on the idea that learners construct knowledge through their own experiences and their interactions with others, Papert proposes that they learn best through the literal construction of public “artifacts,” digital or physical objects that “can be shown, discussed, examined, probed, and admired” (Papert, 1993, p. 142). This type of construction is at the heart of making activity and goes beyond the information literacy approach used in school libraries in the past to move inquiry learning from a process of seeking, compiling, and synthesizing information to a process of exploring, iterating, and producing artifacts.

What Makerspace Learning Looks Like

Some researchers have chosen to simply address the question of whether students are really learning in makerspaces at all. In a survey of makerspace sites receiving funding from Cognizant’s Making the Future Initiative, Dorph and Cannady (2014) found that students increased their Science, Technology, Engineering, and Math (STEM) learning activation, “the combinations of dispositions, skills, and knowledge that position an individual for current and future success in STEM learning” (p. 3). In an ethnographic case study of an afterschool maker club in a high school, Koh (2015) found that students learned self-direction including goal-setting and project management skills, flexibility, problem-solving skills, technology skills,

information skills, and science content knowledge. They learned via three dominant styles of learning: learning by doing, learning by seeking information independently, and learning in collaboration with others. The learning that occurs in makerspaces is hands-on and iterative (Bowler, 2014; Koh, 2015), requiring students to attempt solutions and then modify them as they learn what does and does not work. A comparative case study of three makerspaces (Sheridan et al., 2014) describes makerspaces “as being multidisciplinary both in approach and in work produced, as blending formal learning environments and informal communities of practice, and as being focused on learning as production rather than as mastery of a composite set of skills” (p. 536). These makerspaces accommodated diverse learning arrangements, both self-directed and collaborative, and allowed for a wide range of learners with respect to age and expertise. The culture within the makerspace embraced values such as sharing the results of making, process, playing with materials with no project in mind, and tinkering.

Learning through Tinkering

Bevan, Gutwill, Petrich, and Wilkinson (2014) investigated the learning that occurs throughout the tinkering process.

Tinkering is a branch of making that emphasizes creative, improvisational problem solving. It centers on the open-ended design and construction of objects or installations, generally using both high- and low-tech tools (e.g., Arduino microprocessors with pipe cleaners, hot glue guns, and feathers). At the heart of tinkering is the generative process of developing a personally meaningful idea, becoming stuck in some aspects of physically realizing the idea, persisting through the process, and experiencing breakthroughs as one finds solutions to problems (Petrich, Wilkinson, & Bevan, 2013; Vossoughi, Escudé, Kong, & Hooper, 2013). Problems or challenges are not assigned but are surfaced and pursued by the learner through initial exploratory engagement with the materials, people, practices, and ideas available in the tinkering setting. (p. 99)

In a jointly-negotiated research project between researchers and practitioners, Bevan and colleagues targeted specific individuals to observe as they participated in a tinkering activity. Based on these observations, they negotiated a framework they call the “Tinkering Learning Dimensions Framework.” The dimensions present in this framework are engagement, initiative and intentionality, social scaffolding, and development of understanding. Indicators for each of these dimensions are defined in Table 1.

Learning Practices of Makers and Their Presence in Family Learning

The Maker Movement takes its name from and was first popularized by the magazine *Make:*. The maker community has three primary methods of “social meeting and exchange” (Brahms, 2014, p. 9): remote exchange via the publication of *Make:* and websites such as Etsy, Ravelry, and Instructables; face-to-face exchange via one-time events such as meetups and Maker Faires; and face-to-face exchange via persistent spaces such as makerspaces. To identify the learning practices of members of this community, Brahms performed a content analysis of one year’s worth of issues of *Make:*, volumes 30 to 33. Examining the articles published throughout the year, Brahms identified seven learning practices: explore and question; tinker, test, and iterate; hack and repurpose; combine and complexify; seek out resources; customize; and share. Most articles included two or more of these learning practices. These learning practices are defined in Table 2.

Table 1

Tinkering Learning Dimensions Framework

Learning Dimension	Indicator
Engagement	<ul style="list-style-type: none"> • Spending time in tinkering activities • Displaying motivation or investment through affect or behavior
Initiative and intentionality	<ul style="list-style-type: none"> • Setting one's own goals • Seeking and responding to feedback • Persisting to achieve goals in the problem space • Taking intellectual risks or showing intellectual courage
Social scaffolding	<ul style="list-style-type: none"> • Requesting or offering help in solving problems • Inspiring new ideas or approaches • Physically connecting to others' works
Development of understanding	<ul style="list-style-type: none"> • Expressing a realization through affect or utterances • Offering explanation(s) for a strategy, tool, or outcome • Applying knowledge • Striving to understand

Bevan, B., Gutwill, J. P., Petrich, M., & Wilkinson, K. (2015). Learning Through STEM-Rich Tinkering: Findings From a Jointly Negotiated Research Project Taken Up in Practice. *Science Education*, 99(1), 98–120. <http://doi.org/10.1002/sce.21151>

Table 2

Maker Community Learning Practices

Maker Community Practice	Definition
Explore & Question	Interrogation of the material properties of the context in order to find inspiration or to determine intention for a process or project.
Tinker, Test & Iterate	Purposeful play, experimentation, evaluation and refinement of the context.
Hack & Repurpose	Harnessing and salvaging component parts of the made world to modify, enhance, or create a product or process.
Combine & Complexify	Developing skilled fluency with diverse tools and materials in order to reconfigure existing pieces and processes and make new meaning.
Seek out Resources	Identifying and pursuing the distributed expertise of others, includes a recognition of one's own not-knowing and desire to learn.
Customize	Tailoring the features and functions of a technology to better suit one's personal interests and express identity
Share	Making information, methods and modes of participation accessible and usable by members of the community.

Brahms, L. (2014, May 22). *Making as a Learning Process: Identifying and Supporting Family Learning in Informal Settings* (Doctoral Dissertation). University of Pittsburgh, Pittsburgh, PA, USA. Retrieved from <http://d-scholarship.pitt.edu/21525/>

Having identified these learning practices, Brahms (2014) observed families participating in family learning activities in the context of a museum makerspace. The children engaging in these family learning activities demonstrated all of the maker community learning practices at one point or another. In addition, Brahms noted that while adults in the families observed participated as learning partners, their roles in learning shifted over time. At the beginning of their time in the makerspace, they often served in an instructional role, explaining concepts or activities to children, but over time, as children took ownership of the activities in the makerspace, adults shifted to a more instrumental role, following instructions given by the children to hold supplies or perform actions that the children identified as key to completing the making activity.

Makerspaces as Learning Environments

Drawing on constructionism and multiliteracies theories and the work of Sheridan and colleagues (2014), Litts (2015) proposes an activity-identity-community framework for analyzing learning in makerspaces. “Making” is the activity, “maker” the identity, and “makerspace” the community. Litts examines in great detail three youth makerspaces, operationalizing the activity-identity-community framework with the following questions:

Activity: What happens there? What processes and products are supported (through people, tools, & materials) in the space?

Identity: What identities are taken up and supported?

Community: Who is involved both directly and indirectly? What is the community context and structure? (p. 56)

Activity. The learning arrangements and facilitation-style at the makerspaces varied. They were either youth-driven or facilitator-driven. In youth-driven makerspaces, patrons selected their own projects. In facilitator-driven makerspaces, projects were part of a workshop with specific instruction facilitators. The makerspaces varied as to their design structures, learning goals, and products. Some were specifically designed as learning environments; in other cases, learning happened spontaneously even though the environment was not designed to support it. Activity duration varied from bounded activities lasting less than an hour to extended activities that required work over multiple visits to the makerspace. Activity duration was related to activity scale. Activities might be micro-introductory, limited kit scale, or open-ended. Micro-introductory activities are brief and constrained by specifically supplied tools. Limited kit activities are linear and product-driven, but offer more freedom than micro-introductory activities. Open-ended activities allow for deep investigation and are iterative and collaborative.

Some tools and materials were cheap and replenishable, such as craft supplies, and others more expensive, such as 3D printers and laser cutters. The visibility of tools and materials affected patron activity; tools and materials stored in the part of the makerspace dedicated to making activity were more likely to be used, while tools and materials stored elsewhere might be forgotten or considered unavailable for patron use. Makerspaces might be organized or disorganized, and materials might be arranged either according to their intended use in a specific project or more generally by type.

Identity. Makerspaces encourage youth to take ownership over the space both with their accessibility of tools and materials and messaging such as signage throughout the space and programming. Some makerspaces promote an individualistic identity, focusing on choosing your own projects, while others promote a collectivistic identity, emphasizing the importance of collaboration. It is not only the maker identity for youth patrons that is enacted and influences

activity and community in this space. Facilitators' identities make a difference as well. If facilitators identify themselves as specialists in a particular type of making, they may neglect to offer opportunities to patrons for other types of making.

Community. Each makerspace embraces a particular ethos. This might be focused on the family, the community, or the neighborhood. The scope of patrons the makerspace serves might be as narrow as the local community or as broad as the international community. Makerspaces prioritized different audiences for making; some focused on making for personal use, while others focused on making for local, shared use. All makerspaces emphasized the importance of sharing artifacts produced in the makerspace. Makerspaces engaged in partnerships with other organizations for the purposes of bringing in expertise, gaining funding, and advocating for the maker movement.

Design stances. Having thoroughly explored the activity-identity-community framework, Litts then examined the design stances youth makers took as they worked in makerspaces. "A design stance is the approach a maker takes toward making" and is "defined by unique goals and product features and inspired by disciplinary practices" (Litts, 2015, p. 127). The three design stances Litts identifies are aesthetic, functional, and pragmatic. An aesthetic design stance focuses on making something that will look "cool," a functional design stance focuses on making something that will work, and a pragmatic design stance focuses on making something to solve a specific problem. With the activity-identity-community framework in mind and design stances as a lens for exploring "how experienced young makers demonstrate learning" (p. 133), Litts engaged eight experienced young makers between the ages of 10 and 15 who either self-identified as makers or had participated in making activities for at least six months in a design challenge. These makers were challenged to "make flow" and "use the space as [you] normally would" (p. 143). All three design stances were present in the young makers' processes. The disciplinary practices in which they engaged were brainstorming, iterating, and communicating. Each of these disciplinary practices can be measured as evidence of learning. In addition, makers demonstrated understanding of technical skills such as circuitry, crafting, and woodworking, and content domain understanding of the scientific concepts of electricity, air, water, and gravity.

Equity in Makerspaces

While makerspaces show a great deal of promise as learning environments, their history as the domain of middle-aged, technology-focused White males has led to warnings that they might be seen as exclusionary spaces (Brahms, 2014; Halverson & Sheridan, 2014). Youth makerspaces serve a diverse population; across all makerspaces surveyed by Peppler and colleagues (2015a), "42% of program participants were White, 20% were Black/African-American, 18% were Hispanic/Latino(a), 14% were Asian, 0.3% were Native American, and 5% did not fall in the given categories" (p. 2), demonstrating greater diversity in the population served than in the United States population according to the 2010 census.

Some educators and researchers have created initiatives explicitly designed to use makerspaces to disrupt norms and promote equity. Kafai, Fields, and Searle (2014) observed e-textiles workshops offered to public magnet high school students as a partnership between a science museum and the school. The goal of these workshops was to increase the transparency of computing processes, incorporate aesthetics into making, and increase diversity among makers. They found that integrating crafts with computing did make the coding process more transparent for makers. The desire to pursue particular aesthetics drove makers to consider a broader range of functionality. In spite of this increased transparency and success at incorporating aesthetics,

students in the workshops had difficulty reconciling their notions of typical gendered activities with their making experiences. They tended to expect boys to be more interested in computers and girls to be more interested in aesthetics; as they engaged in these activities, their interests shifted, but they found this shift surprising and contrary to their usual expectations of gendered behavior.

Norris (2014) researched the relationship between designing tangible artifacts, design thinking, and young women's racialized and gendered identity processes. A white woman teacher in her 30s engaged 10 predominantly Latina and African American female students in a design thinking challenge, instructing them to make an ode to someone they loved. Young women struggled with the design process, with turning ideas into tangible artifacts, and with developing a positive self-conception. Some refused to participate in the challenge at all. Many felt that the challenge required them to engage in activities contrary to their lived experiences or to share their own private thoughts and feelings publicly. Norris concludes that "one's own identity processes can hinder one's readiness" to engage in making and learning (p. 74).

Vossoughi, Escudé, Kong, and Hooper (2014) describe the teaching and learning that occur in an after-school making program that approaches tinkering and making from an equity-oriented perspective. They provide key examples from their study to illustrate ideas related to equity-oriented teaching and learning in a making environment. They emphasize the importance of seeing the first failure of a prototype as a beginning, rather than an end. The lead teacher in their project "adopted and developed a pedagogical vocabulary that emphasizes the process of iteration and the development of ideas" (p. 5), inviting students to see themselves as thinkers. Vossoughi and colleagues suggest that this type of teaching "contributes to widening definitions of learning, intelligence and science and creates openings for young people who may not be positioned as 'successful' according to the more narrow measures that (increasingly) characterize learning in school" (p. 6).

Makerspaces Belong in School Libraries

In its standards document, *Standards for the 21st-Century Learner* (2007), the American Association of School Librarians declares, "Inquiry provides a framework for learning" (p. 2). The standards identify key skills, dispositions, responsibilities, and self-assessment strategies that form the foundation for successful learning. The first skill this document identifies is that learners "[follow] an inquiry-based process in seeking knowledge in curricular subjects, and make the real-world connection for using this process in [their] own [lives]" (p. 13). Kuhlthau outlines a framework for this process called Guided Inquiry (Kuhlthau, 2010); school library makerspaces can serve as an extension of the Guided Inquiry process.

The underlying concept in inquiry learning, according to Kuhlthau (2010), is "considering a question or problem that prompts extensive investigation on the part of the student" (p. 2). This is similar to the exploratory, investigative processes that occur in makerspaces. Inquiry learning is a constructivist approach to learning, requiring students to build their own knowledge through investigation and experience. This approach is also applicable to the learning that happens in makerspaces, which is grounded in the constructivist learning approaches of Piaget, Vygotsky, and Papert, among others. Kuhlthau's model of Guided Inquiry emphasizes that students are not performing this investigation in isolation; rather, key adult mentors are available to intervene at points when students might be frustrated or begin to address questions more by compiling and collecting information rather than engaging with it deeply. This

mentoring relationship, usually involving the school librarian and classroom teachers, mirrors the type of mentoring that happens in makerspaces.

The literature on makerspaces repeatedly points to libraries as promising environments for the development of makerspaces. Halverson and Sheridan (2014) point out, “Libraries in particular hold promise for democratization, given their history as free, embedded community resources open to all” (p. 500); the school library is a resource embedded in the school community and open to all members of that community. Koh (2015) suggests that makerspaces located in libraries benefit from having an information literacy expert always on hand, available to assist in information seeking processes. While most of the literature focuses on makerspaces and making in informal learning environments, Fields and King (2014) demonstrate, with their study of incorporating making into a craft technologies university course, that making can shape learners’ identities and learning processes even when embedded in a formal learning environment.

In spite of the promise school library makerspaces hold for transforming education, there are dangers. Martin (2015) warns that, if the adoption of computing within schools is any indication, there is a risk that schools will assume the tools are the driving force behind the Maker Movement and adopt a tool-centric approach to making. For school library makerspaces to be truly effective, they must adopt not only the tools of the Maker Movement, but also its community ethos, culture, and set of learning practices.

School Library Makerspaces: A Proposed Study

Purpose of Research

The purpose of the proposed research is to explore the ways in which exemplary school library makerspaces incorporate key elements of the Maker Movement’s community and culture into their activities.

Research Question

The proposed study addresses the following research question:

RQ1. How are exemplary school library makerspaces rooted in the community and culture of the larger Maker Movement?

Implications and Audience of Research

The proposed research has implications for preservice and in-service school librarians and the academic community. Preservice and in-service school librarians need to be prepared to work in school library makerspaces. Understanding of the extent to which current school library makerspaces have embraced the community and culture of the Maker Movement can provide school librarians with a sense of how to proceed as they implement their own makerspaces and illuminate potential pitfalls of the implementation process. As Koh and Abbas (2015) suggest, faculty in school library preparation programs should consider how they can prepare preservice school librarians to work in makerspaces. A key component of successful implementation of a makerspace is incorporating the community and culture of the Maker Movement. Based on the results of this study, faculty will be able to determine what successful adoption of this culture looks like and what gaps currently exist in school library makerspaces’ adoption of this culture and update curricula to address both.

Contribution to the Academic Literature

The proposed research contributes to the academic literature on both school libraries and makerspaces. While the body of empirical research on makerspaces is in a phase of rapid expansion, thus far few studies have included school library makerspaces in their studied populations, and even fewer have focused exclusively on school library makerspaces. Those that have included school library makerspaces have rarely examined how they fit into the larger Maker Movement. The proposed study addresses these gaps.

Theoretical Framework

The proposed study relies on Halverson and Sheridan's three pillars of the Maker Movement (2014), Litts's activity-tool-community framework (2015), and Brahms's maker community learning practices (2014) to investigate the extent to which school library makerspaces embrace the community and culture of the Maker Movement, as well as its tools.

Methods and Data Analysis

The proposed study uses methods similar to those used by Abbas and Koh (2015) in their investigation of the perceptions of information professionals working in makerspaces in museums and public libraries. Participants will be chosen using purposive sampling, identified via resources such as the Makerspaces directory, list of winners of YALSA's Maker Contest, and the Maker Ed Google+ community.

Data will be collected using a semi-structured interview process. Some interview questions will be developed based on Litts's operationalized activity-tool-community framework:

Activity: What happens there? What processes and products are supported (through people, tools, & materials) in the space?

Identity: What identities are taken up and supported?

Community: Who is involved both directly and indirectly? What is the community context and structure? (Litts, 2015, p. 56)

Others will address Brahms's seven learning practices: explore and question; tinker, test, and iterate; hack and repurpose; combine and complexify; seek out resources; customize; and share. Participants might be interviewed in person, over the phone, or via Skype or Google Hangout. All interviews will be recorded and transcribed.

Coding will be deductive and iterative, relying on themes generated in this literature review such as the fusion of digital tools with DIY-creation, social learning facilitated by connections with both peers and mentors, and sharing of made products. Additional themes may emerge during the coding process.

Possibilities for Future Research

The proposed study may serve as the first phase of a multi-phase project. Results might be used to generate a survey to administer widely to school librarians who have implemented makerspaces in their libraries. Exemplary makerspaces may be recruited for participation in a deeper ethnographic study. This research may connect with future research examining how school library makerspaces facilitate inquiry learning and whether there is a relationship between their incorporation of the community and culture of the Maker Movement and their ability to promote inquiry learning.

Conclusion

Makerspaces are being incorporated into school libraries at a dizzying pace. To ensure their sustainability and their ability to serve the school library's primary mission of promoting learning, further research is needed into how they can incorporate the community, culture, and learning practices of the Maker Movement into their activities. The proposed study addresses this concern.

References

- Abbas, J., & Koh, K. (2015). Future of Library and Museum Services Supporting Teen Learning: Perceptions of Professionals in Learning Labs and Makerspaces. *The Journal of Research on Libraries and Young Adults*. Retrieved from <http://www.yalsa.ala.org/jrly/2015/11/future-of-library-and-museum-services-supporting-teen-learning-perceptions-of-professionals-in-learning-labs-and-makerspaces/>
- About Maker Faire. (n.d.). Retrieved December 1, 2015, from <http://makerfaire.com/makerfairehistory/>
- American Association of School Librarians. (2007). Standards for the 21st-Century Learner. American Association of School Librarians. Retrieved from http://www.ala.org/aasl/sites/ala.org.aasl/files/content/guidelinesandstandards/learningstandards/AASL_Learning_Standards_2007.pdf
- Association of Science-Technology Centers, & Urban Libraries Council. (2014). *Learning Labs in Libraries and Museums: Transformative Spaces for Teens*. Washington, D.C.: Association of Science-Technology Centers. Retrieved from <https://www.imls.gov/assets/1/AssetManager/LearningLabsReport.pdf>
- Bowler, L. (2014). Creativity Through “Maker” Experiences and Design Thinking in the Education of Librarians. *Knowledge Quest*, 42(5), 58–61.
- Brahms, L. (2014, May 22). *Making as a Learning Process: Identifying and Supporting Family Learning in Informal Settings* (Doctoral Dissertation). University of Pittsburgh, Pittsburgh, PA, USA. Retrieved from <http://d-scholarship.pitt.edu/21525/>
- Britton, L. (2012, August). A Fabulous Laboratory: The Makerspace at Fayetteville Free Library. *Public Libraries*, 51(4), 30–33.

Buerkett, R. S. (2014). Make It So: You Can Start a Maker Club at Your School Library!

Teacher Librarian, 41(5), 17–20.

Burke, J. (2013). *Makerspaces in Libraries Survey Results 2013*. Retrieved from

<http://www.users.miamioh.edu/burkejj/Makerspaces%20in%20Libraries%20Survey%20Results%202013.pdf>

Canino-Fluit, A. (2014). School Library Makerspaces. *Teacher Librarian*, 41(5), 21–27.

Craddock, I. L. (2015). Makers on the move: a mobile makerspace at a comprehensive public

high school. *Library Hi Tech*, 33(4), 497–504. <http://doi.org/10.1108/LHT-05-2015-0056>

Daley, M., & Child, J. (2015). Makerspaces in the school library environment. *Access*

(10300155), 29(1), 42–49.

Dorph, R., & Cannady, M. A. (2014). *Making the future: Promising evidence of influence*. The

Lawrence Hall of Science. Retrieved from

<http://www.cognizant.com/SiteDocuments/Cognizant-making-the-future.pdf>

Educate to Innovate. (n.d.). Retrieved November 25, 2015, from

<https://www.whitehouse.gov/issues/education/k-12/educate-innovate>

Fields, D. A., & King, W. L. (2014). “So, I think I’m a programmer now.” Developing connected

learning for adults in a university craft technologies course. In *Learning and Becoming in*

Practice: The International Conference of the Learning Sciences (ICLS) 2014, Volume 1

(Vol. 1, pp. 927–936). Boulder, CO: International Society of the Learning Sciences.

Graves, C. (2014). Teen Experts Guide Makerspace Makeover. *Knowledge Quest*, 42(4), 8–13.

Halverson, E. R., & Sheridan, K. M. (2014). The Maker Movement in Education. *Harvard*

Educational Review, 84(4), 495–504, 563, 565.

Hamilton, B. (2012a, June 28). Makerspaces, Participatory Learning, and Libraries. Retrieved from <https://theunquietlibrarian.wordpress.com/2012/06/28/makerspaces-participatory-learning-and-libraries/>

Hamilton, B. (2012b, August 13). Library as Makerspace: Creating and Nurturing Communities of Teen Writers. Retrieved from <https://theunquietlibrarian.wordpress.com/2012/08/13/library-as-makerspace-creating-and-nurturing-communities-of-teen-writers/>

Houston, C. R. (2013). Makerspaces@your School Library: Consider the Possibilities! *International Association of School Librarianship. Selected Papers from the ... Annual Conference*, 360–364.

Institute of Museum and Library Services. (2012). *Talking Points: Museums, Libraries, and Makerspaces*. Retrieved from <http://www.imls.gov/assets/1/AssetManager/Makerspaces.pdf>

Kafai, Y. B., Fields, D. A., & Searle, K. A. (2014). Electronic Textiles as Disruptive Designs: Supporting and Challenging Maker Activities in Schools. *Harvard Educational Review*, 84(4), 532–556, 563–565.

Koh, K. (2015). *Are They Really Learning? A Case Study of a School Library Makerspace*. Retrieved from <http://tinyurl.com/irving14a>

Koh, K., & Abbas, J. (2015). Competencies for Information Professionals in Learning Labs and Makerspaces. *Journal of Education for Library and Information Science*, 56(2), 114–129.

Kuhlthau, C. C. (2010). Guided Inquiry: School Libraries in the 21st Century. *School Libraries Worldwide*, 16(1), 1–12.

- Kurti, R. S., Kurti, D., & Fleming, L. (2014a). Practical Implementation of an Educational Makerspace. *Teacher Librarian*, 42(2), 20–24.
- Kurti, R. S., Kurti, D., & Fleming, L. (2014b). The Environment and Tools of Great Educational Makerspaces. *Teacher Librarian*, 42(1), 8–12.
- Litts, B. K. (2015). *Making learning: Makerspaces as learning environments* (Ph.D.). The University of Wisconsin - Madison, United States -- Wisconsin. Retrieved from <http://search.proquest.com.libproxy.lib.unc.edu/docview/1651611969/abstract>
- Loertscher, D. V. (2012). Maker Spaces and the Learning Commons. *Teacher Librarian*, 40(1), 45–46,63.
- Loertscher, D. V. (2014). Makers, Self-Directed Learners, and the Library Learning Commons. *Teacher Librarian*, 41(5), 35,38,71.
- Loertscher, D. V. (2015). The Virtual Makerspace: A New Possibility? *Teacher Librarian*, 43(1), 50–51,67.
- Maker Education Initiative. (2015). History. Retrieved December 1, 2015, from <http://makered.org/about-us/history/>
- Martin, L. (2015). The Promise of the Maker Movement for Education. *Journal of Pre-College Engineering Education Research (J-PEER)*, 5(1). <http://doi.org/10.7771/2157-9288.1099>
- Martin, L., & Dixon, C. (2013). Youth conceptions of making and the Maker Movement. Presented at the Interaction Design and Children Conference, New York. Retrieved from https://www.exploratorium.edu/sites/default/files/pdfs/IDC_2013_Martin_Dixon.pdf
- Moorefield-Lang, H. (2014). Makers in the library: case studies of 3D printers and maker spaces in library settings. *Library Hi Tech*, 32(4), 583–593. <http://doi.org/10.1108/LHT-06-2014-0056>

- Moorefield-Lang, H. (2015a). Change in the Making: Makerspaces and the Ever-Changing Landscape of Libraries. *TechTrends*, 59(3), 107–112. <http://doi.org/10.1007/s11528-015-0860-z>
- Moorefield-Lang, H. (2015b). Making, Libraries, and Literacies. *Library Media Connection*, 33(4), 30–31.
- Moorefield-Lang, H. (2015c). User agreements and makerspaces: a content analysis. *New Library World*, 116(7/8), 358–368. <http://doi.org/10.1108/NLW-12-2014-0144>
- Moorefield-Lang, H. (2015d). When makerspaces go mobile: case studies of transportable maker locations. *Library Hi Tech*, 33(4), 462–471. <http://doi.org/10.1108/LHT-06-2015-0061>
- Norris, A. (2014). Make-Her-Spaces as Hybrid Places: Designing and Resisting Self Constructions in Urban Classrooms. *Equity & Excellence in Education*, 47(1), 63–77. <http://doi.org/10.1080/10665684.2014.866879>
- Papert, S. (1993). *The children's machine : rethinking school in the age of the computer*. New York: BasicBooks.
- Papert, S. |. (1991). Situating constructionism. In I. Harel & S. | Papert (Eds.), *Constructionism : research reports and essays, 1985-1990* (pp. 1–11). Norwood, N.J.: Ablex Pub. Corp.
- Peppler, K., Maltese, A., Keune, A., Chang, S., & Regalla, L. (2015a). *Survey of Makerspaces, Part I*. Retrieved from http://makered.org/wp-content/uploads/2015/02/OPP_ResearchBrief6_SurveyofMakerspacesPart1_final.pdf
- Peppler, K., Maltese, A., Keune, A., Chang, S., & Regalla, L. (2015b). *Survey of Makerspaces, Part II*. Retrieved from http://makered.org/wp-content/uploads/2015/02/OPP_ResearchBrief7_SurveyofMakerspacesPart2_final.pdf

- Peppler, K., Maltese, A., Keune, A., Chang, S., & Regalla, L. (2015c). *Survey of Makerspaces, Part III*. Retrieved from http://makered.org/wp-content/uploads/2015/03/OPP_ResearchBrief8_SurveyofMakerspacesPart3_final.pdf
- Piaget, J. (1953). *The origin of intelligence in the child*. Routledge & Paul.
- Preddy, L. (2013a). Creating School Library “Makerspace.” *School Library Monthly*, 29(5), 41–42.
- Preddy, L. (2013b). *School library makerspaces : grades 6-12*. Santa Barbara, California: Libraries Unlimited, An Imprint of ABC-CLIO, LLC.
- Range, E., & Schmidt, J. (2014). Explore, Plan, Create: Developing a Makerspace for Your School Community. *School Library Monthly*, 30(7), 8–10.
- Sheridan, K. M., Halverson, E. R., Litts, B. K., Brahms, L., Jacobs-Priebe, L., & Owens, T. (2014). Learning in the Making: A Comparative Case Study of Three Makerspaces. *Harvard Educational Review*, 84(4), 505–531, 563–565.
- Slatter, D., & Howard, Z. (2013). A place to make, hack, and learn: makerspaces in Australian public libraries. *Australian Library Journal*, 62(4), 272–284.
- Thompson, G. (2014). The Maker Movement Connects to the Classroom. *The Education Digest*, 80(3), 34–37.
- Vossoughi, S., Escudé, M., Kong, F., & Hooper, P. (2014). Tinkering, learning & equity in the after-school setting. Presented at the FabLearn, Stanford, CA. Retrieved from <http://fablearn.stanford.edu/2013/wp-content/uploads/Tinkering-Learning-Equity-in-the-After-school-Setting.pdf>
- Vygotskiĭ, L., & Cole, M. (1978). *Mind in society : the development of higher psychological processes*. Cambridge: Harvard University Press.

Young Adult Library Services Association (YALSA). (2014). *Making in the Library Toolkit*.

Retrieved from

<http://www.ala.org/yalsa/sites/ala.org.yalsa/files/content/YALSA%20Making%20Toolkit.pdf>