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Makers on the move: a mobile makerspace at a comprehensive public high school

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Abstract

Purpose – The purpose of this paper is to describe the implementation of a mobile makerspace program in a public school setting. Insights, challenges, successes, projects as well as recommendations will be shared.
Design/methodology/approach – This paper describes a mobile makerspace program in a public high school in Virginia. It discusses the growth of mobile making, the advantages and disadvantages of mobility, and how the program was implemented.
Findings – Mobile makerspaces are a fast-growing manifestation of maker culture. It is possible to have a makerspace in a public school and take the maker culture to other schools in the area. Having a steady supply of students or library interns that are willing to travel to other schools is critical.
Originality/value – Makerspaces in libraries is still a relatively new phenomenon. While the research is coming on stationary makerspaces, mobile making is a new horizon for the maker movement. This paper seeks to provide a description of one such program.

Keywords Library services, Library instruction, Schools, Makerspaces, Mobile Makerspaces, School libraries

Paper type Viewpoint

Introduction

A mobile makerspace is defined differently by almost everyone who has one. High tech makerspaces lean toward robotics and coding while others are more like garages or woodshops with crafting makerspaces veering in the direction of art. All have value and appeal to different types of students, but the desire to see an idea made real is universal.

The culture of making is critical in the global economy where much of what is known now will be obsolete in three years. That means that what a high school student learns as a first year student will either be untrue or outdated by graduation. Rather than teaching students a specific programing language like Python, maker education focusses on how to use programming to solve a problem and which types of computer coding languages are used for which type of tasks. Upon graduation the student may not have an encyclopedic knowledge of programming commands, but he or she will know how to learn what needs to be known. In a global economy of this pace, employers are less interested in what the employees know as they are in how fast employees can learn. Mona Westhaver (2003), President and Co-Founder of Inspiration Software Inc. noted as far back as 2003 that, "Learning to learn – helping students develop thinking skills, learning skills and, most importantly, a passion for learning – is the solution that will have the most long-term and widespread impact."

Students, too, are interested in learning when content is presented in an engaging, creative and relevant way. Maker education has the advantage of being truly engaging. It teaches students a variety of skills – both technical and emotional. As one student put it "Building a calculator began with learning how to count in binary. Learning how to help my deaf brother feel sound again began with learning electrical inputs and outputs. Once the "complicated" barrier was broken, I realized that I could

learn anything." That confidence to tackle a problem and the persistence to continue are essential life-long skills that maker education fosters.

As a librarian, the culture of making is a different approach to teaching research. More specifically, it teaches students how to read text for information, how to differentiate quality from suspect resources, and how to determine importance. In the past, libraries have been vast warehouses of a shared bank of knowledge preserved between hardback covers. Now, much of that knowledge is freely available online. This has thrust libraries into a situation where holding onto the old ways is impossible. Libraries can no longer be book distributers and equipment warehouses. There are too many other competing elements online. However, these vast online warehouses of information may or may not be reliable. Differentiating the good information from the inaccurate is a skill that should be taught, in part, by school librarians.

As school librarians, we are tasked with teaching students effective research strategies. Making is how research becomes relevant. Source reliability is a hard lesson in making. If students go to unreliable sources to create their project or components, it is not going to work. Teaching students how to identify reliable sources may take more time using this method, but it is more effective and enduring than the lecture model. Nothing communicates "unreliable source" quite like an light emitting diode (LED) that refuses to light, a failed 3D print, or computer code that refuses to compile into a usable program.

Making also taps into the natural talents that students bring to the table. Young artists and young engineers; the right and the left brained students can all work together. They learn critical collaborative skills working together to build something interesting. While some students choose to work alone, many find that they do not have enough knowledge or skills to complete the project. At that point, they turn to each other and to reliable sources to break through and finish.

Permanent makerspaces

Creativity, problem solving, and collaboration are all endemic to the maker culture. Makerspaces that are in permanent locations have several advantages. First, these makerspaces can have a steady stream of regular customers. Students know where to go when they have an idea. There is no waiting when inspiration strikes. A student can conceive of an idea overnight and knows exactly where to go in the morning to make it. Students become familiar with where the supplies they need are located for easy access. Finding a needle for a sewing project, or copper wire for circuit does not require assistance because students know where to look. This is time saving for the librarian. Students also know how and to whom questions should be asked and assistance requested.

In permanent makerspaces, experts in particular skills often take up residence. In the course of becoming a fixture in the space, students begin to refer to each other for help rather than the librarian and in this way; they build skill capacity and a knowledge base. As Ian Hughes notes, "Maker culture is about an open source mentality to almost everything. If something is not working in a maker's life or for their friends, family or colleagues they fix it. "Fixing it," means taking something that is already there and adjusting or hacking a solution."

Second, stable makerspace have the advantage of space for supplies. Anytime one puts an operation on the road, physical space is lost. A makerspace the size of a small classroom demands a huge trailer to hold it all. Supplies at hand necessarily must be pared down. That requires a loss of accessible supplies at any given moment. In addition, permanent makerspaces can take more donations. Community members know where to drop off their usable things and therefore, more things appear.

Current state of mobile makerspaces

Taking a makerspace on the road does have huge advantages. I liken them to food trucks. While they do not have the advantages of vast kitchens to create their masterpieces, they do have one critical advantage. Like a food truck, a mobile makerspace can go to the patron instead of waiting for the patron to arrive. Food trucks, like mobile makerspaces, depend on demand and social media advertising.

The demand for makerspaces is high and it is not just kids who want to make. There are adult makerspaces – both mobile and stationary – that are becoming extremely popular. Makerspaces for women, steampunkers, the homeless, bikers, and tinkerers are popping up everywhere. Funded, like gyms, as subscription services, these makerspaces are becoming increasingly popular with diverse populations. Trucks and trailers are also being outfitted with laser cutters and 3D printers to roll out into neighborhoods. The University of California at Santa Cruz has developed the ArtCrawler, a re-purposed military truck that is designed to cut the cost of studio space and bring diverse communities together. This truck is geared toward adults and points to one huge advantage to mobile making – cost. Because there is no rent required and only a limited amount of space, the mobile makerspace saves on those expenses. Because it is not attached to a single community, the truck can serve as an ambassador for the maker culture. In schools, a mobile makerspace may be a cost-friendly way for divisions to extend the culture of making to many communities without having to fund a makerspace in each school.

TechShop and Fujitsu have recently partnered up to outfit a trailer that is geared toward technology. It is outfitted with laptops, mini-3D printers, and laser cutters. It is intended to travel to schools (Terndrup, 2014). The teachers who invite TechShop to visit control the curriculum rather than the makerspace bringing the projects to the teachers. Mobile makerspaces for education bank on student curiosity; but, acknowledge the reality of school budgets. While not every school has the budget to implement a makerspace, it may be possible for them to host a mobile makerspace for a few days.

There may be a connection between the type of making and the type of transportation chosen. ArtCrawler chose an old army truck; TechShop chose a trailer; Coders chose a bus. Coding in the form of The GeekBus is a high end tour bus that has been converted into a mobile makerspace focussed on computer science and robotics and offers seven different workshops. According to the web site, it is exclusively focussed on STEM (science, technology, engineering, and math) instruction and STEM careers (Geekbus.com, 2015).

Because of the tremendous life-long learning that emerges from the maker culture, schools are taking notice. While not every school has a makerspace, it is possible for a school system or even a school feeder pattern to create a mobile makerspace to follow the demand. Schools interested in kick starting a maker culture may also be interested in hosting a mobile makerspace at their school. A successful visit may build political capital in advance of funding requests or grant initiatives. In a survey of 143 libraries with makerspaces 65 percent of them were funded through grants or donations. Only 36 percent were funded from the library budget (Price, 2013). Like the best taco truck in town, the mobile makerspace can go where there are students ready to make. This is how Monticello High School's budget friendly mobile makerspace came into being.

Mobile makerspace at Monticello High School

Each Thursday, two or three students mount the steps of a short yellow school bus to travel the ten miles to the local middle school. They are carrying a cardboard box full of nearly empty toner cartridges, hairspray, and copy paper. At the middle school, the

interns head straight to the library where the middle school students are waiting to find out about today's maker project. This afternoon, the make is toner art. Students shake toner onto white paper, then use pencil erasers to draw portraits and patterns in the powder. Afterwards, the students will use the hairspray as a fixative to prevent the toner powder from smearing. Both color and black toner is popular with the students.

At Monticello High School, library interns travel to other schools in our feeder pattern to conduct maker workshops. It began with an after school "take apart" at the middle school, but has evolved into a regular Thursday trip. The interns have also hosted professional development workshops for both the middle and elementary school teachers. To begin, the teacher, administrator, or librarian at the school requests the interns. The trips are arranged by their home librarian.

Monticello High School is a comprehensive public high school in Charlottesville, Virginia. It comprises urban, rural, and suburban elements. The school as a whole represents an economically diverse student body including 31.8 percent of students who are economically disadvantaged. The school is 66.8 percent white, 13.7 percent black, and 10.9 percent Hispanic (www2.k12albemarle.org, 2015). This diverse group of students is an advantage in appealing to makers in the younger grades in that the interns who visit the schools come from similar backgrounds. Students can see success that looks like them and that is important.

Not all libraries have interns. The Monticello High School library, however, is a student-run library that benefits greatly from the expertise of its patrons. There are students who work at the circulation desk; students who answer the phones, students who provide tech support; and students who tutor. On average, there are 20 students in the library available to help with a variety of tasks each block.

These students are assigned to the library in three ways. First, they are assigned through the internship class. This is a class in which students are given class credit for working. Second, the students who have a free period and who are assigned to be teacher aides often end up working in the library. Last, unassigned students often volunteer to work in the library prior to beginning formal service as an intern or aide. Each year, depending on leadership skills, academic strength, and experience, a student leader is appointed to regulate activity and train new interns. This student is often referred to as the "head nerd."

As students move from student to volunteer to aide to intern in the library, it is critical that they develop a sense of ownership over the library. In most school libraries, it is the librarian who has ownership of the library and controls what happens and what is learned. In creating a student-run program of this type, it is pivotal to have a librarian as coordinator or facilitator. This ensures a steady flow of workers who value and understand the workings of the library and its satellites.

Satellite makerspaces

Our mobile makerspace has two satellite sites: Walton Middle School, with Librarian Michelle Proffitt and Cale Elementary School with Librarian Anna Balazs and teachers Terry Graff and Helen Miller.

At Walton Middle School, the students go regularly to facilitate and end-of-day extension program. The librarian gathers middle school students to work with the high school students and make interesting things. The high school students bring supplies with them appropriate for the make that day. For example, 3D scanning requires the Xbox kinect and a laptop. Another day, they might take apart some technology; so, they will bring an old laptop, monitor, or printer with them.

Monticello High School's mobile makerspace began with the interns being invited by Walton Middle School's Principal, Allison Dwier-Seldon and Librarian, Michelle Proffitt, to facilitate a professional development workshop at a faculty meeting. The students introduced paper circuitry to the staff and talked a bit about hands-on learning and the value of maker education and exploration in their own educational journey. After the meeting, the librarian asked that the interns come again to work with students. At first, the students came only occasionally, but as the workshops grew more popular with middle school students, the visits were scheduled regularly.

At Cale, the mobile makerspace evolved similarly. The interns attended the school festival with some of their projects. The projects included an assistive hearing device, a drone, and a 3D scanner. This attracted the attention of teachers at the school who wanted help implementing some of the technologies on display into their own classroom instructional practice.

Advantages of a mobile makerspace program

High school students are learning responsibility, leadership, and the importance of building a community. As one high school student put it, "Helping the younger kids is awesome. I am more comfortable with the skill because I'm showing them how to do it and get lots of practice. I think it helps to talk along with what I'm doing and when they get it, it's like a huge high-five."

The mobile makerspace is excellent for teaching responsibility and proper planning to the high school students. There have been occasions where the high school students have arrived unprepared and paid the price in social capital. Being unprepared is completely uncool. On this occasion, the student did not feel prepared to teach parallel circuits with capacitors to middle school students. This problem was rooted in two mistakes. First, the home librarian did not ensure that the interns were comfortable with their task and second, the research process that the intern should have engaged in was overcome by hubris. Looking up how to make a parallel circuit and practicing is essential. Fortunately, the intern was assessed poorly by his students and learned from his mistake. This type of authentic assessment is excellent for students. They learn quickly to ensure that they have both the materials and the skills for future visits. The intern in this case understood that leading a mobile make requires planning and responsibility.

Leadership is also built and developed in a student driven mobile makerspace. Interns are asked to lead sessions of younger students – answering questions, guiding the activity, and maintaining safety standards. This prepares them well to take leadership roles in other areas as well. These students who work in the high school library, where we ask students to triage technology support requests, answer phones, and guide younger students, learn problem solving and effective communication – both critical to developing leadership skills.

The younger students that the interns are teaching will enter high school already knowing something of the maker community at Monticello High School and the librarian can look forward to having students who are tacitly familiar with the expectations of a maker library prior to entering their first year of high school. The older students who are running the mobile makerspace learn important lessons about community. Students they make with at the middle school will soon be colleagues at the high school. So, ensuring that the interactions are positive is important to the students on both sides.

At Cale Elementary School, the arrangement is slightly different. The students are much younger and the lessons are considerably more structured. These lessons are

guided by the classroom teacher and the high school students function much more as classroom aides with a specific skill set. For example, in studying Native American tribes of Virginia, the library interns went to Cale to assist elementary students working to design in FabLab and 3D printing the varying styles of shelters occupied by Native Americans. At the end of May, interns will be in a fifth grade classroom doing circuitry with copper tape on paper. This type of mobile makerspace is very tied to the curriculum, but allows the teacher to focus on curricular content instead of the minutiae of circuitry in guiding the lesson. Ms Miller does not need to know how to make paper circuits because the high school interns do. The students in Ms Miller's class benefit from learning the content and from learning a bit of electrical engineering. This makes maker projects much less stressful for the content area teachers. For the interns, it provides practice in wiring, which may blossom into more complex projects in their home library and a chance to give back to the community in a way that specifically addresses their areas of interest.

Each time the interns visit it is something different and interesting. The variety of projects lends itself to keeping up interest among the students and to keeping the supplies needed available. The issue of supplies is sometimes and area that causes stress and stymies the development of makerspaces. Regarding this issue, however, one must hark back to 2008 and the genesis of the maker movement. At the height of the great recession, there was a shift in some circles from consumption to creation. As Americans were less able to afford to purchase and since we are not about to do without, we turned to making. We fix; we duct-tape; we recycle; we get creative; and we make. Now, even as the economy improves, we like our creations for the same reasons students like theirs: pride. These things we made and make represent accomplishment, learning, skill, and creativity. Our creation is worth fewer dollars, but is ultimately priceless. Unfortunately, despite the "can do" culture of making, funding is almost always the first obstacle that is presented.

Challenges

The word "supplies" and the word "funding" do not necessarily have to go hand in hand. Taking apart technology is an activity that is funded from the recycling bin of the school's technology department. Discarded cartridges that would have gone in the trash bin supply toner art activities. In considering supplies, in mobile makerspaces, more actual money should go toward adhesives and tools than anything else. Hot glue and a broken laptop can make beautiful crafts. Learning the concept of force and motion from poker chips found in the attic and cardboard from the cafeteria requires no funding, but a lot of critical thinking, problem solving, and understanding of scientific principles on the part of the maker. When thinking about what to put in the cardboard box that is taken to the middle school each week, more attention is given to "What do I have?" than "What do I need?"

The interns carry the supplies they need in cardboard boxes. While convenient and budget friendly, this system does have limitations. First, the interns have only the supplies they brought. If a situation should arise where they need something else, it is not available. The same applies if a component was forgotten or left behind. In addition, this method stifles creativity. One of the pillars of the maker movement is the fostering of creativity and problem solving. Should a middle school student have an idea for a really interesting project, he or she just has to wait until the right supplies show up or the student moves onto the high school where a greater variety of tools and supplies are available in a permanent makerspace.

Permanent makerspaces also deal less with the bureaucracy that is both necessary and endemic when dealing with children. While a permanently located makerspace has

the advantage of allowing students to come and make when they need or want to, a mobile makerspace must be scheduled, staffed, and regulated at a level that is unnecessary for a permanently homed makerspace. Each intern needs appropriate transportation, parental permission, and safety releases. While each of these components are necessary in our work caring for the health, safety, and education of students, they are exclusive to traveling and therefore a challenge for mobile makerspaces.

With these struggles in mind, why would a librarian take a makerspace on the road? We go mobile to spread the culture of making. Teaching students to make do, to innovate, to invent, and to be amazing is worth the paperwork required. To see a student who, at 14, can generate hydroelectric power, or make an assistive hearing device, or print and program a quad-copter drone, or attempt to use ambient power to charge a cell phone is amazing and awe inspiring. These students can do awesome things at such a young age that it boggles the mind to think what they will be able to accomplish in ten or 20 years.

The future of mobile making at Monticello High School
As the Monticello High School Mobile Makers move forward, we would like to tackle a few processes: First, we would like to smooth out our bureaucratic processes; second, we would like to expand the number of school visited; and third, we would like to expand the types of projects in which the interns are able to participate.

Smoothing our bureaucratic processes will be essential for our future. Requesting visits from the interns has remained within the system of schools who matriculate students to Monticello High School for a few reasons. First, transportation to schools that are nearby is simple and does not cut deeply into students' instructional time in other classes. Requesting travel, processing parental permission, and securing teacher approval requires time. This process should be streamlined by scheduling internship classes either at the beginning or the end of the day and by putting the parental permission release forms online.

Second, the librarians and teachers in nearby schools could be more aware of the abilities and availability of the interns. The librarians and teachers should know when the interns might be the most helpful. To make other teachers, librarians, and schools more aware of the internship program, asking the interns to offer some county or district level professional development both about making and project based learning would expand the opportunities interns have to make with younger students. For example, in addition to working in classrooms, the interns also visit Cale Elementary to participate in Hour of Code and for Computer Science Education Week. But, teachers interacting with them during this computer coding based activity, may not also realize that the interns also enjoy mechanical and electrical engineering, 3D design and printing, and art.

Publicizing the interns would certainly expand the program; but, a close eye must be kept on capacity. As students, the interns also have their own academic obligations to which they must attend. This balance is critically important. Perhaps the popularity of Monticello High School's interns will encourage the other high schools in the area to begin similar programs. This expands the culture of making without over taxing a particular school.

Expanding the types of projects the interns can do is a matter both of education and of demand. As the library internship program expands beyond the dozen students that are working now, they will gain experience and learn from each other. As teachers work with the interns, they can request a wider variety of help. Sending two interns who know how to do the activity with one who does not have the skills will build the capacity of the interns to learn from each other. The librarian can also help by

introducing activities for students to do in their free time in the library that can be useful when the students visit other schools. This type of learning has relevance and immediacy with room for creativity. It benefits both the interns in expanding their skill set and the younger students by making a greater variety of projects available to them.

Conclusion

Continuing to teach research in the traditional manner does not teach our students to survive and thrive in the new economy where creativity is king. Learning about community service, developing leadership and problem solving skills, and nurturing one's own creativity is critical for the twenty-first century citizen. The culture of making helps students keep pace in the world. These life-long learning skills that they master in their twelve years of public education will serve them well in the wider world. Lectures, powerpoints, and the guide to periodical literature is just not the way to teach research anymore. All of that can be found on Google and Youtube. What cannot be found on the internet are the ideas, inspirations, and innovations that our students have in their minds. Teaching them to turn their minds toward the community and making the world a better place is worth using the short bus to haul a cardboard box down to the middle school every Thursday.

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