Academic Library Makerspaces:
Supporting New Literacies & Skills

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Introduction

As universities look for ways to encourage innovation and entrepreneurship, many academic libraries have begun providing access to maker resources and services. In 2012, DeLaMare Science & Engineering Library became one of the first academic libraries to provide maker resources and services to anyone, regardless of discipline or even university affiliation. Early on it became clear that there were a plethora of skills and knowledge sets users needed in order to optimally utilize the resources. A 3D printer is not used to its full potential if it is only used to print pre-designed trinkets downloaded from the internet. A makerspace is only as vital to innovation and collaboration as its users are educated and skilled to use it. Users needed to learn how to 3D model and design in order to 3D print their own creations. They needed design and editing skills, such as Photoshop and Illustrator, to create complex designs and prototypes on the laser and vinyl cutters. Programming and hardware development skills were necessary to prototype on common makerspace electronics like Arduinos, Lego Mindstorms robotics kits, and Raspberry Pis. In addition, users needed to learn how to record and edit 3D film footage or develop stand alone video games for the wide array of virtual reality apparatuses available for checkout. Depending on the individual makerspace, this list of skills may vary greatly depending on the space's mission, equipment and resource offerings, and user base.

In an effort to help its users acquire these skills, DeLaMare Library looked to repurpose existing models of library instruction commonly used to teach information and digital literacies and instead teach 3D modeling and scanning, design, intellectual property, and other skills utilized in the makerspace. This paper will describe how one library, with limited staff and resources, repurposed three such methods and as a result, users have been able to realize the full potential of the makerspace in supporting teaching, learning, collaboration, and innovation on campus and across the greater region.

Literature Review

Makerspaces in academic libraries have been growing in numbers as their capability to provide opportunities for self-directed and active learning become more widely accepted. The literature on such spaces in academic libraries remains relatively sparse, often focusing on justification and implementation rather than skill and literacy development. Those addressing why makerspaces belong in academic libraries point out that they create opportunities for hands-on learning, co-working, STEM activities, prototyping, tinkering, and experiencing an open culture.[1] Others draw attention to the parallels in the missions and values of both the library and maker or hackerspaces, illustrating how bringing the two together can have transformative effects.[2] Any person who walks

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into a makerspace knows learning is happening. Yet, defining and assessing that learning has proved difficult; perhaps, a reason for the lack of literature on such topics. Some are beginning to look at learning in makerspaces in general, but not in academic library settings.[3] They overwhelming focus on K12 educational settings and whether or not informal and self-directed learning is occurring. They do not focus on particular skill development or learning opportunities.

In looking for literature that describes how libraries are teaching the skills needed to fully utilize common makerspace equipment and services, such as 3D printing, laser cutting, and electronics, little was found to provide information in any depth. The greatest amount of literature about makerspaces in academic libraries focuses on 3D printing specifically. There is certainly some learning and skill needed to make a 3D printer physically go, but the core skill necessary to create and innovate on a 3D printer is 3D modeling. But as Radniecki points out, many of these are case studies discussing 3D printing only describe implementation and management of the physical equipment and how libraries can provide access to 3D printers.[4] There is little to no mention of how academic library makerspaces are teaching their users to 3D model yet, most of the literature recognizes that 3D modeling has a steep learning curve. At the time of their writing, many were investigating possible instruction opportunities on the topic.[5] In various case studies, academic library makerspaces have reported providing workshops, access to learning aids, and consultations to help users 3D print, but none focus on how workshops or consultations are being conducted, what content is being taught, and whether any of the avenues of information provision were successful.[6] In Primary Research Group's "Academic 3D Printing Report," 12 out of 23 responding academic libraries said they provided classes on 3D printing.[7] However, there is no information on what these classes taught attendees, what the format of such sessions were, and if any assessment was done to determine if they were successful.

When looking for evidence of instruction for other types of skills necessary to utilize common makerspace equipment, such as design skills for laser and vinyl cutting or hardware and coding skills for electronics and robotics, the most established concepts in the literature and practice describe coding instruction. Yet, those case studies being presented are taking place in public and school libraries. There are examples of libraries teaching classes on coding, app development, networking concepts, and electronic prototyping by utilizing local experts as well as online materials, such as CodeAcademy and Lynda.com.[8] The case studies discuss how their computer and coding instructional programs developed and grew, how they break down complex topics into manageable chunks for teaching, and how they were able to get their users interested in such programs.[9]

Background

The DeLaMare Library currently provides access to a number of maker technologies and services. Larger equipment includes multiple 3D printers, Artec 3D scanners, a laser cutter, vinyl cutter, PCB milling machine, soldering bar, and sewing machine.[10] The library also has a lending technology collection which includes other items commonly found in makerspaces, such as Sparkfun Arduino Inventor kits, Raspberry Pis, hand tools, and a variety of virtual reality headsets including the Oculus Rift and HTC Vive.[11] While some tools and technologies require little prerequisite knowledge to fully utilize, such as hand tools or even soldering irons, others demand complex skill sets in order to take advantage of their full capabilities.

3D printers are essentially the same as paper printers. A file is uploaded, for example, a stl file instead of a Word document, and the user chooses the command to print. Depending on the model of 3D printer, the user may also have to adjust some of the physical properties of the printer including loading filament, calibrating the printer, and other conditions depending on the job being printed. Many of these skills can be obtained either by reading a manual or learning quickly from a trained professional. DeLaMare Library does not allow users to

print their own jobs on 3D printers as the queues are often long and printing even a small object can take several hours. Users instead bring their completed 3D file to the library and answer questions while the employee processes the job for printing. Questions may include ones such as desired size and density. Quickly after beginning to provide 3D printing services in 2012, the library recognized that while printing trinkets can generate curiosity and excitement, users needed to be able to design and print their own creations. Researchers needed to be able to create unique labware and students needed to be able to print new prototypes. In order to move beyond the initial buzz and see truly innovative change take place in the library and throughout the academic community, the library needed to start provided avenues for learning 3D modeling.

A similar situation occurred shortly after the library acquired a CO2 laser cutter. The laser cutter is also a printer at its most simplified definition. A user opens a file in the program connected to the laser cutter and "prints" it. While it can be simple to take an image and engrave it on a piece of wood, it takes much higher order design, and even engineering skills, to create a file in which users can laser cut a prototype or complex piece of art. Other technical skills like programming and coding to utilize Arduinos and Raspberry Pis, circuit board design for utilizing a PCB milling machine, and film editing for creating 3D video have also emerged as skills and knowledge bases which the library needs to provide opportunities for learning. Along with the skills necessary to fully utilize equipment, programs, and services in the makerspace, there are complimentary skills which help support many of the projects being developed. One such knowledge and skill set is intellectual property. The library saw many never-before-created objects being 3D printed and built in its space and as longtime experts in intellectual property, saw the opportunity to provide avenues for users to learn about patents and trademarks.

Short on staff—having only six full-time employees—, time, and financial resources, the library chose to repurpose existing models of information literacy instruction for teaching many of these new skills and knowledge sets.

Online and physical materials, ranging from manuals and short tutorials to full self-directed courses, were gathered and made available. Workshop series were developed to help introduce skills to beginners and serve as a catalyst for deeper engagement later on. Even the research consultation was repurposed for makerspace skill instruction. The library has successfully utilized all three methods to provide users paths for learning 3D modeling and scanning, Photoshop design and editing, programming, and intellectual property.

Workshops

Workshops are a traditional form of teaching skills to multiple library users at once. Over the past 3 years DeLaMare Library conducted roughly twenty-five drop-in and registered workshops that specifically addressed skills and literacies needed to utilize software, equipment, and tools in the makerspace. These workshops included *Intro to 3D Modeling*, *Photoshop for Laser Cutting*, *Intro to the Makerspace*, *Intro to GIS*, *Ruby on Rail*, and *HTML and CSS*. The library has also put on several hands-on maker workshops like *Lock Picking*, *Take it Apart, Sticker Making*, and more. However, the library has not seen the number of attendees expected and has been disappointed with low turnouts. The attendance for software-related maker workshops ranged from one to six attendees with the exception of GIS, which saw eight to fifteen attendees per workshop. Often the GIS workshops were targeted to specific student groups, classes, and faculty who already utilized GIS and wanted to improve their skills. Maker hands-on workshops see much higher attendance. *Lock Picking* is consistently the library's most attended workshop with anywhere from thirty to sixty people participating. This workshop has grown in popularity by regular advertising and word-of-mouth over the semesters. It also normally occurs near finals and at night, proving to be an appreciated study break. This workshop is interesting because it teaches students about the engineering of locks and is provided by our local chapter of the TOOOL organization. Our marketing strategy for all workshops has consisted of flyers, social media, website advertisement, and word-of-mouth.

Most DeLaMare Library workshops are targeted towards the general community and are not put on to support a particular class or assignment. They are geared towards the novice makerspace user who is most likely not an engineering student. As a science and engineering library, it can be difficult for marketing efforts to reach those targeted populations outside the library who may benefit the most. Workshops also have difficulty in addressing the different levels of skills, knowledge, and expertise attendees bring with them. For example, an *Intro to 3D Modeling* class may bring someone who cannot yet name a single modeling program and another who is familiar with the very basics but looking for a bit more knowledge. When teaching complicated skills like 3D Modeling, these differences can easily allow for some attendees to be left behind.

In the of Fall of 2015, the library created a series of 3D modeling workshops instructed by expert student employees called Tech Wranglers. These workshops introduced new users to 3D modeling over the course of six workshops. The first two sessions had very poor attendance with only two people. Due to these results, the Tech Wrangler instructors were asked to develop themed workshops for the remainder of the series, then remarket the series to see if attendance would increase. These workshops were creative, fun, and based on what the library had seen being created in the makerspace. They were marketed as beginner workshops where attendees would learn to model key chains, phone cases, and holiday knick knacks. The rest of the workshops did improve in attendance but remained low overall with four to five attendees for each.

During the same time frame, themed workshops were developed to help users learn how to create and edit images to engrave or vector cut on the laser cutter. Photoshop is the software most commonly used on the laser and vinyl cutters and was taught in the workshops by two student employee experts. These workshops were *Laser Cutting Pumpkins*, *Designing Your Paddle* (marketed to campus fraternities), *Design a Holiday Card*, and *Design a Sticker*. The Photoshop series saw more attendance than the 3D modeling, attracting between four and eight attendees per workshop, and was repeated in Spring of 2016. However, it was still not the kind of attendance the library would like to see for the amount of staff time necessary to put them on.

During the Summer and Fall semesters of 2016, the library focused on the intellectual property aspect of the makerspace. The engineering librarian hosted one patent and trademark workshop with an attendance of five. The library also hosted a manufacturing representative who spoke about how to take a prototype to market. This workshop was targeted to students who had already met with the engineering librarian for a patent consultation. DeLaMare Library faculty and staff were also invited and the workshop had ten attendees. This higher turnout supports the idea that those workshops targeted to specific groups of users already familiar with the topic, such as the GIS workshops, attract more attendees.

The overall low attendance rate of workshops raises the following questions: Are we using our time and resources effectively conducting workshops? And are the users getting the information, skills, and support they need from them? Are workshops available at times and locations that make sense for users? The much higher usage number for individual consultations, discussed below, seem to suggest they meet more users' time and knowledge needs. The library wants to further investigate ways to better market workshops, as well as determining the best content for such venues. The authors recognize other libraries see high numbers of attendees for various workshops but have not yet been able to replicate such efforts with their making-related series.

Consultations

Arguably, the most successful implementation for providing instruction on maker skills was and continues to be one-on-one consultations. As is common in other libraries, when 3D printing was first implemented many of the items being printed were freely available doodads from the internet. 3D modeling is only taught in specific disciplines on campus, including engineering and some art programs, leaving the majority of campus and the

greater community without the skills necessary to create and 3D print their own design. 3D modeling, being a complex skill set, seemed to be a good candidate for the research consultation model. Scholarly research is a complex process that can differ greatly depending on the project one is working on. While workshops can serve as helpful introductions and online tutorials as invaluable point-of-need assistance, the reference consultation remains a critical service provided by every academic library. It allows librarians to address the individual user's particular need at their exact level of experience and knowledge. It's a truly customized learning opportunity. While 3D modeling is not as complex as high level academic research, it does contain a vast skill set, pieces of which may only be utilized when modeling particular projects. Recognizing the need for personalized instruction on 3D modeling, DeLaMare Library hired two student employees to serve as Tech Wranglers. Inspired by AnyThink's innovative Wrangler positions,[12] these student employees were empowered to become experts not only in 3D modeling, but every service the makerspace provided. They utilized Lynda.com and other online tutorials to learn the official library supported 3D modeling programs, SOLIDWORKS and OnShape, and worked with librarians to understand how to conduct a teaching consultation. It is important that the service reflect the values of the library and Tech Wranglers are trained on how to ask the right questions, how find out the real needs of the user, and how to teach someone rather than doing it for them.

Tech Wrangler appointments are free to anyone and can be made in advanced through the library's website. The library utilizes the Room Booking module in Springshare's LibCal product for their student provided consultation services. The Room Booking module allows the library to gather some statistics and helps determine the success of the program. In 2016, the Tech Wranglers were pre-booked for 682 time slots by 351 unique users. This is a large increase from 2015's 374 time slots booked by just 166 unique users. The Tech Wranglers often see repeat users as they work on complex modeling projects over the course of multiple bookings and users are allowed to book up to two time slots a day. During 2016, the library moved from thirty minute consultations to forty-five, decreasing the amount of available consultations slightly. On average, the Tech Wranglers are pre-booked 20% of the time and spend the remaining 80% helping walk-in users who need assistance 3D modeling or using other equipment in the makerspace. For a more in-depth look at the 3D modeling Tech Wrangler service, see Radniecki's forthcoming publication.[13]

After the successful launch of the Tech Wrangler program for 3D modeling, the library sought out other interested student employees to provide consultations for Photoshop. While the library ultimately chose to officially support Photoshop, it wanted to simply provide instruction on a design and editing software program compatible with the laser cutter, allowing users to create complex works of art or prototypes on the machine. While a percentage of existing users knew how to 3D model when 3D printing was first introduced in the library, very few students or faculty members in the STEM disciplines had any design and editing skills when the laser cutter was acquired. The library quickly saw an increased amount of questions on best ways to format images for engraving and how to create a file for vector cutting. While all student employees in DeLaMare Library are trained on how to use the laser cutter, two were chosen to give consultations based on their advanced knowledge of the laser cutter and interest in furthering their Photoshop skills. Like the Tech Wranglers, the Photoshop experts were given work time to learn Photoshop from Lynda.com and worked with librarians to learn the basics on teaching consultations. In 2016, the Photoshop experts were booked for fifty-three time slots by thirty-eight unique users. This is an increase over 2015 which saw forty-seven time slots booked by twenty-seven unique users. The lower number of users overall compared to the Tech Wranglers is not surprising as the Tech Wranglers provide services beyond 3D modeling, including 3D scanning and prototype development, and all employees of DeLaMare Library can help users with basic to moderate level projects on the laser cutter.

Individual consultations are also offered on intellectual property, mainly patents and trademarks. As the number of prototypes being developed in the library grew, it was clear many of these never-before-created objects had the potential to be brought to market. However, the first step is protecting prototypes with a patent, which is often a confusing and expensive process. As a Patent and Trademark Resource Center (PTRC) as designated by the USPTO,[14] the business and engineering librarians are USPTO-trained in assisting users with learning what patents are, what can be patented, and how they can get started with the process. The business librarian at UNR has a long established relationship with the local inventor community and conducted twenty-eight consultations related to patents and trademarks in 2016. The engineering librarian conducted thirty-one patent consultations, primarily with science and engineering undergraduate students. While filing a non-provisional patent application can be costly and require legal assistance and expertise, the library has been able to guide many users through the process of filing a provisional patent application. The librarians cannot provide any legal advice, but can help provide to the most pertinent information available from the USPTO. The librarians are planning to conduct a user survey in 2017 to determine how many users went on to file patent applications after having a consultation, how satisfied users were with the service, and what improvements they would like to see.

Tutorials

The University of Nevada, Reno subscribes to Lynda.com, an online learning platform that allows users to learn a new skill online on their time.[15] This subscription resource is a self-directed learning alternative the library supports for learning skills. As an online learning platform, it provides access to approximately 5,500 courses with video tutorials on a wide range of areas including business, software, technology, and creative skills. Depending on the subject, these courses ranged from one video to hundreds per topic. Each video lasts approximately one to ten minutes, with complete courses combining videos to reach over eighteen hours. These short videos teach users one task at a time and can be accessed at any time of the day, wherever there is an internet connection. For this article, user statistics were pulled and analyzed to determine what courses were viewed, how many total views those courses had, the number of unique users, hours of video viewed, and the number of users that completed an entire course. The authors recognize that there is no way to determine how many Lynda.com users applied their newly acquired skills in the library makerspace. However, Lynda.com is marketed to library users through a variety of channels and is the first resource users are referred to when inquiring about learning new skills. The resource is also marketed to users after a Tech Wrangler consultation as way for them to continue learning on their own time.

Courses that teach literacies and skills needed to use the library's makerspace were identified. The areas of skills included 3D modeling and printing, Photoshop and other design and editing software, coding and programming, and virtual reality. The usage statistics for Lynda.com were analyze for the 2016 calendar year and it was determined that 41% of all the courses and video tutorials offered were viewed by UNR users.

Coding and programming courses we the most highly utilized, both viewed and completed in Lynda.com. The top course was *Foundations of Programming: Fundamentals* with 1,493 total views by 165 unique users. The course was viewed for 117 hours and nine individuals complemented all sections of the course. C++, JavaScript, Python, R and other C language essential training courses were also highly accessed, viewed, and completed. Additional software courses viewed were CSS, Raspberry Pi, Lego Mindstorms programming, and other *Foundations of Programming* courses. Many of these computer language skills are taught in the College of Engineering curriculum. In total, 132 courses related to coding and programming were accessed by 766 unique users who viewed those video courses for 735 hours. Courses were accessed 10,057 times and ninety-one individuals

completed full courses. Again, these courses can be short, less than twenty minutes, but some went over eighteen hours; proving some users find this type of instruction helpful and worthwhile.

The next skill and literacy evaluated was 3D modeling and printing. In Lynda.com there are a large number of courses teaching various software programs designed for 3D modeling, animation, and more. The vast majority of software courses accessed by users were those the University supports and teaches in the Engineering and Art programs, including SOLIDWORKS, AutoCAD, Maya, Blender, Rhino, and SketchUp. Not surprisingly, the most heavily used 3D modeling courses were SOLIDWORKS and AutoCAD, both taught in the Colleges of Engineering and Science. SOLIDWORKS had 881 views by seventy-six unique users who viewed the content for fifty-five hours. AutoCAD had 1,329 total views by seventy-three unique users who viewed the content for 102 hours. Maya, a software most commonly used for computer animation but has been used to create 3D models for printing at DeLaMare Library, was also heavily accessed. It had 927 views by fifty-five unique users who viewed the content for sixty-eight hours. In total, 115 courses related to 3D modeling and printing were accessed by 306 unique users who viewed that content 4,366 times. Users watched a total of 310 hours and twenty-one users completed full courses.

Lynda.com also provides access to courses teaching Photoshop and other design and editing programs. Many of these courses and video tutorials teach creative skills that can be utilized on several pieces of the library's makerspace, including the laser cutter, vinyl cutter, and sewing machine. Photoshop and Illustrator are the most used programs for developing content for the laser and vinyl cutters in DeLaMare Library and on Lynda.com *Illustrator CC Essential Training* was the most accessed course with 131 unique users viewing it 1,459 times. *Photoshop CC 2015 One-on-One: Fundamentals & Essential Training* was also viewed frequently getting 574 totals views by twenty-six unique users. In total, 205 courses were accessed which taught skills related to design. These courses had 744 unique users who viewed the content 7,488 times for a total of 576 hours. Fifty-one users completed entire courses.

The library has had virtual reality sets available for check out since early 2013, starting with the Oculus Rift D1 Kit. Later the Oculus Rift D2K model, a mobile VR One, and the HTC Vive were all acquired for the lending technology collection and continue to see high usage numbers. The creation of 360 video content, which can be viewed on these devices, is one of latest skills the library is beginning to support. While the library is not yet offering workshops or consultations, Lynda.com does provide one course, *3D Content Creation for Virtual Reality*. In 2016, there were two unique users who viewed this course nineteen times for a total of 1.75 hours.

Lynda.com provides an online alternative for students and faculty to get the help when and where they need it. The authors acknowledge there is no data to support that any of the Lynda.com users accessed the online courses to develop skills specifically to utilize equipment or services in the makerspace. However, the resource is highly used on campus in general and provides online access to a wealth of content not otherwise available to users. In 2016, Lynda.com had a total of 80,332 views by 6,331 unique users for tutorials on skills and programs that can be utilized in the makerspace. These users watched 5,709 hours of content and completed 899 courses. The library knows the makerspace best serves the user population when they have the skills to use it and Lynda.com is one of the more flexible ways to acquire key skills that support innovation, prototyping, and entrepreneurial activities.

Conclusion

This case study has shown how one library was able to repurpose common instruction methods for teaching maker skills. Users need to acquire these skills and knowledge sets to engage with the makerspace equipment to its full potential. The library was able to so without hiring additional full-time employees and still provide multiple avenues for learning to accommodate as many users as possible.

Lynda.com tutorials provide a valuable point-of-need learning resource and the library will continue to market it as the premier resource for learning a wide variety of software and maker skills on one's own schedule. It will also continue to monitor usage statistics to determine if new software programs are being viewed, as this could provide information on other programs the library should be supporting through workshops and consultations. While workshops do not often attract large number of attendees, they provide a familiar platform for users to be introduced to new topics or engage hands-on with technologies. Individual consultations have proven very successful with usage numbers going up each year and the library hopes to expand all these services to include more in the way of programming and coding, as well as circuit board design and milling and 360 video content creation.

Notes

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