Learning in Makerspaces

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A makerspace is “a physical location where people gather to share resources and knowledge, work on projects, network, and build” (EDUCAUSE, 2013). A typical makerspace may have 3D printers, laser cutters, Arduinos, Raspberry Pis, and accompanying resources to help someone use the software and tools. The concept of a “makerspace” originated outside of the academic world in a community of creative tinkerers and experimenters. However, makerspaces have now started to appear in universities and community colleges and they are used in a variety of ways. At some institutions, makerspaces are based in academic departments and are only open to students in that discipline. For example, the Longhorn Maker Studio at the University of Texas (<http://makerspace.engr.utexas.edu/)> is specifically for engineering students. At other institutions, makerspaces are open to the entire university community. At Georgia Tech, the Invention Studio (<http://inventionstudio.gatech.edu/)> is student-run and is free for all students to use. Case Western Reserve University’s seven story innovation space is called think[box]  (<http://engineering.case.edu/thinkbox/)> and is open to faculty, students and alumni.

At the University of Georgia, there is a makerspace in the Science Library (<http://guides.libs.uga.edu/makerspace)> that is open to current UGA faculty, staff and students. This space includes three 3D printers, a laser cutter, a vinyl cutter, and soldering irons. In addition, there are Arduinos and Raspberry Pis available for use.

**Statement of the Problem**

**What is a problem in your field that you could study?**

Makerspaces are becoming more common at colleges and universities, but there is very little research about what happens in a makerspace in terms of learning. How are makerspaces being used by students and faculty? What kind of learning is occurring in the spaces? What are the benefits or drawbacks of having a makerspace in an academic setting? This paper will examine how this topic has been addressed in the literature, and propose a research study to explore related research questions.

**How has this topic been addressed in the literature?**

Halverson and Sheridan (2014) define the maker movement as “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” (p. 496). The beginning of the maker movement is often traced to 2005, when MAKE magazine was started by Dale Dougherty. MAKE encouraged readers to experiment and play with do-it-yourself building, creating and making, and Dougherty coined the terms “maker” and “makerspace” with the inception of the magazine. Dougherty (2013) describes makers as “enthusiasts who play with technology to learn about it,” and makerspaces are the physical spaces where the “experimental play” can occur. In 2006, MAKE magazine enthusiasts and others in their community organized an event called the Maker Faire, where participants could set up things they’d built and share ideas with other makers (Dougherty, 2012). The first Maker Faire had 25,000 attendees (Hatch, 2014). Now, nine years later, a million people are expected to attend Maker events all over the world (McCracken, 2015). The concepts and ideas that define the maker movement have extended to events, workshops and spaces where makers can go to create, tinker and share ideas about technology and making.

Sheridan, Halverson, Litts, Brahms, Jacobs-Priebe and Owens wrote a case study in 2014 examining three makerspaces in three different contexts: a member-based makerspace, a community makerspace and a museum makerspace. Although the study does not focus on makerspaces in formal educational settings, their research is relevant because they are looking at makerspaces as learning environments (Sheridan et al., 2014). Sheridan et al. use previous literature on studio structures and communities of practice to frame their exploration of makerspaces as learning environments.

Makerspaces in K-12 schools can provide space for children to play, explore, and improve their creativity and imagination (Abram, 2013). They are typically located within school libraries. The American Association of Schools Librarians (AASL) Standards for the 21st Century Learner focus on, among other competencies, inquiry as a framework for learning, and technology skills as essential for future employment (2007). Educational makerspaces can be aligned with these standards and facilitate learning through inquiry and technology (Canino-Fluit, 2014).

**What is the gap in the literature?**

The majority of the literature on educational makerspaces focuses on the K-12 context. Research is needed to learn more about how makerspaces are currently being used in higher education.

**What theories are currently used in your discipline to address this type of research?** A makerspace is a learner centered environment that provides space for creativity, experimentation and play. Community desire for the space and resources drove the creation of the original community makerspaces, and many institutions have created their makerspaces in a similar fashion. An institution may provide space and tools and students, faculty and staff can use it as they please. (The Science Library at the University of Georgia has their makerspace set up this way.) Thus, anyone, including students, can come to the makerspace without a project to work on - they are free to experiment with the tools and play with ideas.

We can use multiple learning theories as a framework to examine learning in an educational makerspace. While many learning theories may apply to the makerspace environment, constructivism and communities of practice are particularly relevant. Constructivism is the idea that “learners create their own learning” (Schunk, 2008), and learners should be actively involved in the classroom. The goal of a constructivist learning environment is to “create rich experiences that encourage students to learn” (Schunk, 2008). Communities of practice are groups of people who come together because of a shared passion for an activity. A community of practice has three significant elements: the shared interest, the community that forms, and the activities they engage in as a community (Wenger, 1998).

**Purpose of the study**

**What do you want to learn about?**

I want to examine the learning that occurs in makerspaces. From the literature and anecdotes, I know that often engineering and computer science students use makerspaces. I’d like to learn more about what other disciplines are using the makerspace, and for what kinds of projects. Are they course-related projects, or personal projects? Are they trying to learn or improve a specific skill? What motivates students to come to the space? When they come to the space, how do they learn to use the tools and resources? Does having the makerspace in an academic setting affect the typical set up and “maker mindset” of a makerspace?

**What is the purpose of your study?**

The purpose of this study is is to explore how students learn while using a makerspace. Makerspaces are emerging as a new type of learning environment in higher education. However, there is little research on how students are learning in makerspaces at their institutions. As makerspaces become more common, it makes sense to explore their use in teaching and learning. Theory generated from this research could help inform future design of makerspaces, help facilitate instructional projects in makerspaces, and provide support for the types of learning that happens makerspaces in higher education.

**What kinds of research question(s) are you posing?**

The research questions for this project are:

* How are students learning in makerspaces at UGA?
* How are faculty using makerspaces at UGA?
* What motivates faculty and students to use a makerspace?
* What challenges or barriers exist to faculty and student use of makerspaces at UGA?

**What theory/epistemology will inform your research?**

As an interpretivist and a constructivist, I will seek to understand the phenomenon of makerspace learning in higher education through the views and perceptions of the participants in the study. In addition, I will acknowledge that my own beliefs and experiences about the world will affect how I construct meaning from the experiences of the participants. I will use Strauss and Corbin’s grounded theory approach to collect data, construct meaning from the data and generate a theory about makerspace learning in higher education.

**How will your study answer or inform your questions?**

I will collect data from interviews, observations and focus groups of students and faculty who are using a makerspace. I will look for categories, themes and patterns in the perceptions and experiences of the participants, and ultimately develop a theory about makerspace learning in higher education.

**Subjectivities Statement**

As the Coordinator for Emerging Learning Technologies at the Center for Teaching and Learning at the University of Georgia, I work regularly with faculty to use learning technologies in their teaching. Sometimes it can be tempting to use a learning technology because it is new and exciting. Makerspaces seem to offer unlimited possibilities for creativity and innovation, but I am skeptical about their usefulness as learning environments in the higher education context. The elements that make community makerspaces successful may not be as easily achieved in an academic setting. For example, one of the hallmarks of community makerspaces is the ability for participants to play and experiment in a fairly unstructured environment that is also “failure-positive” (Martin, 2015). A failure-positive environment sometimes seems unlikely in an educational setting.

However, I also believe that people learn best in constructivist learning environments, and makerspaces seem to fit into that paradigm. I anticipate finding that students are largely intrinsically motivated to create in the makerspace, and are thus engaged in their process as they create objects. I also anticipate finding that students improve their problem solving skills, and that a community of creators emerges in the makerspace.

**Research Design**

**Proposed Methodology**

This study will use a qualitative research design using Strauss and Corbin’s grounded theory approach to collect data from participants. Creswell (2012) describes grounded theory as a research methodology that seeks to “generate or discover a theory” (p. 63), and Strauss and Corbin’s approach provides a systematic process for analyzing data and generating a theory. This process includes: coding of the data as it is collected, constant comparison of the data with the categories that are emerging, and development of a conditional matrix, which is a coding device to connect conditions influencing the phenomenon being studied (Strauss & Corbin, 1994).

**Type of Data to be Gathered**

The research questions are suited for a qualitative research study that will include interviews and observations. Individual interviews will consist of open-ended questions about the participants’ experiences using the makerspace. For observations, I will come to the makerspace at varying times to observe faculty and students using the makerspace. The observation notes and transcripts from the interviews will be analyzed using open, axial and selective coding (Corbin & Strauss, 1990).

**Participants**

The participants in this research study will be faculty and students who have used or are using the Science Library makerspace at the University of Georgia. The Science Library makerspace has a record of every person who has used the space since its inception. I will recruit participants by using this list to contact faculty and students who have previously used the makerspace, and ask if they’d like to participate in a research study about their experiences in the makerspace. Additionally, I will ask faculty and students who use the makerspace moving forward to participate. I will seek to obtain perspectives from faculty and students who come from a wide variety of disciplines. As I collect and analyze data, I will use the emerging categories to guide my selection of participants. Participants will be interviewed individually, and I will observe participants using the makerspace at the Science Library and take notes on my observations.

**Method of Analysis**

Analysis will occur as the data is collected using Strauss and Corbin’s grounded theory methodology. The goal with grounded theory research is to develop a theory that has many conceptual relationships (Strauss and Corbin, 1994). The interviews will be transcribed as they are conducted, and the notes from observations will be included in the data analysis. Initial analysis will be done through open coding, which involves creating conceptual categories based on the data, and constantly comparing the data with the emerging categories. Further analysis will use axial coding, where “categories are related to their subcategories, and those relationships are tested against the data” (Corbin and Strauss, 1990). Then, based on the analysis, I will identify a core category (selective coding) that is the central phenomenon of the study. Data will be collected until the emerging categories are saturated. Trustworthiness will be achieved by collecting data in multiple ways (interviews, focus groups and observations), and sharing data with the participants to verify that their meaning is being reflected. I will also be explicit about my own bias and ideas when writing and analyzing the data.

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