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Maker Literacy, Metaliteracy, and the ACRL Framework

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Throughout the last decade, makerspaces and other experiential learning labs have grown in popularity in academic libraries, following trends set by community makerspaces, public libraries, and K–12 schools. Academic libraries have been established as ideal spaces on college campuses for makerspace technology and the experiential learning that it enables. The central, open nature of the campus library meshes well with the collaborative and interdisciplinary character of makerspaces. But trends move quickly in the realm of emerging technologies, and librarians must demonstrate the sustainability and enduring benefits of makerspaces in order to garner the continued support of administrators. The huge potential that makerspaces hold for student engagement and learning may be the key to ensuring that makerspaces remain relevant in the future. Most academic library instruction focuses on information literacy competencies as defined by the ACRL (Association of College and Research Libraries) Framework for Information Literacy. This chapter will use two of the foundational concepts of the ACRL Framework—metaliteracy and liminality—to demonstrate how maker-centered learning can help librarians further their institutions' information literacy goals.

MAKER-CENTERED LEARNING

As makerspaces have become more popular in all levels of education, some important projects have arisen to study the benefits and outcomes of maker-centered learning. Agency by Design (AbD) is a multi-year research project that has studied maker-centered learning in K–12 environments.[1] Clapp et al. explain that, in contrast to some of the popular narratives, the benefits of maker-centered learning are seen most on a personal, character-building level. The culminating outcome of the research

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project, the AbD Framework for Maker-Centered Learning (AbD Framework), revolves around maker empowerment and design sensitivity. The project found that through maker-centered learning, students develop design sensitivity, defined as "being attuned to the designed dimension of objects and systems, with an understanding that the designed world is malleable."[2] The empowerment that students gain from maker-centered learning is the result of a sense of agency, described as "seeing oneself as an agent of change within the designed environs of one's world."[3] With these goals in mind, the AbD Framework contains thinking routines and activities that educators can use in their classrooms. Although the project focused mainly on K–12 education, many of the findings can apply to maker-centered learning for any age level. Later in this chapter, I will describe how I have successfully used an AbD thinking routine with college-age students.

One of the most prominent and well-developed frameworks for maker-centered learning in higher education is the Maker Literacies Project,[4] an initiative started at the University of Texas, Arlington. The project has developed a list of maker competencies for higher education, in addition to providing a wide range of examples of makerspace course integrations. The project, funded by a $50,000 grant by the Institute of Museum and Library Services (IMLS) and bringing in four partner institutions (University of Nevada, Reno; University of Massachusetts Amherst; Boise State University; and University of North Carolina Chapel Hill), was based on faculty partnerships to incorporate maker projects into courses. The resulting list of fifteen maker competencies listed on the Maker Literacies Project website cover a range of outcomes for maker learning, including identifying needs that can be fulfilled through making, working in teams, and understanding the cultural and social issues that making entails.[5] What is not included in the list of maker competencies are specific tools or technology skills. The competencies, like the AbD Framework, instead focus on enduring, transferable skills that students gain through maker-centered learning.

Other scholarship has studied the ways that academic makerspaces can further support learning at the university level, without explicitly arguing for either maker literacies or connections to the ACRL Framework. Nichols, Melo, and Dewland demonstrate that through the collaborative, transdisciplinary nature of the academic makerspace, "scholars find dynamic relationships that support multiple points of inquiry, expertise across design, programming, a marriage of science and arts, and a nexus of innovative and scholarly production."[6] Referencing the iSpace at the University of Arizona, Tucson, the authors highlight partnerships with student organizations as well as digital humanities curriculum integrations through the College of Humanities. Mathuews and Harper also point out the importance of collaborative learning to the future sustainability of academic makerspaces, arguing that the true value of library makerspaces can be found in cross-disciplinary knowledge sharing practices.[7] Other scholarship on academic makerspaces has advocated for incorporating maker technology into curricula. Lippincott, Vedantham, and Duckett, in a 2014 article, when makerspaces were very new additions to university libraries, argue

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for the integration of emerging technology into coursework, as a way to increase student engagement, allow students to explore new technologies and create more innovative work, and allow for more individualized work from students.[8] Wilczynski et al. studied how makerspaces can not only create "an intentional collision of random ideas" when open to all disciplines on campus, but can also be useful for discipline-specific accreditation, specifically ABET standards for engineering education.[9]

While the above literature reflects varying outcomes of maker-centered learning, whether creating campus collaborations, improving student engagement, or obtaining disciplinary accreditation, many academic makerspace practitioners place emphasis on enduring, transferable skills rather than discrete acquisition of technical knowledge. A common thread for maker-centered learning frameworks is the development of a maker mindset, which includes personal empowerment, failure positivity, and critical thinking. In other words, even though students are learning specific tools, technologies, and software, the enduring value that they receive from maker-centered learning experiences is primarily related to mindset development.

CONNECTING MAKER LITERACY TO INFORMATION LITERACY

The question of how maker-centered learning connects to information literacy instruction remains largely unanswered. The literature on maker-centered learning in higher education often does not approach the concepts in the context of the ACRL Framework but, rather, examines maker literacy as a separate set of competencies. However, Milne-Lane and Vecchione from the Boise State University MakerLab created a "Maker Instruction Toolkit," which provides a roadmap for implementing maker instruction in an academic library setting through the lens of the ACRL Framework.[10] The Toolkit includes practical tools such as lesson planning templates, as well as a literature review on academic library makerspaces and an argument for experiential learning in academic libraries. The section, "Matching the MakerLab with ACRL Framework," provides examples from the Boise State University MakerLab that highlight the ways that maker learning connects to each ACRL Framework frame.

Attempting to map maker literacies to the ACRL Framework can be a difficult task on the surface; there are many similarities, but there are also many outcomes of maker-centered learning that may not fit perfectly with the ACRL Framework. However, Milne-Lane and Vecchione's work helped me to begin making connections and prompted me to view the ACRL Framework as it was designed to be viewed—not as a set of skills to master, but as the fostering of enduring, lifelong dispositions. From there, I delved into two of the underlying concepts of the ACRL Framework, metaliteracy and liminality, where I found strong and deep connections to maker literacy. The concepts of metaliteracy and liminality emphasize students as active creators, contributors, and independent agents in the world of information—goals which line up nicely with the practices and outcomes of maker-centered learning.

Maker Literacy and Metaliteracy

Metaliteracy puts emphasis on students as active "consumers and creators of information who can participate successfully in collaborative spaces."[11] Metaliteracy was first proposed by Mackey and Jacobson in a 2011 paper, but the concept has since grown and been interpreted by a variety of librarians and scholars. Rather than presenting literacy as a set of skills to master, metaliteracy represents a more student-centered idea of information literacy in which students are functioning participants and creators in the information economy. "In proposing metaliteracy as overarching and related to many literacy frameworks, we suggest changes to the way information literacy is perceived as a primarily skills-based approach to learning."[12] Mackey and Jacobson explain that through metaliteracy, students can use their knowledge of technology topics to build a real-world resume or portfolio. They propose that in addition to metaliteracy broadening the scope of information literacy, it can be used at a larger scale as a model to bring together a variety of similarly technology-focused literacies.[13] Maker literacy is an emerging literacy, alongside digital literacy, media literacy, visual literacy, and can be seen as a new subset of metaliteracy. Metaliteracy broadens the scope of library instruction and makes room for new and innovative literacies, such as maker literacy. Some of the important mindset elements that connect maker literacy and metaliteracy include student empowerment, the shift from consumer to creator, civic mindedness, and metacognition. As mentioned earlier, important frameworks for maker-centered learning, such as the AbD Framework and the Maker Literacies Project, as well as a wide range of literature on maker-centered learning, place emphasis on similar mindset development.

Many instructors have found metaliteracy useful in helping students develop a similar critical and creative mindset. Borrowing from feminist pedagogy, Wallis and Battista designed a one-credit course, The Politics of Information, which had the overarching goal of empowering students to not only question traditional power structures in academic information creation but also to develop their own identities as creators of information.[14] Setting the tone for the course, no traditional textbook was used, but instead, Wallis and Battista created a free zine, called *Authorize This!*, in which the authors showcased, in their own drawings and handwriting, childhood experiences that related to questioning authoritative information sources. Students also developed five creations throughout the semester, which were delivered in non-traditional formats—a Buzzfeed article, a Wikipedia edit, engaging in a blogosphere, creating a "Bizarro research paper," and, finally, creating a way to spread the message of said paper. The author/instructors concluded that "metaliteracy teaching helps students develop as critical creators and users of both digital and traditional forms of information."[15]

Irene McGarrity similarly incorporated metaliterate learning practices into an undergraduate course, Digital Identity and Participatory Culture.[16] The librarian-taught course used the flipped classroom model and asked students to create the assignments rather than the instructors. Placing their practice upon a strong foundation of decades of research on student-centered learning, including Jean Piaget's

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constructivist philosophy, Paulo Friere's *Pedagogy of the Oppressed*, Lev Vygotsky's social constructivism, as well as the more recent work of George Siemens on connectivism. McGarrity designed the four-credit course to emphasize student agency and empowerment, she acknowledged that metaliteracy has been an important instigator in the shift toward the incorporation of active, student-centered learning in information literacy instruction. McGarrity underlined the importance of students' active role in their learning, stating, "Agency is about empowerment, but it's also about responsibility. For those students who are trained as passive recipients of knowledge and learning, the prospect of making decisions about their learning can be paralyzing."[17] McGarrity and her co-instructor helped students to move beyond these fears and undergo the mindset shift to take control of their own learning. Although these examples of metaliterate teaching and learning do not connect directly to maker-centered learning, they employ many of the same tactics and have similar outcomes. Incorporating maker projects into course content is a tool for instructors to foster active, experiential, and student-centered learning in the classroom. Next, we will look more closely at four elements of the maker mindset that are encompassed by the overarching framework of metaliteracy.

From Consumer to Creator

The "2018 Metaliteracy Goals and Learning Objectives" represent years of work in developing and refining the main tenets of metalierate learning, and include overarching goals, each of which consist of several learning objectives.[18] The document explains that multiliterate learning falls into four domains: behavioral, cognitive, affective, and ~~metacognitive.~~ Each objective is assigned one or more of these categories. Goal 3 of the "2018 Metaliteracy Goals and Learning Objectives" includes students' ability to view themselves as producers of information, along with the ability to ethically share and evaluate information in collaborative environments. This lines up with some of the important outcomes of maker-centered learning, including the student's shift in mindset from consumer to creator, as well as a student's ability to understand the cultural and societal significance of the things that they create. Rooted in the ideals of the maker movement, the shift from consumer to creator fundamentally changes students' outlook and connects closely with the theme of empowerment. Students are no longer blindly consuming information and things, but rather looking critically at all aspects of the designed world around them, with a confidence that they can analyze, tinker with, and design new objects.

Student Empowerment

In Jacobson, Mackey, and O'Brien's "Metaliterate Learner Roles," the concept of empowerment is directly linked to students' ability to step into the various scholarly roles that are represented.[19] Empowerment is important to metaliteracy learning practices, as evidenced by the classroom examples outlined previously in

this chapter. Empowerment is also a key outcome of maker-centered learning, both in the predominant maker learning frameworks and in the literature on maker-centered learning. As described previously, the ultimate outcome of the AbD Framework for maker-centered learning is maker empowerment. Clapp et al. state, "Maker empowerment is a sensitivity to the designed dimension of objects and systems, along with the inclination and capacity to shape one's world through building, tinkering, re/designing, or hacking."[20] Maker-centered learning culminates in students' ability to critically evaluate the world around them, to understand how things work, and to become confident in their ability to tinker, fix, improve upon, and create things from scratch.

Civic Mindedness

One of Mackey and Jacobson's "Metaliterate Learner Characteristics"[21] is the tendency to be civic-minded, a mindset where students use what they have learned to better their communities or the larger society. This proclivity toward civic-mindedness is also a natural outgrowth of the maker mindset. As I explained in a 2020 blog post for Metaliteracy.org, "when students experience empowerment through maker-centered learning, this empowerment begins to extend beyond themselves, often resulting in students' commitment to use their newfound agency to make a difference in the world at large."[22] Within the maker movement, there is a definite trend of makers using their skills and experience to give back to their communities and to the world at large. Many nonprofits and other organizations have emerged from maker projects because tinkering and making resulted in technology that could benefit humanity in some way. One example is Enabling the Future, a project that provides open-source schematics for prosthetic hands.[23] The project started in 2011 when a maker named Ivan Owen created a moveable metal hand for a steampunk cosplay. As it turned out, the technology that made the cosplay hand moveable was also revolutionary for the prosthetics community. It led to the e-Nable project, which now exists under the title of Project Enable. The organization not only provides plans and resources for the creation of low-cost, easily replicable prosthetics, but also acts as a connector between interested makers and those who need prosthetics. Project Enable is just one example of maker projects that have become worldwide humanitarian efforts.

Another recent example of the civic-mindedness of the maker community is the response to personal protective equipment (PPE) shortages resulting from the COVID-19 pandemic. Early on in the pandemic, the worldwide medical community was overwhelmed by the sudden need for PPE, hygienic supplies, and medical devices. The maker community's response to this crisis was immediate and huge. Individual makers and large organizations launched a monumental effort to design and manufacture PPE, such as face masks and shields, as well as parts for medical devices, particularly ventilators.[24] A guide that I created in April, 2020, lists many of these efforts, which include commercial companies and organizations

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such as Matterhackers and America Makes helping to match makers and hospitals in need, as well as challenges for the design of PPE and devices with large prizes.[25] According to AbD, community making is an important benefit of maker-centered learning, defining it as, "Finding opportunities to make things that are meaningful to one's community and taking ownership of that process of making, either independently or with others."[26]

Metacognition

Metacognition is an integral component of metaliteracy, and is one of the four domains of metaliterate learning. In the "2018 Metaliteracy Goals and Learning Objectives," the metacognitive domain is defined as "what learners think about their own thinking—a reflective understanding of how and why they learn, what they do and do not know, their preconceptions, and how to continue to learn."[27] To my knowledge, the current literature on maker literacy learning does not address metacognition as an outcome of maker-centered learning. I would argue that metacognition is integral to the maker learning process. Although metacognition is not specifically addressed, many practitioners place emphasis on introspection, reflection, and critically evaluating one's own core beliefs and principals. Wallace et al. explain that the incorporation of self-reflective components into maker projects, such as journaling, led to observable growth in students.[28]

I have found this to be true in my own practice as a makerspace librarian and educator. I start my instruction sessions by introducing students to the maker mindset, which gives students the opportunity to understand and evaluate their own shift in thinking as they develop themselves as makers. A favorite activity to kick off my maker learning sessions is, "Memorable Making Experience," an activity from AbD that I have modified.[29] In this activity, students are asked to think of a time they made something and to think about why it was memorable. It sounds extremely simple, but the great thing about this activity is that it helps students to expand their idea of what "making" is. I make sure to emphasize at the beginning that by "making," I don't just mean 3D printing, sewing, or something that might have initially come to their minds. I explain that making can be anything where they are using their hands to create something, digital or physical; it could be baking a cake, or fixing a car, or drawing a picture. After students have shared their making experience, I finish the activity with these words from the original AbD activity:

- We do this activity to make the point that everyone is a maker in some way—we have all had memorable making experiences: making is what makes us human!
- We do this activity to show the range of activities that may be considered making—it's not just about robots, drones, or the latest technology.
- We do this activity to show that making is not discipline specific—it's not just about increasing proficiency in the STEM subjects.
- We do this activity to demystify making and maker—it's not an esoteric practice practiced by few, but something we all do/are.[30]

By doing this activity at the very beginning of the maker learning experience, just as students are being introduced to the idea of maker literacy and the maker mindset, we not only encourage metacognition throughout the learning process, but we immediately make students feel more included and capable of working in the makerspace environment. This small metacognitive activity spurs creativity and helps students get past any potential hesitancy they may have about whether they are makers. Another important thing to note is that this activity was developed for K–12 learners (AbD's focus area), but, in my experience, it works equally well for college-age students. This illustrates that frameworks like AbD can be beneficial tools for students of all ages.

Maker Literacy and Liminality

The concept of liminality originated in the field of anthropology, coined in 1908 by Arnold van Gennep and further developed in the 1960s by Victor Turner.[31] In anthropology, liminality represents "the transition from one social identity to another, such as from child to adult, from citizen to king, or from living body to dead corpse."[32] Individuals enter a state of liminality when they are in between who they used to be and who they are becoming. Liminality has evolved beyond its anthropological origins to find its way into many disciplines, including performance studies, religious studies, literature, and popular culture. The concept is interpreted differently based on the area of study, but generally represents the in-between—of identities, understandings, states of being, or of space. Meyer and Land apply liminality to higher education learning theory, in the context of threshold concepts. Threshold concepts, conceived by Meyer and Land in 2003, are irreversible and transformative learning events that are integral to students' understanding of a particular subject. In the process of students' navigation through threshold concepts, they pass through a liminal space, in which there may be uncertainty or anxiety, or feel that they are "stuck."[33] While threshold concepts may be structured by the instructor and more or less predetermined, liminality "offers less predictability, and appears to be a more 'liquid' space, simultaneously transforming and being transformed by the learner as he or she moves through it."[34]

In a 2015 paper presented at the LILAC conference, Fister discussed the concept of liminality, while reflecting on the newly-created "ACRL Framework for Information Literacy." Fister began by pointing out that information literacy, especially as represented in the ACRL Framework, is much more than just learning to find information. Instead, she explained that information literacy is the active process of acquiring "experiences, skills, and dispositions" that empower students to become creators and effective users of information.[35] Speaking about threshold concepts, Fister discussed the idea of liminality. She describes liminality as "the place where we are between understandings. It's the borderland we're passing through as we move from a familiar place to an unknown place. It's where we are unsettled, where we might turn back because it's just too uncomfortable—or where we might feel exhilarated

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by the challenge."[36] She explains that when students learn to navigate this area of uncertainty, they develop enduring, transferable skills that go beyond their major of study and benefit them in the workplace of the future.

I argue that maker-centered learning exists in this liminal state. The mechanisms of maker learning depend upon pushing students just beyond their comfort zone, while also supporting them and making them feel empowered and capable. In my makerspace classes and workshops, I have found that the best way to encourage creativity and push students toward developing a maker mindset is to allow for some uncertainty, improvisation, and even failure in the making process. If students are told exactly what to do, exactly what to make, they will not learn as much as they would if allowed to tinker and iterate. In *The Art of Tinkering*, Wilkinson and Petrich describe the benefits of this type of learning. They explain that tinkering is "whimsical, enjoyable, fraught with dead ends, frustrating, and ultimately about inquiry."[37] But the sometimes-frustrating process of tinkering is well worth the effort, because it is when we enter this state of uncertainty, when we struggle and overcome obstacles, that we create amazing things, learn enduring skills and dispositions, and develop a maker mindset.

Another interesting connection between maker learning and liminality comes to light when we imagine the role of makerspaces on college campuses. Miller et al. make the observation that makerspaces on college campuses exist in a "liminal space," because they are informal learning spaces that fall outside of the structured university curriculum.[38] Using the example of the Curtin Library Makerspace in Australia, they argue that makerspaces have great creative potential because of their location at the outskirts of the traditional university. Makerspaces often work alongside and in collaboration with faculty teaching semester-long courses, but offer students a place in which to explore, tinker, and play that falls outside of their normal courses. In this way, the university makerspace not only facilitates learning opportunities for students that push them into the area of liminality, and foster deep, inquiry-based learning, but the makerspace *itself* lives in an area of liminality that allows for flexibility and creativity potentially not available in students' daily university life.

Maker Literacy in Action

As I have taken the underlying concepts of maker-centered learning and translated them into practice, I have witnessed how these theoretical frameworks affect real-life students, both in formal classroom settings and informal interactions in the makerspace at Miami University Libraries. In 2019, I worked with Kristan Kanorr, an instructor for one of Miami's University Studies (UNV 101) courses to develop an assignment that prompted students to explore their identity. Students used several tools in the makerspace for two projects, "Who I Am Not," at the beginning of the semester, and then "Who I Am," near the end of the semester.[39] For "Who I Am Not," students created a wood block on the Carvey CNC machine of the Miami "M" logo, and then cut three words out of vinyl on the Silhouette Cameo craft cutter

that represent stereotypes that others may hold about them. For "Who I am," after a semester of experience and personal growth, students designed a personal logo in Inkscape that contained three to five words that represent who they truly are. They then cut out their logos as stickers on the Silhouette machine.

The students in UNV 101 are first-year undecided students, and part of the goal of the course is not only to help students adjust to university life but also to better understand their own goals and dreams in order to situate them for success during and after their college life. This project provides a way for students to explore their various identities through making. The project incorporates metaliteracy in several ways, by helping students develop skills as creators of information and things, by empowering students to embrace their true selves, and through metacognition, as students must introspectively explore their growth throughout their first semester at university. Additionally, I incorporate liminality by allowing students creative freedom in designing their "Who I Am" logos. I give the students the basic concepts of vector design and a quick tutorial of Inkscape but stop short of any prescriptive instructions on how to create their logos. The students must overcome the initial uncertainty of how to make a logo from scratch, which pushes them into the area of liminality and allows for creative thinking to blossom. This project is one of many that I have facilitated within existing courses; I have worked with faculty in a wide variety of disciplines (English, History, Public Speaking, Chemistry, Italian Renaissance, Spanish/Portuguese, Fashion Design, etc.) in the past three years. By situating maker-centered learning within academic library information literacy practices, the possibilities of engaging students in maker-centered learning are virtually limitless.

CONCLUSION

In order for academic library makerspaces to maintain relevance in the ever-changing realm of innovation in academia, makerspace organizers must continually demonstrate that these spaces align with library and university priorities, and provide enduring benefits for learning. We can do this by connecting makerspaces to the information literacy goals of academic libraries, as represented by the ACRL Framework. And as Milne-Lane and Vecchione attest, "The ACRL Framework is the embodiment of the maker spirit, cementing the home of the makerspace on a college campus to belong squarely within the responsibilities of the academic library."[40] Viewing maker literacy through the lens of metaliteracy and liminality further connects maker learning to information literacy and the ACRL Framework, imbuing maker literacy with legitimacy and ensuring the long-term survival of maker services in academic libraries. The future of academic library makerspaces lies in the enormous potential of maker-centered learning to transform student engagement and learning, allowing students to develop lifelong, transferable skill sets, such as critical thinking, creativity, empowerment, and many more. Maker-centered learning can have long-lasting positive effects on students that they can carry with them into their future lives and careers.

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NOTES

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