

# **Makerspaces as complex sociomaterial assemblages: Is networking the key factor?**

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## **(NLC Abstract) Abstract**

The emergence of makerspaces is an outgrowth of our current educational and technological era. While *making* is not new, networking capabilities has made it relatively easy to locate materials, knowledge, procedures, and expertise. Through technologies that are now affordable to consumers, there is a *folding* of human activity, digital, and material; that is, these practices, previously viewed as separate phenomena or separate regions of activity, *blend* (Mol & Law, 1994). Physical computing and 3D printing are becoming part of our practice. We can combine electronic, programmable circuitry into traditional crafts such as sewing or origami. Makerspaces are difficult to define because each one is unique, fitting on a continuum of formal to informal and offering different levels of learner/participant control. For example, in some makerspaces facilitators explicitly guide projects; other makerspaces may be gatherings of individuals working on different projects without any discernible leadership. Gatherings may be physical, virtual, or both. The projects, people, and problems may lead to differing degrees of collaboration, sharing and problem solving. We argue that the activities that occur at a given makerspace emerge from the unique characteristics of the space, participants, materials, and networking practices. From a sociomaterial perspective, makerspaces may be viewed as complex assemblages in which the human, digital, and physical are highly entangled. In this paper, we describe a single phase of a larger research project examining the experiences of makerspace facilitators. Our main goal in this phase of the research was to examine the extent to which curating, creating, relating, and networking, as per the makerspace activity (MAP) diagram (Figure 1), are part of the makerspace assemblages described to us by our study participants. For this research, we conducted semi-structured interviews with 13 makerspace facilitators. The participants included teachers, librarians, school technology consultants, and makerspace club members. Our first pass at coding the transcripts resulted in a significant number of codes emerging in the *relate* category in comparison to the *create*, *curate*, and *networking* categories. This result led us to question the centrality of networking and whether or not relating should be considered the central characteristic of makerspace assemblages. We conclude that networking, while less prevalent in the transcripts (i.e., less salient to our interview participants), remains a significant characteristic. However, we offer a revised version of the MAP diagram in order to recognize the significance of relational learning.

## **(NLC Abstract) Keywords**

Makerspace, sociomaterial, networked learning, assemblages, relational learning

## **Introduction**

Humans have been *making* and sharing *things* for centuries. What is made and how it is made is related to the nature of the environment, resources, and people involved; they are co-emergent. The current makerspace movement reflects the entanglement of human, material, and digital assemblages. The affordability of personal computers alongside advances in graphical-user interfaces, software, memory capacity, and electronic networking capabilities has coincided with the emergence of new genres of writing, speaking, and means of information exchange. It is now commonplace to create, share, and modify words, images, videos, and audio digitally through blogs, vlogs, websites, suites of editing software, and networking systems. Through the confluence of today's technologies and educational practices, the digital, the human, and the material are folded

into each other. Material can become digital through electronic recording of audio, video and photography; the digital artefacts can become material through 3D printing, robotics, and physical computing; human activity and ideas can become digital and material, and the digital and material influence who we are as humans.

According to the makerspace activity process (MAP) diagram (Figure 1, left image), networking is a significant aspect of the maker assemblage(s) (Koole, Dionne, Todd McCoy & Epp, 2016). Our goal in this study was to explore whether or not the activities outlined in the MAP diagram are reflected in makerspace activities. In particular, we were interested in the extent to which curation, relation, creation, and networking practices are important in makerspaces. In examining interviews with makerspace facilitators, we began to question: is networking the central characteristic of makerspaces? We present our preliminary observations here.

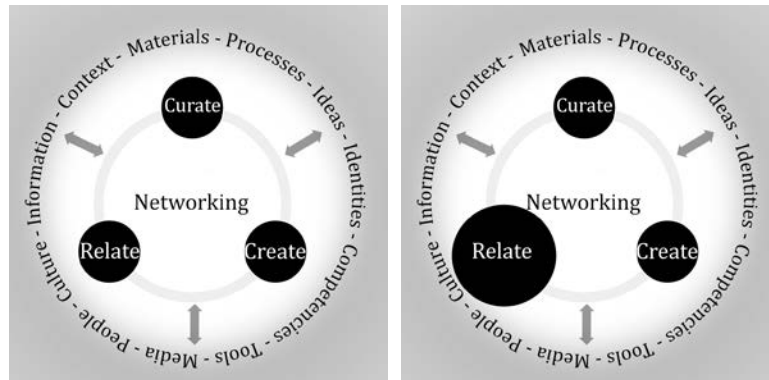


Figure 1. The makerspace activity process (MAP) diagram (original on left; revised on right)

## Background

The roots of the makerspace movement are often associated with Dewey and Papert (North American constructionism) (Dougherty, 2012; Libow, Martiznez & Stager, 2013). It is also now associated with problem-based learning, discovery learning, and inquiry-based learning (Justice, 2015). While the types of makerspaces are highly varied in terms of formality and learner control (Koole, Dionne, Todd McCoy & Epp, 2016), the makerspace ethos generally emphasizes *active doing*, dealing with uncertainty, problem solving, and authentic learning (Bevan, Gutwill, Petrich & Wilkinson, 2014). We argue that the constructionist and pragmatist philosophies underemphasize the depth of the embodiment and the role of things and spaces entangled in the makerspaces assemblage(s). The intangible nature of the digital, in particular, is ontologically problematic when examining it through a philosophically binary lens. From a sociomaterial perspective, human agency is inherently entangled with material and digital agency. This is not to say that their agencies are the *same*, but they are equally *significant* in the analysis of learning environments (Decuypere & Simon, 2016). As argued by Goodyear, Carvalho, and Bonderup Dohn (2016), the “influence of the physical setting (digital and material) on learning activity is often important, but is under-researched and under theorised: it is often taken for granted” (p. 94). The sociomaterial perspective allows us to engage with the tangible and intangible through the recognition of agency: how activity comes to matter. This perspective seems particularly suited to the makerspace phenomenon in which the human, digital, and material are so highly entangled.

Networked learning is defined as “learning in which information and communication technology (ICT) is used to promote connections: between one learner and other learners, between learners and tutors; between a learning community and its learning resources” (McConnell, Hodgson & Dirkckinck-Holmfeld, 2012, p. 6). We find networked learning to fit within our sociomaterial approach as networking facilitates the interweaving of heterogeneous assemblages of tools, resources, and activities allowing the emergence of learning activity. Other aspects of networked learning’s pedagogical orientation that fit with the makerspace ethos includes: openness in the educational process, self-determined learning, purpose in the cooperative process, supportive learning environment, and a focus on process (McConnell, Hodgson & Dirkckinck-Holmfeld, 2012, pp. 8-9). While much makerspace activity is hands-on, physical, and involves face-to-face interaction, it is a highly relational style of learning that is enhanced, and in some ways made possible, through online interaction with remote people and resources.

## Framework

The original makerspace activity process (MAP) diagram (Figure 1) grew out of a preliminary review of the literature on makerspaces (Koole, Dionne, Todd McCoy & Epp, 2016). In the diagram, the outer grey problem space on the outside ring is replete with possible materials, procedures, ideas, identities, competencies, tools, media, people, cultures, and information. Hypothetically, through networking, these potentialities move in and out of the problem space as they are curated, created, and (inter-)related. Networking enables the exchange of resources, ideas, plans, successes, failures, and creations. Curating moves from sharing into filtering, selecting, and rejecting shared resources and ideas. Creating involves using, reusing, remixing, repurposing, and experimenting. Finally, through relating, learners come to understand how elements within their sociomaterial worlds are related. Relating involves contextualization, engagement, and identity/positioning.

## Preliminary Results

Our main question was: Do makerspace facilitators experience creation, curation, relation, and networking? Our team interviewed 13 teachers, librarians, school technology consultants, and makerspace club leaders (age range: 30 to 55). The makerspaces they facilitated varied on a continuum from participant driven (i.e., the makers decide on the projects they would do) to facilitator driven (i.e., a facilitator would set up a problem, and guide the makers in solving it). The age level of the makerspace club attendees varied highly—ranging from adults to children. The interviews were semi-structured. The participants were asked to describe how they facilitated their makerspaces, what tools they used, what activities occurred during the makerspace events, the reactions of their participants, and what the facilitators observed and identified as learning. We analysed the transcripts using codes derived from the MAP diagram (with some codes emerging during the coding process). Within the four categories of networking, curation, relation, and creation, 69 codes emerged (Table 3).

**Table 3: Codes**

Code Category	Number of codes
Create – reusing, remixing, repurposing, experimentation, functionality, aesthetics	18
Curate – filtering, selecting, appropriating, and rejecting resources, ideas, procedures	4
Relate – connecting ideas, contextualization, engagement, identity	39
Networking – connections between people and resources.	8
TOTAL	69

## Preliminary Observations

What we found striking was the number of codes that emerged within the relating category. This made us question whether or not networking should be replaced by relating as the central process in the MAP diagram. Further analysis and discussion amongst our research group, however, has led us to suggest that networking is still a significant underlying characteristic that enables the processes of creating, curating, and relating. Relational learning (relating) appears to be the most evident process from the viewpoint of our makerspace facilitators. As such, we propose a revision of the MAP diagram (Figure 1, right). The significance of relating (see Figure 1, right image) may have been significant for the facilitators because of their struggle with new orientations and entanglements within the makerspace assemblages—that is, as their own roles were shifting away from traditional teacher and/or leader roles.

The interview transcripts revealed how traditional boundaries appeared to collapse in makerspaces, as people interacted with one other and materials (digital and physical) in their environments. For example, the study participants observed how technology was advancing with such rapidity that they found it impossible to master it all. They commented on their lack of expertise and knowledge regarding the science underpinning the technologies, which sometimes led them to draw upon the expertise others inside and outside their immediate makerspace environments:

*Facilitator1: We got a Raspberry Pi...and I still don't really know how they work. Um, but the students are explaining to me and communicating to me and teaching me and so, it's, it's beneficial in two ways: they have to really know what they're talking about in order to be able to communicate it with me.*

Furthermore, social media and networking make it possible to share and access expertise from almost anywhere, thereby eliding time and space. Facilitators no longer need to be the expert because there are so many other experts at a one's disposal. So, the pressure to 'know everything' is reduced.

Facilitator2: *Like I said, there was the one other guy . . . I think we might have been the first or second school in our division to purchase one. There just wasn't much of a network. My network was more... it was a little outside the school division and then Twitter again and Googling . . .*

The folding of roles was particularly salient when participants spoke about how making disrupts the traditional binary roles of the teacher as the 'expert' and the student as 'non expert'. This finding in turn, allows for a multitude of opportunities to engage with others and materials in novel ways. Even more strikingly, perhaps, it reconfigures how participants relate to themselves and others.

Facilitator3: *And so, she actually had a kinda, [makes exploding noise], just threw it off her desk . . . And you know, she came back in and she's like, 'I think I need a bigger battery.' But, I thought that was kinda clever on her part. I really honestly, hadn't thought of that . . . the bigger battery worked!*

Facilitator4: *Anyway, this little girl who has, who struggles, she sat in her spot the entire time [in regular classes]. But she rose up to be the Sketchnoting superstar, which she never is in class . . . All the kids were coming for her, to her for advice: 'How do draw that? How did you make that? What shapes did you use?' And so, she's one that was giving advice to all the other kids.*

Expertise and the identities that flow out of making can also be a shared experience, which is both fluid and dynamic. As the circumstances change, so do the opportunities to share expertise. In other words, traditional boundaries do not appear to be simply replaced with new boundaries, but rather, making may inhibit boundaries from becoming fixed and rigid. As such, new ways of relating can emerge.

## Conclusion

As sociomaterial assemblages, makerspaces appear to allow the emergence of new ways of relating. For our interview participants, their interactions within the makerspaces brought to their awareness shifting roles and expectations. The participants' narratives led us to better acknowledge the importance of relational learning. In addition, it caused us to question the central role that we had earlier attributed to networking. In re-examining networking within the MAP diagram, we maintain that networking underlies relating. As such, networking appears to be the grease that lubricates the creating, curating, and relating wheel.

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