Learning and Teaching Through Social Fabrication: From an Ethnographic Study in "Fablab Kamakura"

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Abstract
This paper analyzes the relationship between participation and learning represented in ethnographic case studies of ten informants aged 23-59 participating in a common-based peer production site, the FabLab Kamakura community. Digital-based personal fabrication is a new wave culture of mavens, who are devoted to alternatives to mass production, and are on a mission "to make (almost) anything". FabLab Kamakura is a valuable venue for exchanging information about, for example, digital tools, Arduino, crafts, textiles, and so on. First we frame this work as an effort to think about their participation and learning using the concept of "wildfire activity theory" (Engeström, 2009) and "legitimate peripheral participation (LPP)" from Lave and Wenger (1991). Then we argue an overview of FabLab culture in Japan and at FabLab Kamakura.
Using SCAT methodology (Otani, 2011), we group our findings in two different categories: (1) learning through participation in FabLab Kamakura, (2) the visualization of weak ties and mobility through participation in wildfire activities. We conclude that participants at FabLab Kamakura are producing and designing available artifacts for their lives and works, and in doing so, what they are designing is the physical manifestation of their very thoughts.

Keywords: FabLab Kamakura, learning, personal fabrication, wildfire activities

Introduction

This paper examines FabLab Kamakura as a site that, like other FabLabs, promoting the paradigm shift away from making as mass production and specialist esotericism. As of 2015, there are over 250 FabLabs spread over fifty countries. FabLabs are run by researchers, creators, designers and artisans, and created a space for these groups who had already been working individually on personal fabrication or open data and shared the same set of values. Each FabLab is uniquely tailored to its local social context and needs. Although they receive no particular government support and have no central managerial system, FabLabs allow anyone to create and cooperate in almost any place. We can apply Engeström's (2009) concept of wildfire activities to FabLabs. Wildfire activities are defined as dispersed and local activities that start simultaneously in separate places and spread out until they eventually connect with each other. Wildfire activities, the motivations for participating in such activity, the formation of knowledge and skills in informal activity, and what this means for learning are now core academic interests for cognitive psychology, especially in

Activity Theory and situated learning. Activity Theory and situated learning, following research on everyday cognition such as Lave, has understood individual skill and knowledge as being made visible through interaction with outsiders, artifacts and systems. Many studies in these areas have tried to capture the wealth and complexity of human knowledge and skills through examining activity in a wide range of situations, such as airport operating rooms, insurance billing, shipping and medical companies, school classrooms and science laboratories, and have conceptualized the learning observable in these social situations. On the other hand, Engeström (2009) have looked at the characteristics of learning in wildfire activities, which occur simultaneously in separate social contexts, such as skateboarding, flashmobs, birdwatching and open source communities.

While the field examined in this study, FabLab Kamakura, shares the mobility of members and expansive movement of these activities, unlike wildfire activity it was not born from an accumulation of individual spontaneous and creative activity. FabLab Kamakura has its own charter and is managed by the FabLab Japan Committee. Each FabLab is part of a global movement run as an alternative to mass production and the monopoly of making by specialist designers and creators.

Although FabLab Kamakura is bound to a particular place, it is open to all participants, and follows the basic FabLab values as appropriate to the local conditions of Kamakura. The approach we see in FabLab Kamakura, which is to design a society where anyone can create and connect without being held back by administrative barriers, while simultaneously determining what is needed to make such a society possible, is also found in the open data movement and community activities. Ito et. al (2013)'s model aims at 'Connected Learning'—that is, the ability of young people, with the support of their peers, to connect learning across their communities of interest (be that school, home, the library or an online community), to academic success, career development or civic participation. In Japan, disparities in access to educational opportunity have become starker, so new design based Connected Learning theory is notable.

This study interprets FabLab Kamakura as a production site endeavouring to overcome traditional, systematic relationships while maintaining its wildfire capabilities. Based on interviews and participant observation at FabLab Kamakura, we explore the merits of learning in a space where people from all kinds of backgrounds come together through making, using methods irreparably different from the division of 'maker' and 'user' characteristic of mass production. Secondly, we utilize the perspectives of the participants in FabLab Kamakura to rethink the framework of wildfire activity as a comprehensive account of a particular activity.

Characteristics of FabLab Kamakura

In this section we describe the development of FabLab Kamakura and the motivations behind this development according to the owner in FabLab Kamakura. FabLab Kamakura was established in May 2011 as the first FabLab in Southern Asia, quickly followed by FabLab Tsukuba. FabLab Kamakura is located five minutes from Kamakura Station, in a 125 year old *sake* storehouse brought from Akita to Kamakura. FabLab Kamakura aims to connect contemporary production methods with traditional techniques, cutting across age group and nationality. The makers of FabLab Kamakura therefore highly value reciprocal making. For example, once seminar participants learn how to use one of the tools at the lab, they are expected to teach each other. Local artisans develop and present new programs that meld new machines with traditional techniques(ex, in combination with laser cutter and wooden mosaic work). Projects that emphasize the character of Kamakura are encouraged, and the participants in FabLab Kamakura cooperate across complex motivations and projects. A key aspect of Yūka Watanabe's direction is that FabLab Kamakura is not a place just for printing or cutting, but a place for learning.

FabLab Kamakura offers a number of tours and seminars for a small cost, which usually run for two hours and can be applied for online. Seminar participants automatically become members of FabLab Kamakura. Other programs include 'Morning Fab,' where members of the local community meet at nine o'clock Sunday morning to clean inside the clubhouse in return for free use of the equipment for several hours. Payment at FabLab Kamakura is not solely monetary as labor is recognized as an exchangeable value.

Methodology

We selected FabLab Kamakura as our field site for three reasons. One, it was the first FabLab to open in Japan, and one of the founding members, Hiroya Tanaka, had been instrumental in introducing the Fab concept to Japan. Secondly, we were able to build strong relationships during our time in the field (over a year) with the members of FabLab Kamakura.

Interview Protocol

We conducted semi-structured interviews with eight participants of FabLab Kamakura (four men and four women) for ninety minutes and sometimes up to four hours. Their roles in FabLab Kamakura included those in the management team organizing and running tours, seminars, the member's club and workshops as well as

teaching, and also freelance engineers and artisans who collaborated with FabLab Kamakura on their own work.

Table 1. Interview Participants

ID	Age	Gender	Role at FabLab
info.1	30s	M	Project member
info.2	30s	F	Project member
info.3	20s	F	Management team
info.4	50s	M	Management team
info.5	30s	M	Management team
info.6	30s	M	Project member
info.7	20s	M	Management team
info.8	30s	F	Management team
info.9	20s	F	Seminar participant
info.10	20s	M	Seminar participant
info.11	30s	M	Management team

Analytical Method

We created transcripts from our interview data and compared them with our field notes, and analyzed them based on our guiding concept, learning through making in situated wildfire activity. We utilized Ōtani's(2008) SCAT methodology when creating transcripts and field notes. SCAT is a method of analysis particularly suited for qualitative data such as observation notes and interview records and is known for being easy to apply. We use SCAT to understand the big picture of our data, and then combine key concepts for further analysis.

Results and Discussion

We argue that FabLab Kamakura is a semi-designed field with wildfire characteristics where individual production and common-based production cut across systematic organization. A theoretical framework for activities that are designed to spread like wildfire, but lack the unconscious nature and weak connections of wildfire activities is under development (by, for example, Hippel 2005). In management studies, organizational research has revealed a new model that works on both top-down and bottom-up mechanisms, known as 'middle up-down'. The success of middle up-down model in the management of knowledge creation is well-attested. FabLab Kamakura's utilization of the middle up-down model to sustain creativity and reach out to the local community without losing sight of the FabLab charter is not seen in other wildfire activities. (FabLab Kamakura makes this concept known on the Web). Although FabLab Kamakura revolves around those with specialist knowledge and techniques teaching those who don't, it differs from vertical teaching approaches, and the community itself is constantly being remade by its members.

Learning through Making

Through dialog 1 and 2, we'd like to show that FabLab Kamakura provides the opportunity to realize one's hidden rules of making submerged in their unconscious. First dialog looks deeply at the conversations between the authors and info.3 and info.4. Both info.3 and info.4 participated in Fuji Mockfest, an event organized by

FabLab Kamakura and a non-profit organization in Shizuoka Prefecture, Fujinomiya City. The festival has been held since 2012, and involves making mockups from timber taken from the Mount Fuji area during thinning of the forest. The two informants are talking about drying out the timber, and cracks in the wood. Info.3 has participated in Fuji Mockfest since its inauguration, and info.4 from the second time.

Info.4 had previously worked as a technician at a metal-processing company and at the time of the interview was participating in Morning Fab. Info.3 is a graduate of design school, and sells her wooden handicrafts on her own online store while managing Morning Fab, facilitation of member's club, seminars and tours at FabLab Kamakura. In dialog 1, based on his experience of factory processing, info.4 emphasizes quality control of the wood by cutting the logs thinly and drying them so they do not crack. On the other hand, info.3 does not perceive a cracked cut as defective, but focuses on the best design for the given material.

[Dialog 1]
info.4: I heard that you have to leave the logs to dry for about three months. I wanted to know how dry the log would be by the time production started.
info.3: I wanted to know how to make the most of the crack. info.4: I wasn't thinking that much about the crack, but once I thought about it, all the cut boards are cracked. And I went, these are defective, we can't sell these.
info.3: That's where we differ. For me, any wood is usable, so whether it's cracked or whole doesn't matter. If it's wood, I can use it.
-- This is interesting!
info.4: Well, I work in a factory as a technician, I used to be a salaryman in a factory, and the staff always used to tell us, this is a place for making things. The technicians oversee the factory, but they would say, what is your job? You can't make things directly, so make things with data. In that sense, I have the habit of accumulating numbers and working from that.
info.3: I couldn't accept that just because the wood had a crack in it, it was no good. I knew that I couldn't design it perfectly as it was, and if it had been naturally cracked I would have had to cut away that part, but in my heart I wanted to use it.
(-- indicate interviewer's remarks.)

Fuji Mockfest requires participants to cut their own timber and design it into their desired shape. The participants thus cut the logs into thin circles, but in 2012, the timber cracked during the drying process. According to info.3, during the first Fuji Mockfest, both the staff of FabLab Kamakura and the participants had focused on how to make the most of the cracked log. She reported that one participant suggested to make a clock face, with "the crack to represent an important time to the owner. For example, someone who always has a snack at 3pm could position the dial so the crack would fall at the 3. They would make up a story behind it." Info.3, who started from the position that the crack was a feature, was shocked by info.4's perception of the crack as a defect.

[Dialog 2]
info.3: That presentation at FujiMock (note: the second Fuji Mockfest), I just didn't think the timber cracking was a problem, so when they started talking about how to fix it I was shocked. I hadn't thought there was anything we could do about it, but listening to info.4 come up with a way around it, that was big. He was like, "I came

because the log won't crack," and for the next three years we were in a totally different world of what to do about the logs that *don't* crack.

Info.3, based on her experience with working with timber offcuts at design school, had approached her materials from a perspective of utilizing any flaws, and applied that to Fuji Mockfest. However, when info.4 joined the festival and introduced quality control to ensure the logs didn't crack, she was in a "different world." In one sense, her perception of the wood and its value expanded. As a result, info.3 began a new process of "using a modeler to cut from a $10cm^3$ block of wood," and consulted info.4 on the most appropriate method. We consider that the new way of making has changed her perception from "pretty limited, those 5 millimeter boards at Tokyu Hands." (from the authors' field notes, January 2015. Square brackets represent info.3's utterances)

As seen in dialog 1, multiple attitudes towards making and materials are constantly colliding at FabLab Kamakura. This conflict is part of the very core of FabLab Kamakura, which is organized around 'making while encouraging participants to teach each other and collaborate with people of genres and ages they would never meet in everyday life.' It is because of the fluid, wildfire aspects of FabLab Kamakura, expanding based on what its participants bring to the lab but always maintaining its common values, that the learner can see the experiences of others and reconfirm the patterns of learning inscribed upon their body. FabLab Kamakura provides the opportunity to realize one's hidden rules of making submerged in their unconscious. The value of learning through the intense experience of that moment when a well-known skill or pattern is overridden, or a new technique is learned. Through participating in everyday life at FabLab Kamakura, our informants similarly began to be aware of the techniques they already possessed and they take delight in those experiences.

Co-construction of action possibilities

In this section, we would like to examine the ways in which the participants at FabLab Kamakura expand the speed and variety of their making through interaction with others. We will call this 'expansion of action possibilities.' Action possibilities mean looking at the world not as predetermined movements, but statements of possibility ('I might be able to move this way'). Info.4, who had brought his experience with quality control to Fuji Mockfest, created a new possibility for making and a new way of looking at materials at FabLab Kamakura. Like info.4, the 'brokers' who cross the boundaries between fields have great influence. However, at the same time, info.4 was also able to reinterpret the timber as an object for new activity for himself.

Just as info.4 became a catalyst for info.3 and for FabLab Kamakura, info.4 was inspired by their perspective of utilizing the flaw. The task at Fuji Mockfest was to design the timber into their desired shape. Info.4 brought his individual context, to answer the needs of the people who would need uncracked timber once making had spread further into society. In addition, he melded his well-known techniques of metal-processing quality control with the activities at Fuji Mockfest and FabLab Kamakura to search for new potential. A more detailed example is offered below.

[Dialog 3]
info.4: Everything is quantified. The moisture will evaporate, so I weighed the timber and recorded the numbers. It's habit, I didn't have anything in mind for the wood at first. Once you've cut it, you can't get this data anymore, so I always get the numbers just in case. And this time I could develop a new material from observing the change in the numbers. I could have gone into actually making the works, but what I really wanted to do make good materials. To make the perfect material, and for everyone to use it. If the number of workshops like FabLab keeps increasing, more people will want to use my materials. And that's what my contribution to everyone is.

In dialog 3, info.4's desire to 'contribute to those who will come to making with the expansion of FabLab' is merging the two contexts of his insistence on quality based on his experience in the factory with the focus on design sought by FabLab Kamakura and Fuji Mockfest. In addition, be it consciously or unconsciously, he is referring to FabLab charter (the key characteristic of FabLab Kamakura's unique wildfire nature) which calls on makers to document their processes of trial and error. Furthermore, as we will show in dialog 4, info.4's bank of knowledge of materials processing inspired the members of FabLab Kamakura. They expanded their action possibilities of production, and gained a new object of activity. Through this co-construction, info.4 went on to determine how thick and in what shape he should cut the timber, and how to control the moisture. In other words, his motivation for processing the timber was not pre-given.

[Dialog 4]
info.4: Someone at FujiMock asked me for the thinnest cut possible. I didn't want to say I couldn't do it, so when they asked me how thin I could do it I showed them this offcut (note: while showing a cut piece of wood around 2mm thick). I wouldn't have tried it if someone hadn't said. Here (note: FabLab Kamakura) there tends to be leftovers, and there's no rotation system for who can come in, make something and then go home. If I show them, "it's ready!" (note: timber cuts with no cracks), someone will be attracted to that, and change it into a new work. That's why I do this.

Info.4's choice of 'contribution' through his well-polished quality control skills while touching on info.3's 'use the crack' design, is not simply a matter of being limited to fossilized learning from his time in the factory. Rather, as actors, the woodworker info.3 and info.4, are expanding the range of possibilities of mutual action. The result of info.4's contribution through processing and quality control expands the action possibilities of those who use his timber, in turn creating new motivations for action. Moving from 'use the crack' perspective to the ability to create timber cuts without cracks opens up new possibilities for future production. This was a result of a request to info.4, who was not experienced with timber. His perspective changed qualitatively through his search at FabLab Kamakura for the motivation to produce as he participated in the practices there.

Furthermore, a key point in dialog 4 is that the request for the thinnest timber possible came not from the management, but from a participant. At FabLab Kamakura, the co-construction of action possibility is not limited to the experienced management team, but also occurs between participants. For example, during a seminar info.7 saw info.10 making a support for his camera with the laser cutter, to be used photographing motorsport (his hobby). Info.7 later used the parts info.10 had made

with the 3D printer to design a bumper bar for her car. In addition, info.7 realized the compatibility of digital manufacturing with motor shows and customized cars, and stated that she wanted to find a way to connect the two. A similar proposal to design and cut out a diagram drawn in 3D CAD with a laser cutter was overheard in a conversation between by info.3 and a university student experienced with digital manufacturing and software.

As seen in the case studies above, the value of making at FabLab Kamakura is in the learning opportunities available in an everyday context to become aware of variations to familiar skills, and rewrite one's own through contact with new techniques. Diverse and flexible techniques may yield new action possibilities in various contexts inside and outside FabLab Kamakura. The construction of a resilient body cannot be divided from the individual production and the sharing of technique and knowledge that makes up the social space unique to FabLab Kamakura, which is both drawn to common objects and actions, while constantly seeking change.

Conclusion

This paper has discussed the emerging movement of learning from hands-on production, peer production and personal fabrication through a case study of FabLab Kamakura. In the variety of wildfire activity characteristic of FabLab Kamakura, participants exchange and rearrange familiar skills, developing a more flexible body and way of thinking. The members of FabLab Kamakura positively evaluate the techniques of others made visible through making and combine them into their own.
It is this experience that becomes motivation to participate in FabLab Kamakura, and expands their action possibilities. Lave's theory of legitimate peripheral participation argues that attaining a certain skill or gaining new knowledge is needed to move from a peripheral member of a community of practice to full-fledged member status (Lave and Wenger 1991). However, in a site of wildfire activity like FabLab Kamakura, 'full-fledged member' is not a fixed position. What makes new knowledge, or the attainment of a new skill, or motivation, is not predetermined.

We consider it paramount to conceptualize the actions of local people in fields that are aimed at gradually creating social reform, such as social innovation, shared economies and shared creation. From the eighties to nineties, the internet grew from a grassroots phenomenon at universities to national policy and is now a part of the fundamental infrastructure of society. From 2013-2015, FabLab has been moving in a similar direction, and is gradually being adopted by the government. We expect that analyzing the wildfire activities unique to FabLab Kamakura and the future development of learning through personal fabrication will serve to advance social change and the study of how societies evolve.

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