Connected Making: Designing for Youth Learning in Online Maker Communities In and Out of Schools

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Abstract: While here is ample research on how youth are connected in online spaces and how youth participate online via sharing and reviewing artifacts, yet less is known about how these social connections and contributions emerge, especially in the context of physical making and what can they contribute to learning and assessment. Thus, our symposium primarily addresses two questions: (1) How do youth connect and learn in online maker communities? and (2) How can we design online maker tools *for* learning in and out of schools? We share efforts examining how sharing artifacts, documenting design processes, and providing feedback via online tools can support young makers in creating physical artifacts and offer insights to new assessment models.

Introduction

New technologies (e.g., mobile devices) and platforms (e.g., Internet forums, social media and other online spaces) are making the Internet not only more accessible but also keeping youth connected with each other across time and space. These online tools and communities have been dubbed one of the main propellers of the maker movement in education that advocates learning through making, building, tinkering, playing, and creating three-dimensional objects and installations (Dougherty, 2012). While there is much research on how youth are connected in online spaces (e.g., Ito et al., 2008; Jenkins, 2006) and how youth participate online via sharing and reviewing artifacts (e.g., Brennan, Monroy-Henadez, & Resnick, 2010), less is known about how these social connections and contributions emerge and how they can be supported for youth engaged in physical making. In this symposium, we bring together current efforts to review the critical element of sharing and providing feedback (Paper 1), encourage youth to take ownership over their learning through documentation (Paper 2), support learning through sharing, commenting, and connecting (Paper 3), and establish portfolios as an assessment model (Paper 4). The studies are collectively drive by two primary questions: (1) How do youth connect in online maker communities? and (2) How can we design online maker tools *for* learning in and out of schools?

Our symposium addresses how we can leverage online tools to support young makers' physical making in and out of schools. To begin, Fields and Grimes outline the landscape of how youth use online tools in the wild. Their findings survey youth participation in over 120 DIY sites and the tensions of designing online tools for youth that not only support sharing but also other forms of social networking such as commenting and critiquing. The next three presentations will each showcase a different design-based approach on how to provide essential social networking supports for making: Halverson and colleagues review efforts in public library system that encourage youth to take ownership over their drop-in work at their makerspaces. Litts and colleagues designed an online platform to connect makers locally and globally and foster interactions around maker activities within school settings. Finally, through the Open Portfolio Project Peppler and colleagues investigate a range of ways to document making and learning in the making with a particular focus on assessment within the context of a community center. Each study sheds light on a different dimension of how to design online maker tools and communities for learning by sharing, documenting, and giving feedback on physical maker artifacts.

A comparative study of child-inclusive DIY media websites

Deborah A. Fields and Sara M. Grimes

One of the most important aspects of the do-it-yourself (DIY) media trend is the way it has increased children's access to tools of "mass" distribution. Whereas child-made media was once relegated to refrigerator doors and classroom bulletin boards, it can now be published on shared, public venues. From an educational perspective, this shift has the potential to open up a number of social learning practices for children online, building on long-acknowledged aspects of learning including developing technical and artistic skills in community, fostering identity creation and self-expression, and encouraging creativity (e.g., Buckingham, 2009; Vygotsky, 2004). At the same time, designing websites for children is situated in a number of larger issues that influence those designs including legal and policy issues; commercial influences and advertising; and hierarchies of access arising from different funding models and safeguards (Grimes & Fields, 2012). To date, much of the scholarship on kids online has focused on single websites, some of which were developed under highly unique circumstances—such as out of a university (e.g. *Scratch*), or through a special funding initiative (e.g. *YouMedia*)—leaving a dearth of comprehensive and comparative research in this area.

Now in its second year of research, *The Children's DIY Media Partnership* seeks to identify the types of support systems—regulatory, infrastructural, and technical—that most effectively and sustainably foster a rights-based, inclusive, child-centric approach to addressing children's cultural participation online. As a first step, we conducted a media scan with the goal of finding all available, English-language websites where children could make and share media content that they themselves had created. While this included intergenerational websites, we focused on searching for websites targeting children under age 13 a neglected population in research on kids online (Grimes & Fields, 2012). The scan was conducted using multiple search engines (i.e., Google, Bing) and search terms by different researchers on multiple browsers. A thorough search identified 140 websites that allowed children to share content that they made (see Grimes & Fields, 2015). Of these, 100 were open or public spaces. The remaining 40 were closed to children only, and of these, 20 sites gave us permission to research their website designs (a requirement of our Institutional Review Board). The contents of the 120 sites were recorded using a standardized, 83-item coding protocol, developed collaboratively by the entire research team over the course of four months and several iterations. Three researchers coded the websites after achieving a 93.7% inter-rater reliability. The content analysis included elements of the sites' designs (particularly the mechanics and features involved in creating and sharing user-made media), descriptive texts (e.g. About Us pages, instructions), advertisements, funding models, terms of service, and privacy policies.

One of the most unexpected findings emerged from the media scan search: relatively few sites that allow children contained sharing features. A great number of early search results were ultimately eliminated because they failed to provide tools or mechanisms for sharing content. These sites provided media making tools, instructions, or resources to help kids create media without any tools or support systems for distributing or sharing that media with other users, or with the broader public. In addition to the multitude of websites excluded during the scan itself, another 107 sites (nearly half) were eliminated during the early stages of the content analysis. Although sharing was mentioned in the sites' descriptions, the sites themselves contained no built-in support for publishing and distributing content. In terms of design, "making" trumped "making and sharing" in the sites available for children.

The content analysis revealed a number of interesting trends. As an example we present some of the findings related to the display and support of community on the main pages of the websites: the very mixed visible representation of community, community activities (versus individual contributions) and support for community participation. A number of sites had some sort of *representation* of *community* participation, mostly in terms of displaying some users' shared content (65%), featuring individual user profiles (23%), and in a few cases showing the results of user polls (9%). However, even when other members' projects were shown, these were not often displayed in ways that made navigating them easy. Features such as tagging, following, or gathering sets of projects (for instance in a gallery) were rare. Further, more than a quarter (26%) of the websites surveyed did not display any community features at all on the homepage. About half of the sites featured some sort of *community activity* such as hosting competitions, contests or challenges (49%) or displaying group projects and collaborations (30%). Sites seemed to struggle especially with providing a means for providing *community support* to users. The most common form of support was user forums (44%), with a few websites hosting peer reviews, awards for user participation, or encouraging in-person meet-ups. Additionally, while most sites (69%) provided tutorials through recordings or embedded guides for users but lacked ways to support users socially. All of these findings show that a large proportion of children's DIY media websites are not well designed to support navigating projects, finding others, and building interest-driven relationships.

Overall the findings show that in many of the sites examined, sharing content with the public and sharing ideas with other creators were not sufficiently supported in the sites' designs. Since sharing and interacting with others is important to so many of the benefits associated with media-making, from the development of 21st century

literacies to children's cultural and communication rights, this omission is concerning. At the same time our research did reveal a few unusual sites that explored creative models to socially supporting children's media-making online, including a site that incorporated creative commons licensing, as well as a few sites that facilitated peer mentoring among users. This demonstrates a need for discussions with designers, businesses, and policymakers about supporting the development of richly designed websites for children's media making, sharing, and community. Providing a means and support for children to respond to authentic audiences, share ideas, and give and receive constructive feedback is important to truly making the most of the distribution channels available in social media.

Technologies for learning in library-based makerspaces

Erica Halverson and Mike Tissenbaum

Libraries have become sites for pushing the boundaries of informal learning. Once almost exclusively sites for accessing information, many public libraries are redefining their mission and core services as places for learning, creating, and sharing. The Maker Movement has proved a great catalyst for integrating engaged learning experiences into libraries; Britton (2012) describes makerspaces as, "a natural extension of library services" (p. 32). In a meta-analysis of the relationship between makerspaces and public libraries, Willett (in press) highlights shared core values including a DIY ethic, open access to peers and information, and an emphasis on attracting traditionally non-affiliated populations. It is within this context that we are conducting a two-year study with the public library system of a mid-sized Midwestern City to understand: a) How to make "making" a core service across the library system and b) What people who participate in the making activities and maker culture of the public libraries learn as a result of their engagement. Early findings from our ethnographic research have revealed three problems with addressing *learning* in the context of our library makerspaces:

- A focus on drop-in programs means that maker experiences are routinely introductory and therefore do not expect participants to connect experiences together;
- There is no mechanism for tracking individuals' work;
- Expertise is often contained within the drop-in program and very rarely persists beyond a single space or an experience.

Despite these challenges, library staff are motivated to create learning experiences for participants that are grounded in what we understand about how people learn through making (Bevan, Gutwill, Petrich, & Wilkinson, 2015; Peppler, Halverson, & Kafai, in press). As a result, we have worked together to design and integrate technological tools into a range of maker programs.

Connected peer spaces framework

The "Connected Peer Spaces Framework" (CPSF) is is a lightweight technology framework that logs an individual participant's presence (using either RFID or Bluetooth) in any makerspace within a network of makerspaces and tracks their current making activity as well as the growth of their personal learning trajectories and "maker skills" acquisition. Participants' data is represented in the space through a series of ambient dashboards situated in each of library spaces where maker activities occur. These relatively minimalistic dashboards show the real-time activities of the participants across all of the connected spaces, as well as the "maker proficiencies" they have developed over time and enable low-latency low-friction videoconferencing. These representations are designed for learners to be able to evaluate potential productive peers and easily connect with them. By providing this information CPSF attempts to answer the two main challenges described above: 1) Giving participants insight into the skills of their peers to help know who to reach out to when they need help with a specific maker-skill related problem (e.g., 3D Printing) and; 2) Giving them a sense of the broader making community of which they take part.

As part of this symposium, we will share our findings from the deployment of CPSF at a series of 3-day summer "maker camps" and through individual workshops at a range of library locations. We find a tension between participants' desire to be connected with others who are working with the same materials and tools as they are (e.g. Minecraft, knitting) but a strong distaste for being "tracked", something that the library has traditionally avoided. We are continuing to iterate the design of CPSF to afford connections, distributed expertise, and broader sense of community across the city.

Build in progress

We have also worked with libraries to incorporate Build in Progress into more extended maker activities. Build in Progress (BiP), a web-based-platform for makers to document and share their design process (buildinprogress.media.mit.edu). BiP allows participants to capture their personal experience of developing a project, including setbacks and changes over time. These iterations and communal commentary are visually organized using a two-dimensional tree structure. Since the BiP website launched two years ago, over 750 projects have been shared, ranging from "EL Wire Boots" to "Making Soda." The site has been developed iteratively, building on studies of how users engage in design processes and synchronous and asynchronous communication as the means to continuously develop BiP's features (Tseng, in press). The developer's investigations into how users understand their motivations for openly sharing their design process, the strategies they use to solicit feedback from other makers, and the role that visualization can play in encouraging reflection, parallel our work.

The emergent themes found in BiP research such as documenting-in-action (using process-oriented documentation as a dual planning and reflecting tool), vulnerability in sharing design process (in order to help others or seek advice), and documentation as its own form of creative expression and identity representation, are intimately connected to the challenges we have identified in the library makerspaces. Here we share the design features of BiP as well as our pilot efforts to incorporate the tool into digital making experiences at the libraries to scaffold iteration, ideation, and critique encourage participants to extend their making experiences over time and place. Bringing BiP to library makerspace settings combines the expertise of on-site experts and facilitators with documentation software that serves as an ongoing portfolio of project development. From a research perspective, the software environment allows the tracking of how the use of such software impacts makers' learning, development, and self-efficacy and the role asynchronous documentation might play in the makerspace environment.

Library makerspaces are one example of a growing category of "drop-in learning environments", where a persistent challenge is how to encourage participants to take ownership over their own learning. As learning scientists, we view learning as involving some kind of change - cognitive, behavioral, distributed, or sociocultural - where participants are different than they were before the experience. Furthermore, we believe that this change out to be documentable, something that can be shared with others. This research aims to create a sociotechnical system that both values change and provides opportunities for learners to document these changes in a way that doesn't betray the library's history of providing a safe space for patrons to access information without feeling tracked. We hope this research opens up a conversation about the role of technologies in creating opportunities for ownership over maker learning processes.

Designing for connected crafting: Using an online platform to support maker activities and communities

Breanne Litts, Yasmin Kafai, and Orkan Telhan

Much of the recent research on online DIY sites, participants, and activities has focused on understanding social dynamics, motivations and challenges in self-organized online or offline maker communities. Extensive surveys have examined what motivates members to participate and share projects in DIY sites and communities like *Instructables, Dorkbot, Craftster, Ravelry, Etsy*, and *Adafruit* (Kuznetsov & Paulos, 2010). Other have conducted more ethnographic observations to understand the contributions of experts in local maker communities (Milne, Rieke & Antle, 2014) or focused on motivations of how and why makers search for craft knowledge on the web (Torrey, Churchill & McDonald, 2009). The findings from these studies reveal that not only producing an artifact but also sharing the design process and final artifact with others are driving forces for makers' participation in DIY activities, spaces, and communities (see also Gauntlett, 2011).

Research on designing and supporting learning in educationally-oriented DIY efforts and makerspaces is just beginning. Most relevant to our efforts is the earlier design (and failure) of designing a web community, called *Lilypond* (Lowell & Buechley, 2011), that was intended to offer a home for designs made with the LilyPad Arduino. After a three-year run, the site had hundreds of e-textile projects of varying difficulty levels, but most of these were uploaded with very few of the interactions that make sites like *Ravelry* or *Instructables* not only repositories but also social networks of makers. It is not clear how social connections can emerge in the design of online DIY communities with an educational focus. So far most popular DIY online communities have evolved organically from makers' interests. While the communities use web portals to communicate and coordinate design activities, the platforms themselves do not deliberately address the needs for connected making such as allowing members to build on each other's work, share know how, and critique each other's design to foster new iterations.

We created a platform, *Ecrafting* (ecrafting.org), that affords multiple ways for participants to engage with one another around making: calls, circles, and projects (Telhan, Kafai, & Litts, in press). The platform facilities interactions among participants through *calls,* which are theme-based announcements for maker events,

activities, and challenges. This allows members across previously established groups to participate in each other's events either by attending in-person or discussing online. Moreover, the calls are mapped onto a timeline so that makers can anticipate upcoming events and plan new ones. The *circles*, a concept inspired by traditional quilting and knitting circles, can be created either by institutions who support structured curricular activities or by interest groups or individuals who organize informal gatherings.

Our design-based study investigated how aspiring makers can use the *Ecrafting* platform before, during, and after their activities to facilitate critique-style discussion around students' projects. We implemented a workshop with sixteen high school students, between ages 14-15 years, in which they designed a human sensor project using the LilyPad Arduino, an electronic textile construction kit. During the design process for their human sensor projects, we invited students to share examples of their initial project designs on *Ecrafting*. Three graduate students, who were enrolled in a more advanced in electronic textiles at a university in the western United States, gave online feedback to each project. The high school students continued to work on their projects and integrated the feedback they received where they felt necessary. When they completed their projects, they shared their final artifacts with a description on *Ecrafting*. In interviews after the project, even if students did not explicitly integrate the online feedback into their projects, they all reported that the feedback process was useful and valuable either serving as an encouragement, constructive correction, or creative suggestion for the future. For instance, Gannon, a student who remixed the triforce logo from The Legenda of Zelda, reflected on receiving online feedback:

> It was very encouraging actually. I didn't actually expect to get my work published online so that other people who honestly know more about this could see it. I thought it would just be in our little group every day at the [science museum]. It was definitely something that changed me... One of [the comments] was very encouraging saying that this is a great project and I should just keep going with it, everything is fine. The second one was saying that my wiring was confusing, and it was so I flipped the LEDs and I changed my wiring and it looks a lot better.

Here we saw the critical value that social interactions and feedback can provide to aspiring makers. The design of the *Ecrafting* platform connected online and offline maker activities. After completing a few of these types of user tests, we began to redesign the platform to support specific forms of interactions, namely, sharing and critiquing maker activities. The redesign is an ongoing effort we are testing with nine graduate students enrolled in a maker studio course at a university in the northeastern United States. We are adding and testing several new features, but here we highlight *project sharing* and *project iterations*. From user testing, we learned that there were too many obstacles preventing users from submitting projects in response to calls, so as part of the redesign we are streamlining this process and allowing new users to respond to a call with a project even if they are not part of a circle. Originally, we designed *Ecrafting* to start locally and expand or continue online, but we identified a need to better support participation that begins online. Moreover, we realized that if we wanted to support dialogue around projects, then we needed to allow users to easily submit multiple iterations of a single project, so that they can report their progress and continue receiving feedback. We want to make sure that an online platform for a maker community can function not only as a repository, but also as a social networking forum in the process of making.

Maker portfolios: Documenting and assessing making

Anna Keune, Kylie Peppler, Stephanie Chang, and Lisa Regalla

> *T-shirt tucked into jeans, Elliot leaned over Jabari's computer screen pointing at the village he discovered in the networked virtual reality game that they and a handful of other makers were engaged in. When documenting his digital making, Jabari augmented screenshots of the village with words: "I feel that everybody contributed equally because we split up the work."*

Encouraging peer-reflection of learning through artifacts and evidence of learning is a key catalyst for learning environments that foster critical literacy skills (Hetland et al., 2007). This is closely tied to the interest-driven, production-based learning that can be observed when youth make together (Peppler, 2014). More than 20 years ago, Niguidula (1993) convincingly presented the need for showing the richness of a person's accomplishments, work, and learning beyond standardized test scores, suggesting that digital portfolios that emphasize student work in context and engender an understanding of what it means to be a graduate could provide this richer picture. Today, the work on portfolios gains new traction in the context of making and youth-serving makerspaces as makers' portfolios become important parts of both higher-education and job admissions processes outside of the

art and design tradition (Byrne & Davidson, 2015). With makerspaces serving socio-economically diverse youth (Peppler et al., 2015), espousing maker portfolios promise to broaden access to economic and educational opportunities. What youth document today can dramatically shape their access to diverse opportunities in future phases of their lives.

To broaden our understanding of high-quality maker portfolios, what they may include, and how they may be assessed, we conceptualize maker portfolios as a portfolio *system*, in which makers maintain control over content and curation. Challenges for youth to create maker portfolios pertain to policy, practice, and tools. Although we know that learners achieve best when their learning is connected across multiple settings (Ito et al., 2013), we observed that youth are often disenfranchised from their work, with artifacts stranded in systems owned by schools or in platforms that do not allow for easy or automatic migration over time. Additionally, in the flow of making, makers often want to keep doing what they set out to do, rather than pause for documentation. This places a core tension on balancing automated and manual documentation with least disruption of making and just enough data collection. These challenges are connected to hardware and software challenges to build on the mobility of making. Among others, these challenges prevent youth from creating rich portfolios of their learning and from prompting assessment that could make the youth's accomplishments relevant for future life phases. To understand successful portfolio practices and assessment, we ask: What practices and types of portfolios lead to high quality documentation of making and promote the assessment of rich learning?

To answer this question, we observed the native portfolio tools and practices of two makerspaces that have exceptional portfolio practices in place. Through synchronous and asynchronous engagement with the makerspaces, we selected youth who were particularly engaged in portfolio creation, observed the digital portfolios of the selected youth, took snapshots at regular time increments, analyzed changes in their documentation over time, and observed their practices on site. To triangulate and complement the observations, we conducted interviews with parents of the focal youth and makerspace educators. The interviews included questions related to adult support for documenting, values of portfolios, and hypothetical questions for parents and educators to imagine themselves in the role of an admissions officer assessing youth portfolios.

Looking across observations and interviews, we identified two intersecting axes in relation to which we characterize and highlight maker portfolios and the assessments they prompt. The axes stretch from collaborative to individual making and from collaborative to individual documentation. While all portfolios gave youth a chance to present their products and processes of making, some painted a richer picture of learning than others. Individual making, paired with individual documentation, frequently focused on reflection of the technical aspects of making rather than rich insights that sprang from peer interactions. This was contrasted by individual portfolios that captured making done collaboratively. Here, technical process reflections were often augmented by displays of how small groups of makers worked together and contributed to projects, prompting answers to questions about how well a prospective candidate might fit into the culture of a college program or work place. This addressed challenges of assessing collaborative making that is documented collaboratively, namely the uncertainty of one individual's contribution to the group's work. While the makerspaces we profiled offered youth the opportunity to create their own personal websites to document making, spaces also integrated the individual sites into a collage of youth projects, representing the collective learning of the space to outside viewers. This gives potential employers or higher education institution admissions officers the opportunity to see a youth's portfolio in the context of the overall work done at the applicant's affiliated makerspace. In the nascent maker movement, where definitions of making expertise diverge, our findings point to the need to take a broader look at assessment, one which encompasses ongoing and casual everyday practices by adults and youth at makerspaces. Specifically, our work also points to the importance of collaboration in making as a way to lead to higher quality portfolios that prompt assessment of the rich learning.

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