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DESIGNING LEARNING PATHWAYS IN A COMPLEX LEARNING ECOLOGY: A RESEARCH-PRACTICE PARTNERSHIP FOCUSED ON PARENT BROKERING

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In this chapter we describe an exploratory, design-led research project to align a top-down learning innovation and improvement agenda (to support youth-centered, interest-driven learning pathways) with the needs and interests of a local community-based creative arts and technology organization. To negotiate alignment of stakeholder priorities and values, draw on theoretical learning sciences research to inform practice, and to guide us toward productive innovation, we turned to a participatory, design-centered process to enact theory and creatively synthesize multiple perspectives for action. Our claim is that design-led modes of inquiry are especially needed to respond to ambitious visions of educational transformation and funding directives, which leave much unresolved detail to be determined and realized by local practitioners, leaders, and learners. Our case study provides one example of this kind of design-led learning innovation that builds on and extends our understanding of interest development, and describes its local application in a series of design probes to support forming and deepening interest-driven learning pathways for youth.

A growing body of empirical research takes ecological perspective to account for the dynamic nature of learning that evolves across the multiple and diverse settings in which youth spend their time (Brofenbrenner 1979; Barron 2006; Banks et al. 2007; Bricker & Bell 2014). A related line of learning research emphasizes the critical enabling roles adult and peer relationships play in supporting youth learning and interest development (Barron et al. 2009; Weiss & Lopez 2015). Interest formation itself is highly contextual and deepens through socially supported "lines of practice" that span contexts and enable identity formation in culturally valued life activities (Hidi & Renninger 2006; Azevedo 2011; Järvelä & Renninger 2014). Rather than examining learning in episodic encounters in

settings, researchers are now thinking about designing for "connected learning" where learning experiences fit together to form coherent, interest-driven learning pathways that sustain and develop into the future (Ito et al. 2013; Sefton-Green 2016). This broader ecological view of youths' learning lives has led to calls for a more coordinated and intentional brokering of interest-based learning opportunities for youth across time and place (Rosenberg et al. 2014; Ching et al. 2015; Russell et al., under review).

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An expanded view of youths' learning lives has inspired the implementation of new intervention approaches such as a set of regional City of Learning[1] initiatives to build and study coordinated ecologies of opportunity through networked infrastructures, programs, and platforms that seek to equitably open learning pathways for youth to pursue and deepen their interests across settings (Barron et al. 2014; Pinkard 2015). In our region, the learning pathways agenda has been shaped in part by a local backbone organization and associate network of organizations.[2] To support this effort, a local foundation funded a university-based research team of "design fellows" to collaborate wit a set of local learning providers to interpret and support efforts to create learning pathways of opportunity for youth.

Our case study focuses on one of the design fellows (the first author) who was embedded in a community arts with technology organization. The case describes how a participatory design process enabled a professionally diverse team to first reckon with multiple perspectives on what constitutes valued learning, and to collectively define and ground the abstract concept of learning pathways in ways that are locally relevant, valued, and actionable with respect to learning providers, youth and their families

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Case Study in Design-Led Learning Innovation Research

How do families, mentors, and caring adults in youths' lives identify learning opportunities and help youth make choices that cultivate the development of their individual interests? How can we help families interpret complex citywide learning ecosystems in ways that make learning pathways apparent?

To better understand how families navigate Pittsburgh's informal learning ecosystem (the physical, social, and culturally situated sites of learning locally available) and broker learning opportunities for their youth, our research-practice partnership focused on the decision-making criteria that families and adult caregivers use when choosing out-of-school experiences for their children. In particular, we explored how parents and mentors find, value, and encourage children's participation in creative technology and maker-based program offerings. The framing of this study emerged through a participatory process where stakeholders engaged in learning design are positioned as co-creators and included from the inception of the project through data analysis, interpretation,

AU:2 **FIGURE 8.1** Moving from a Program-Centric to a Learner-Centric View of Opportunities

and dissemination activities. The founding director of a local informal learning provider (ASSEMBLE),[3] her teaching artist staff, and the volunteer board were included in problem formulation and goal setting for the design of this study, as well as in the data synthesis and presentation of findings at professional and academic conferences.

As with many nonprofit organizations, ASSEMBLE has the perennial goal of increasing the recruitment and participation of youth in its programs, and in particular reaching the underserved community in its immediate neighborhood. The organization uses its website, associated social media channels, tabling events, paper fliers, direct mailings, and word-of-mouth reputation as the primary strategies for raising awareness and interest in programming.

To address ASSEMBLE's goal of increasing and broadening participation in their programs, we wanted to better understand how families navigated the so-called Pittsburgh learning ecology of out-of-school time (OST) programs—such as summer camps, weekend workshops, after-school activities, and weekend family events—and selected these opportunities for, and with, their children. In particular, we sought to understand how adults decided to encourage (or not) children's participation in creative technology-rich programs (e.g., robotics, digital media production, coding, and maker activities) being offered around the city.

Study Design and Methods

Our research questions and study design sprang from a collective problematizing process where the expanded research-practice team engaged in facilitated discussions over several months in order to surface organizational challenges and opportunities. Moreover, we were able to identify key problems of practice related to the regional charge to develop learning pathways as part of the Pittsburgh 2014 Cities of Learning[4] initiative. Much conversation centered on the challenge of reaching parents and recruiting underserved youth in ASSEMBLE's economically distressed neighborhood. The team decided to focus our design research efforts on better understanding how families choose to participate in informal learning activities.

Parent Way-Finding in a Complex Leaning Ecology

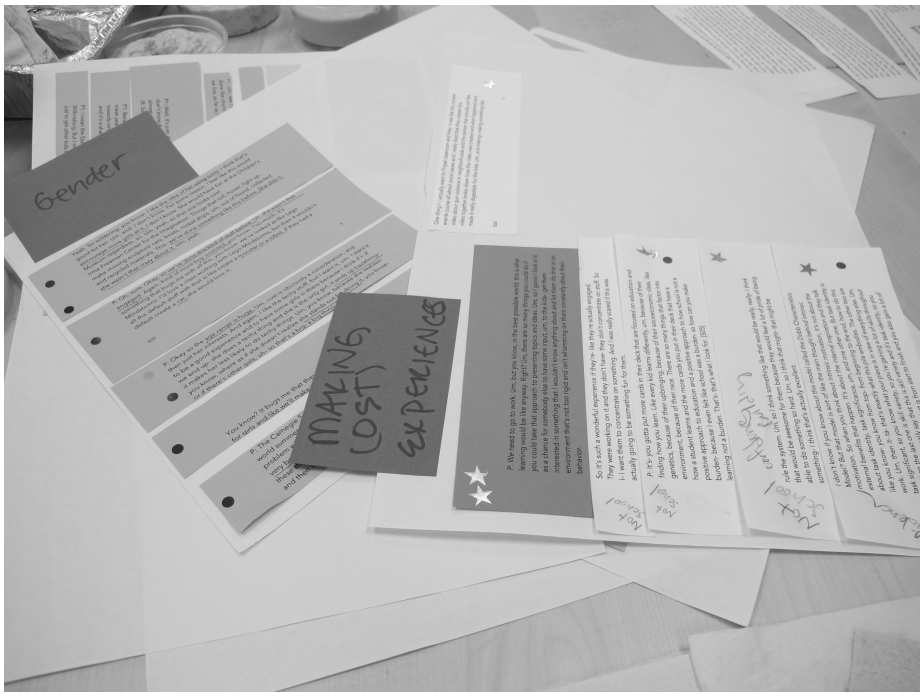
To reframe this challenge as a learning research design question, we developed and piloted a parent way-finding study to (1) understand how parents and supporting adults in youth lives become aware of organizationally hosted informal learning opportunities for their children (i.e., characterize their information-gathering needs and habits), and (2) identify the decision-making criteria that families use when choosing technology-rich programming with their children. We used a mixed-approach to examine how supporting adults (i.e., parents, mentors, caregivers) find out about creative technology programs, and surveyed various pragmatic and logistical factors that might influence their decision to support a youth's participation in a program.

For the study 10 adult caregivers were recruited from two ASSEMBLE programs: "Learn to Scratch" and "Make It," both aimed at preteen audiences. These adults included parents as well as two mentors, and one parent-child combination also participated. Of the participants, four were male, six female, and four were of African American decent. These caregivers were invited at drop-off and pickup times to engage in a program flyer think-aloud & sort activity, where they told us what they were thinking as they read through 10 short program descriptions (robotics, digital media making, robotics, scratch programming, and maker activities) offered by various informal learning providers around town, including museums, community organizations, arts groups, and after-school programs. Adult participants then sorted these programs descriptions into "likely," "maybe," and "unlikely" piles and described their reasoning for these selections out loud. In addition, participants responded to a semi-structured interview about their child's interest areas and how they find and select informal learning programs, and they were asked to describe their family's approach and philosophy to informal, out-of-school learning time. All the interviews were audio-recorded and transcribed. We then analyzed the data in two rounds, first with researchers and ASSEMBLE staff in a Data Synthesis Workshop described next, and then in a second round where the research team identified and collapsed thematic categories in the dataset.

Data Synthesis Workshop

As a vital step in the co-design process, the researchers and ASSEMBLE staff worked together to review and make sense of the parent interview data. This workshop activity enabled us to listen closely to parent concerns and priorities, jointly synthesize and identify patterns in the data, and finally to discuss the implications and design opportunities. Five members from ASSEMBLE participated, including, teaching artists, the director (second author), and a volunteer board member together with the research team in a three-hour workshop session. For the workshop, each participant was given an envelope containing excerpted comments from the full parent interview transcripts presented as color-coded strips of paper. Initially unknown to participants, the color codes were related to parent gender and ethnicity.

First, the group individually went through each parent interview transcript (edited only for off-topic chat and process comments) and used green dots to mark positive statements and red dots to mark negative ones. Each participant was given a set of silver stars to call out particular quotes of interest they wished to discuss with the group. This seeded the next activity, where we began a visual clustering exercise to group comments into categories, first reading them aloud, then moving them into groupings and labeling them. After formulating high-level categories, we revealed the gender and ethnicity color-codes to check for any visually prevalent clusters of parent talk based on these demographic factors.



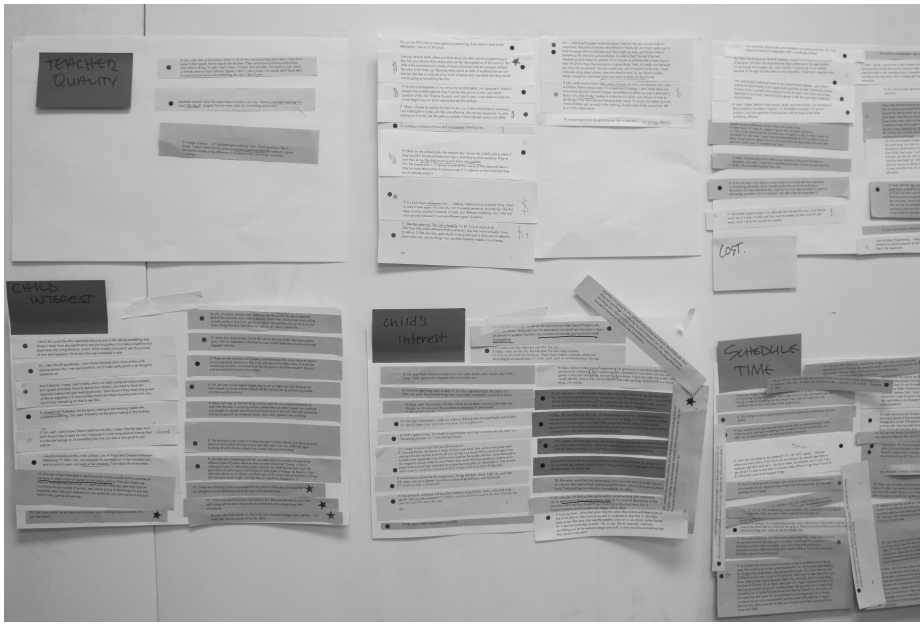


FIGURE 8.2 Images from the design workshop activity showing the color-coded transcriptions, coding and examples of shared categories generated during our discussion of parent talk

Design Research Findings and Insights

Our parent way-finding study highlighted the important enabling role adults play in supporting youth participation in informal learning opportunities. In particular we see evidence of the "learning broker" role (Barron et al. 2009). In Barron et al.'s typology, a learning broker "seeks learning opportunities for children by networking, the Internet, peer networks, and other information sources. This adult signs a child up and provides necessary support for endeavor." In our interviews we saw this brokering role articulated as fourfold: logistical brokering (e.g., transportation to a site, registration), financial brokering (program fees, bus fares, material costs), transactional brokering (tapping personal networks for opportunities, recommendations, reviews, and advice), and sourcing/vetting forms of brokering (searching for appropriate high-quality programs, activities and events).

In survey questions, we asked adults to weigh the relative importance of six factors influencing the selection of informal learning opportunities for their children: ease of getting there, cost of program/event, when offered (schedule), where held (location), hosting organization, and activity focus. These program factors were ranked on a scale of 1–3, with 1 being not important, 2 being somewhat important, and 3 being very important. Parent participants rated, on average, all six factors as at least somewhat important, with location of the organization hosting the program scoring the lowest in terms of relative importance. Cost and ease of getting to a program ranked slightly higher in terms of relative importance.

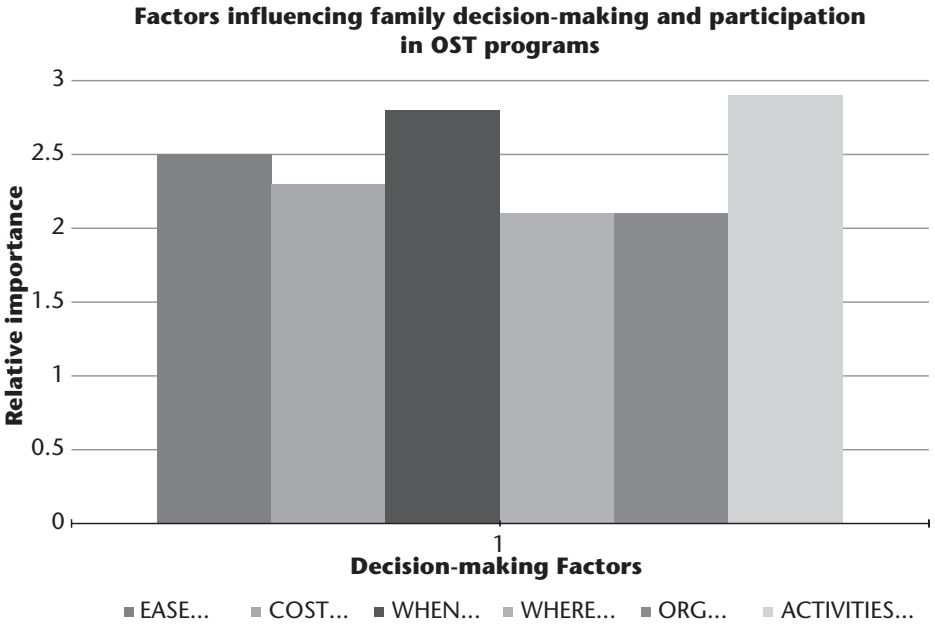


FIGURE 8.3 Relative importance of factors influencing OST program participation (n=10)

Participants indicated the most important factors influencing their support for a child's attendance in a program revolved around when a program was offered (scheduling), ease of getting there, and program activities. The program activity focus was consistently selected as very important by both parents and adults mentor participants.

Our analysis of interviews and think-alouds from the adult brokering study provided insights into why adults rated the program activity focus as very important, and shed light on the considerations parents weigh when choosing an informal learning activity for their child. Not surprisingly, we found that a common sort criterion adult caregivers used to judge the appropriateness of a creative technology program was their perception of a child's interest in the topic.

Interest-Brokering Considerations

At the heart of much of the parent talk we heard was a deep concern for cultivating children's interests through informal, out-of-school learning experiences. Parents of primarily tween-aged youth frequently mentioned they would have discussions and involve their child in the decision-making. We coded for these interest considerations and found that parents described interest in terms of four distinct dimensions: matching, exposing, expanding, and deepening.

A. Matching interests

When reviewing program descriptions, many parents first scanned the copy for interest matches. They used words like "my kid likes or doesn't; is interested in or into" to quickly weed through program descriptions and assess programs fit for their child:

> So the first thing I always look for is anything science related because when it goes into anything just straight art related, they kind of pull back from it, but if it's tied with something science for whatever reason, that's their gateway into anything. [Father (S09) / Son, age 12]
>
> . . . Intro to Video Game Programming, um, I think just from the description, he would be interested in that. So almost no question that this matches his interests and would be worth investigating. [Father (S02) / Son, age 13]

B. Exposing to new interests

A second form of interest brokering talk we heard from parents revolved around exposure, and the need to provide youth with opportunities to find and explore new areas of potential interest by introducing them to unfamiliar topics and contexts, and giving them access to different kinds of tools, materials, and forms of expertise. There was an admittedly coercive attempt to encourage youth to move outside their comfort zone to discover and develop new interest areas. We heard this exposure-seeking talk most frequently with mentors and our African American parent participants:

> She says she just wants to sketch. But I want her to be exposed to a list of, a lot of different mediums, lots of different types of art. And again, I know the importance of the STEAM education initiatives and I'd like her to be exposed to that in a way that's interesting to her. [Mother (S08) / Daughter, age 12]
>
> I would love to get involved with these organizations and introduce them to the tech world, introduce them to the making world, introduce them to art, introduce them to everything. But if it's not affordable . . . [Mentor (S04) /Son, age 11]

C. Expanding an existing interest

A third category of interest brokering talk involved using a youth's expressed interest in one affinity area to expand interest in another. Parents talked about using a child's existing interest as a hook to pull them into trying out a related but unfamiliar activity. We also heard parents wanting to use a strong interest to broaden or shore up learning in a perceived deficit area. These caregiver comments often centered on taking a youth's interest in computers or video games

and trying to bend that interest toward a more "productive" or creative output through a game design or coding class, or by connecting a youth's interest in art to technology though STEAM kinds of programs.

> So this would be really interesting Introduction toVideo Game Programming because they're interested in programming and they always talk about doing it for video game stuff. But they never make the connection between the two. So that one I'm drawn to just to give them a real sense of what it actually would take or be like. [Father (P09) / Son, age 12]
>
> She's interested in crafts, art, science, drawing sketches specifically and so forth . . . . and learn about the chemistry behind the awesome printmaking process. So it's art and science, which I think is good for her because art is just like the perfect avenue for her to start learning, you know, about more science and advanced science and technology. [Mother (S08) / Daughter, age 12]
>
> So he's interested in computers. I mean we tried to steer him towards more the producer-producing stuff, as opposed to just consuming it. [Father (S07) / Daughter age 7, Son age 10]

D. Deepening an interest

A fourth interest brokering category of comments centered on finding ways to support deepening an area of interest. Families were looking for, and often not finding, informal learning opportunities to "level up" and build on emerging creative technology skills and talents. Parents expressed frustration at not being able to finding stepping-stones on which to deepen and extend interdisciplinary digital making, coding, and technology-infused interest areas.

> [My child] has learned Scratch, that will definitely be something that we try to do continuity on things that he's already done. The question would be—whether or not it's at a new level—if it's a beginner level that he's already done, he may not want to do that and look for something that's more advanced. [. . .] So looking for the continuation of the next level up is one of the things that we look for, for sure. [Father (P09) Son, age 12]
>
> The electronics stuff there . . . you do it once and you're done with it. [Mother (S05) / Daughter, age 11]
>
> They've taken one and then another and it's been too similar to the thing they already did, so it wasn't very excited because they already learned everything they were gonna learn out of it. They needed the next level. [Father (S09) / Son, age 12]

Lastly, the data synthesis workshop marked a turning point in the embedded design fellow's relationship with ASSEMBLE, as it helped convince a somewhat

skeptical staff about the value of research activities and the use of "data" and evidence to uncover new opportunities; and it helped built trust in the interpretation and authenticity of the findings. Subsequent to this workshop event, the research team was more frequently included in internal e-mail chains with staff members, and invited to a broader set of ASSEMBLE board meetings and planning activities. This trust-based relationship was vital to productive research-practice collaboration.

Design Implications and Probes

Communication Design Issues

As parents read through program descriptions several communication design issues were noted. Parents appreciated graphic treatments in the copy that boldly called out date, time, age, location, and cost information that could be gleaned in quick scan. Not all program descriptions clearly stated age ranges or limits. And when an age was listed, adults also questioned whether participation in a technology-related offering should be strictly based on age and not competency. In several cases parents had to reread copy to determine if a program was a one-off event or a series, and guess at whether "drop-in" or partial participation was allowed. To address these communication issues, providers could indicate whether a program is an open studio arrangement that can support learners at different skills and ages, or instead follows a more planned curriculum intended to move a cohort along a set learning progression.

With regard to program descriptions and copy, the use of jargon can be a double-edged sword. Terms such as "tween," "making," "STEAM" and "hack" can be appealing, and indicative of a certain kind of cultural affiliation to those who recognize it. But several parents were put off by the use jargon, and tripped on unfamiliar and insider terms that resulted, in several cases, in parents rejecting a potentially appropriate program for their child. Parents also honed in on the specific description of the activity to determine whether the experience would be worthwhile in terms of offering something special or fun. Parents commented positively when activities seemed unique and provided access to novel materials, specialized tools and expertise, or offered hands-on learning opportunities not available at school or home. More than organizational reputation, university affiliated "brands," such as MIT SCRATCH and the CMU CREATE Lab's Hummingbird, were noted by several parents, and these names seemed to function locally as a seal of approval for technology education programs. Having somewhat consistent and related programming strands from one semester to the next also helps parent find and fit programs around seasonal constraints and future schedule expectations. Lastly, parents often tried to gauge the likely expertise and instructional talent of the staff who would be facilitating the programs.

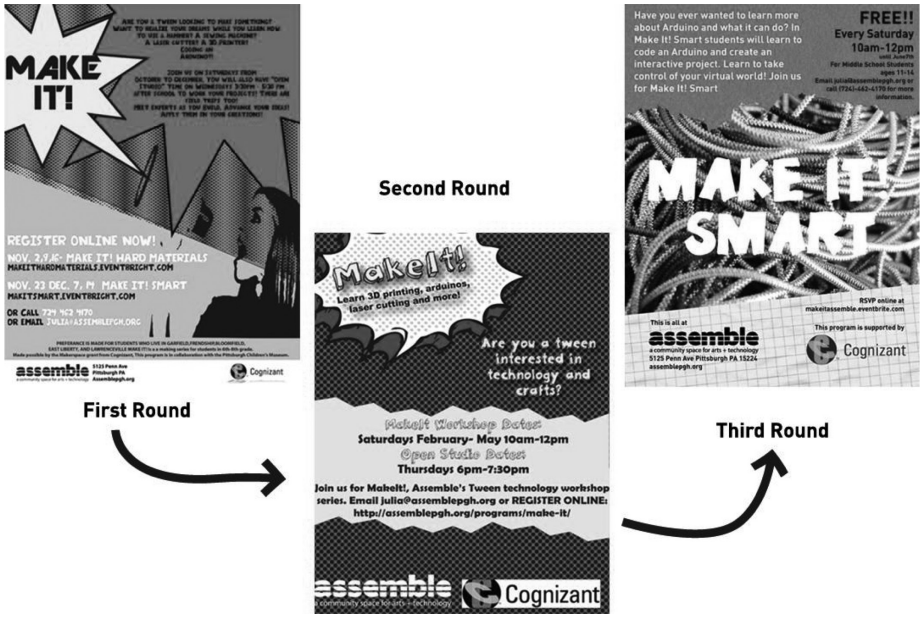


FIGURE 8.4 Design Probe 1: Refining key information callouts, and reducing jargon in program communications.

With ASSEMBLE staff, we piloted simple design probes such as making intentional changes to copy in communication materials (web descriptions, print flyers), minimizing insider language, and clarifying jargon to improve communications with parents and students. At staff and board meetings, we presented our findings, including the important role of interest brokering and how adults use interest matching, exposing, expanding, and deepening as key decision criteria when choosing informal learning opportunities for their children.

We then discussed suggestions for how this adult role in interest brokering might be used to improve communications and the understanding of learning pathways. Ideas generated during these meetings included communication strategies ASSEMBLE staff could engage in, such as talking directly to families about a youth's interests at community outreach events instead of just promoting the particular programs that ASSEMBLE is trying to "sell." Communications could describe how OST and enrichment activities are important for youth to exercise creativity, build technology fluency, learn hands-on skills, and deepen interests, all of which can have positive academic, civic, and vocational impacts. Other hooks and value propositions include reminding parents that ASSEMBLE is a place and a community in which to develop a creative arts, technology-savvy maker identity and network with a supportive community of practice. Communicating this character of the space, and connecting youth with local and online communities of practice, would entail rethinking communications with an intentional focus on connecting youth interest with opportunities—a move that we talk about next.

Family Engagement Design Opportunities

Starting from our interest brokering findings, the team set out to develop a set of design probes for ASSEMBLE's "Make It" and "Gotta Scratch" digital fabrication and media-based coding programs. We prototyped two new kinds of parent communication formats, and explored ways to connect families to future learning opportunities and events for their youth. We also worked with program facilitators on ways to flag and share relevant online opportunities to encourage youth's emerging and developing interests.

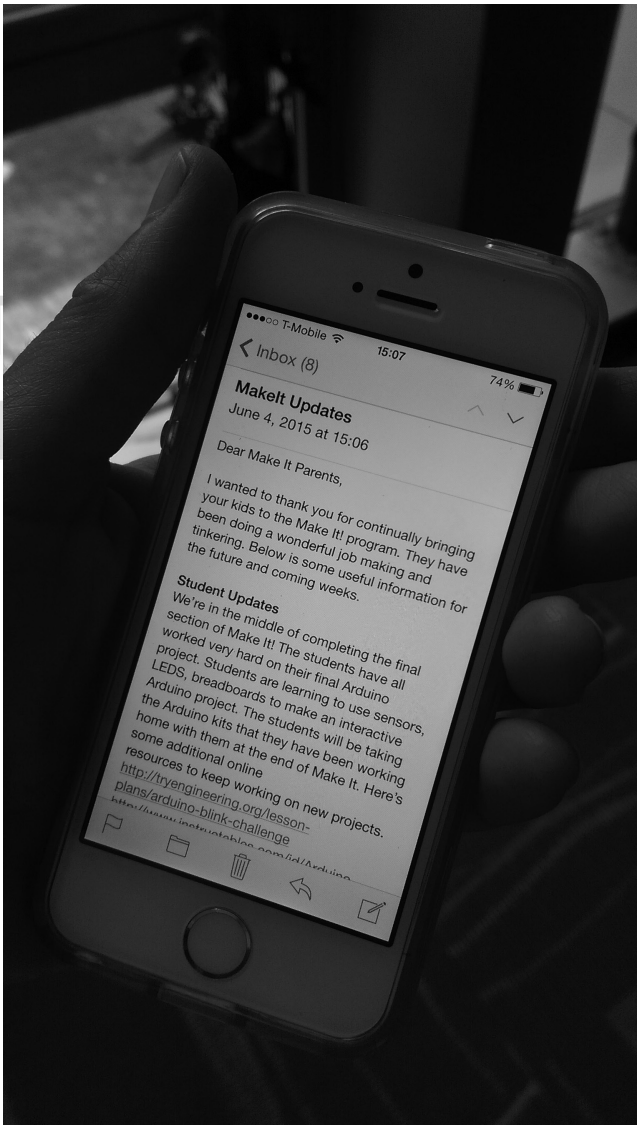


FIGURE 8.5a Design Probe 2: *What's Up* and *What's Next* Messaging to Parents

FIGURE 8.5b Design Probe 3: Reframing Conversations around Interest Brokering at Family Engagement Events

To be good learning brokers, adults need ongoing ways to remain aware of their children's evolving interests and strengths, find resources, and develop networks of learning supports to encourage those interests and associated skills development (Rosenberg et al. 2012); they require technology supports that fit seamlessly into the family's existing communication practices (Lewin & Luckin 2010). With this in mind, we piloted "What's Up" and "What's Next" communication probes with adults during the Make It program to offer learning supports. We began by surveying adults as to whether they wanted these kinds of communications, and what type of content and formats they preferred. Our goal was to brief adults in person (at pickup) and via messaging (e-mail/text) to provide insights on what children enjoyed, gravitated toward, shined at, and where they might go next in terms of other programs, resources, and events happening around town. We e-mailed adult caretakers activity updates, and created a youth-facing blog for the program with curated, safe, high-quality online resources and community sites that instructors frequented, so that youth could continue use the technology (e.g., Arduino kits) in new projects and find online support once the program was completed.

Another touchstone idea we used to help focus the organization's work around learning pathways was to view ASSEMBLE program experiences as part of a larger "cycle of engagement" (Goffman 1963). This perspective reminded the program design team to consider holistically not only the program activities, but also the beginning phase (awareness and attraction phases of an engagement) as well as closure and "what's next" transitional moments following an informal experience. This cycle of engagement framing also moves us from a provider-centric

to a more learner-centric focus that strategically considers how children develop, nurture, and grow an interest.

We discussed goals and engagement approaches for community tabling events that would focus on learner-centric interest brokering, rather than a program-centric recruitment frame. Our interviews suggested that matching, exposing, expanding, and deepening considerations operate as key factors adults use to select informal learning program opportunities for their youth. At outreach events, ASSEMBLE staff began to talk to parents about their youth's interests in these terms, as well as open up discussion about learning beyond school walls. Other communications materials contained information and invitations to ASSEMBLE's upcoming Youth Showcase, local open studios, a Youth Maker Night event at the Children's Museum of Pittsburgh, and a sponsored invitation to a Maker Event in Detroit. The goal of these communications was to help families find places, tools, resources, and learning environments that allow children to experiment with creative activities aligned to their interests.

We brainstormed with ASSEMBLE staff other ways to be mindful of the rhythms of family life and discussed adding calendar reminders about public school in-service days to the internal calendar, and adding reminders to start the summer camp marketing push in February, when working parents start to commit to camps for the summer. Other ideas included offering pop-up maker programming on snow days for busy working parents. We also considered more conceptual ideas such as starting to think about the organization not just as a provider of programs, but also serving as a guide and way-finding resource that supports a learner's journey. ASSEMBLE already functions to some degree in this way, with an enticing table of flyers with hip-looking events and programs, promoting not just their own programs but citywide opportunities as well (Figure 8.1). This lightly curated set of STEAM activities around town is a useful resource for youth and families to discover, and something parents told us that they wished existed more formally online in a centralized resource of informal learning opportunities and interest pathway guides.

Conclusion

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Pathways in youth sports and performing arts have, in many ways, mastered the learning progression aspects of program design and parent communication with clear skill development trajectories and participation structures that grow with interest, age, and competency. However, in relation to creative digital making and technology programming, we heard repeatedly from adults that the next steps for children who had completed a program were lacking, hard to find, redundant, and did not "level up" as kids grew. Our small sample reflects what is perhaps a larger issue in youth informal learning programming: it is often fragmented, redundant, and potentially "dead ended" (Kehoe, Russell, & Crowley 2016). AU:4 Adults were voluble about how hard they had to work to help their children find

appropriate learning pathways to deepen skills and interests. Furthermore, this highly structured parental approach to enrichment and "concerted cultivation" of youth's informal learning activities also tends to correlate with higher socioeconomic status (Landau 2003; Putnam 2015). We know from research that, when adults are able to broker learning opportunities successfully, it can be life-altering for the youth (Crowley, Barron, Knutson, & Martin 2015). But for adults to play that critical role, culturally appropriate and socially appealing on-ramps to learning pathways must exist and be evident, when decisions are being made about how and where youth spend their time (Martin et al. 2015).

"Unhiding" learning pathways will require a regional set of learning providers and communities to intentionally organize and make interest-driven learning pathways visible and navigable to youth and adults. This exploratory learning design research highlights the ways in which adult caregivers operationalize interest in terms of matching, exposing, expanding, and deepening—and use these features of interest development to way-find and broker learning opportunities for their children.

In conclusion, our work suggests three sources of design inspiration:

1. Parents and supporting adults in youth lives play a vital role in brokering appropriate learning opportunities for children.
2. Adults struggle to navigate complex and fragmented learning ecologies to find places, tools, resources, and social networks that will allow youth to experiment with creative, technology-infused activities aligned with their interests.
3. Learning brokering requires a solid, ongoing awareness and insight into a child's specific and evolving interests (and skills), as well as trusted guides to link those interests to appropriate opportunities.

Reflections Design, Learning Research, and Educational Innovation

The call for design, or design thinking, in learning research is not new. Against the backdrop of student uprisings on college campuses in the late 1960s, Joseph Schwab, a progressive 20th-century educational reform scholar and noted raconteur, expressed deep frustration with the ongoing failure of educational research to effect lasting change. He specifically blamed the fragmentary and incomplete nature of contemporary educational theories, and pointed to the inability of applied research to effect positive change. Schwab believed moving educational research and practice forward would require paying much more attention to what he called the eclectic and practical arts of deciding and doing (Schwab 1971). The "Eclectic Arts" are the means by which theory and insights are selected and readied for practical use through the arts of polyfocal conspectuses, integration, and framing. By "Practical Arts," Schwab references the arts of perception, problematization, prescription, and commitment that enable groups to decide what to do. What Schwab was describing was the need for what we might call design today.

Design research and practice at its most ambitious seeks to be the integrative 21st-century discipline that combines the eclectic arts of finding, selecting, and synthesizing multiple perspectives and theories with the practical arts of seeking to perceive, formulate problems, deliberate on solutions, and take planned action (Buchanan 1992). Since Schwab's time, design as an inquiry approach, an array of methods, and a set of disciplinary commitments has increasingly surfaced in educational research discourse and practice. In the early '90s Ann Brown and colleagues began to call for situated design experiments (Brown 1992; Collins 1992; Design-Based Research Collective 2003) as a way to make learning theory more sensitive to the particulars of real-world conditions, enable a methodologically grounded process for reformulating questions, and make design changes in response to findings that emerged during the research process. The field has since continued to explore disciplinary connections between design and research (e.g., special issues of *The Journal of the Learning Sciences* [Vol. 13, No. 1, 2004) and the *Educational Researcher* [Vol. 32, No. 1, 2003]), debating the complexities, fuzziness, and slow theoretic yield of design-based research in applied, practice-oriented settings. "Design" in learning sciences has become a term that signals a practice-oriented research agenda that will intentionally adapt and evolve in response to iterative design challenges to the learning intervention or object under study.

In 2011 Penuel and colleagues began advocating for design-based implementation research (DBIR), to address the challenges of effectively scaling successful educational programs. DBIR draws on participatory design traditions, with its roots in Scandinavian workplace democracy movements, as a means to bring about a more grounded and inclusive research process to large-scale implementation projects (Penuel et al. 2011) The DBIR model emphasizes the need to focus on "persistent problems of practice" that often thwart efforts to scale and sustain policies and programs in education. Participatory design methods and approaches are called upon to enable greater stakeholder involvement, elicit tacit issues, and give problem-solving agency to a broader set of affected actors in order improve teaching and learning as well as the culturally sensitive "infrastructuring" of learning systems (Simonsen & Robertson 2012). Equity-oriented researchers push even further, calling for the positional and relational work involved in design-based interventions to be made explicit so to reveal underlying power and racial dimensions in the research-practice endeavor, and furthermore encourage researchers to be more fully open to community-valued definitions of learning (Vakil et al. 2016). AU:8

Our case study follows in a participatory design tradition and contains many of the practical theory-testing features associated with design-led research. However, we think of this work primarily as an example of participatory design informed by the learning sciences, or a form of research-based design. Design is a form-giving mode of inquiry that strives to democratically involve users in a full innovation cycle that includes shared problem-finding (envisioning) and defining (framing) and continues through project realization and engagement in outcomes. In doing

so, design shifts the role of stakeholders from informants to participants in the design research process. For research on learning, we believe that a participatory design-led approach offers a strong set of disciplinary practices to reckon with multiple value-laden learning goals, wrestle with the application of incomplete or fragmented theory, and finally to help ground sweeping visions of educational change that speak only partially to the complex, locally situated learning design problems at hand.

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1 https://hivelearningnetworks.org/; http://:://lrng.org/cities
2 http://remakelearning.org/
3 ASSEMBLE is a creative arts and technology organization that serves the community as an OST provider of semi-structured STEAM learning programs, youth maker space, multi-use events venue, and gallery curating the work of local artists. www.assemblepgh.org
4 Learning pathways were part of the 2014 *Cities of Learning* initiative in Pittsburgh; http://hivepgh.sproutfund.org/about-hivepgh/welcome/

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