Probing participatory partnerships: Equitably-consequential making by, for and with marginalized youth

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ABSTRACT

In this paper we investigated the role youth participatory ethnography played as a pedagogical approach to supporting youth in making. To do so, we examined in-depth cases of youth makers from traditionally marginalized communities in two makerspace clubs in two different mid-sized US cities over the course of three years. Drawing from mobilities of learning studies and participatory frameworks, our findings indicate that participatory ethnography as pedagogical practice repositioned youth and making by helping to foreground youths' relationality to people, communities, activities and timescales in collaborative, critical and connected ways. This pedagogical stance centralized co-making (including the co-production of design problems and solutions with a wide range of stake holders across setting and time). Three pedagogical principles emerged from analysis of these two interrelated findings: Participatory ethnography as pedagogy 1) emphasized youth participation, not just as respondents, but as people who contribute to the research by bringing in their concerns; 2) situated knowledge production within local contexts in decolonizing ways, and 3) contributed to the improvement of conditions for youth. We conclude with a discussion of how these pedagogical principles can inform the equity agenda in making.

CCS Concepts
• **Social & Professional Topics** **User Characteristics** Adolescents • **Applied Computing Education** Collaborative Learning

Key words
• equity   • making   • learning   • pedagogy

1. INTRODUCTION: EQUITY AND MAKING

Inequity and underrepresentation in STEM of youth from marginalized communities persists despite decades of school reform. However, as noted by the Harvard Family Research Project [1] high quality out-of-school time STEM experiences can

positively impact participation and learning in STEM, particularly among youth from lower-income communities. The "maker movement," has evoked interest for its potential role in breaking down barriers to STEM learning and attainment (Martin [2]). Advocates, such as Hatch [3] argue for its "democratizing effects" – with access to a makerspace, "anyone can make… anyone can change the world" (p. 10). However, there is little evidence that the maker movement has been *broadly successful* at involving a diverse audience, especially over a sustained period of time.

As makerspaces continue to appear across the nation, understanding and shaping this movement with an equity-oriented lens is important. A few studies (Buchholz, Shively, Peppler & Wohlwend [4] Halverson & Sheridan [5], Bevan [6], and Calabrese Barton, Tan & Greenberg [7]) call attention to the potential youth-oriented makerspaces can have in supporting youth in framing, unpacking, and interrogating salient concerns and needs with the tools of science, engineering and communities so as to innovate unique solutions to address particular inequities in their lives.

Building on this nascent literature, for this paper we investigated "equity-oriented making pedagogies." Current research studies within the making movement have shed important insights into the design of making spaces and its relationship to supporting making practices (e.g., Martin [8]). However, with few exceptions (e.g., Vossoughi et al [9]; Ryoo et al [10]), how youth are facilitating in these making practices through pedagogical actions of mentors and educators is under-explored. We are particularly interested in those pedagogies which expand opportunities to make, and which incorporate youth's diverse interests and ways of being in the world. We are interested in understanding what role youth participatory ethnography plays as a pedagogical approach to supporting youth in making.

Our research questions are:

1. What role does 'participatory ethnography as pedagogy' play in supporting youth in the co-construction of new making practices, narratives and spaces that position youth with agency and power to make on their own terms?
2. How does participatory ethnography support mentors/practitioners/researchers in making-spaces to learn more about youth concerns and desires for making and the cultural practices they bring to making?

2. BACKGROUND: FRAMING MAKING AS CRITICAL AND PARTICIPATORY

Youth participatory methodologies, such as Youth Participatory Action Research (YPAR), can be powerful ways to engage, position and apprentice marginalized youth to become change-

agents in their communities across settings and time (e.g. Mcintyre [11], Cammarota & Fine [12]). For example, Cahill, Rios-Moore and Threatts [13] argue that through engaging in critical ethnographic research processes, youth have critiqued the injustices meted out by more powerful others in their communities, including their residential neighborhoods schools and their future working lives. Morell [14] expands on this showing how such critiques cut across such areas as gentrification, stereotypes and who should decide what constitutes a minimal living wage. These inspiring studies illustrate how youth can be empowered to begin to "de-normalize" the injustices they experience through a more informed framing of the forces that precipitate such injustices, and to craft an agentic response that can bring about positive change. In these studies, youth chiefly operate from the stance of a youth researcher exploring existing, societal inequities. However, how youth move from understanding inequality through their YPAR work to taking informed action to make change is often fraught with uncertainty, and muddled up in relations of power.

In probing participatory partnerships such as YPAR, we find it useful to consider the idea of "relationality" –specifically how youth are related to the issue they are investigating, to other youth involved in the project, to community members they interview, to adult mentors apprenticing them in YPAR, as well as to the broader systems of power which shape their experiences in the world as young people of color growing up in lower-income communities. We are concerned, for example, with how youth are positioned as creators of their own stories about their community, capable of representing themselves and others, and with important insider knowledge for doing so in powerful ways.

We are also concerned with youths' relationality to activity and time scales, given our interest in mobilities of learning. We are concerned with how youth's engagement in participatory partnership research on a given issue take shape over time as they develop and learn to use new knowledge gained along the way in order to effect concrete changes. For example, how does their in-the-moment shifting understandings of inequality, STEM, making and community contexts transform their actions and intentions in-the-moment and over time? How do they see the relationships of their work in context articulating with broader social and political concerns? Focusing on relationality helps us to be more precise in identifying the different ways youth approach and engage with an issue, depending on what they deem salient as they launch their projects, and work to bring them to fruition over time.

Along these lines, in the world of making, we are deeply concerned with how youth are granted opportunities and supported in taking on making projects of relevance to their communities – both as they consider the social, political and ethical dimensions of the problems and solutions they hope to tackle, as well as the importance of their work towards community development. However, such making endeavors incorporate a wide range of technological and social dimensions in addition to their responsiveness to inequality. We conjecture that when youth have opportunities to engage as community ethnographers as a part of their making work, they are compelled to be responsive to basic questions of social justice and equity as a part of – not a part from – the technical and social dimensions of their making work: "Who is their making project for? Whose knowledge counts in their making project? Who takes part in defining the problem, data collection, interpretation, and analysis? Who owns their making project, and to what end? How youth makers are taught to examine and incorporate these concerns, as part of making, shapes not only their development as makers, but

also how their making work may potentially impact both the individual and society.

Thus, we endeavor to learn about and be sensitive to, through youth participatory partnerships, the nuances inherent in equity issue such as what it means to make and become a community maker in the youths' particular contexts.

3. CONCEPTUAL UNDERPINNINGS

We are interested in questions of youth learning and engagement in making and how it is mediated by pedagogical practice. In particular, we are concerned with how youth's making practices take shape relationally across multiple scales of activity and communities simultaneously, but also over time – e.g., locally among peers in small group work in makerspaces as well as in the real and imagined spaces of STEM. Thus, we draw from mobilities of learning studies and participatory frameworks to frame our concerns. We are particularly interested in those studies that take a critical orientation, weaving in issues of power and positioning.

Our study is grounded in what we refer to as a "mobilities of criticality" framework in order to call attention to how learning and doing associated with making always take shape across the powered boundaries of gender, race and class in space and time. This framework is grounded in expansive and connected views of learning, emphasizing the importance of learning that which is not yet there. Different from more widely promoted views of learning as either participation or acquisition, expansive learning emphasizes, as Engeström & Sannino [15] argue "transformation and creation of culture, on horizontal movement and hybridization" and the formation of "new objects and concepts for their collective activity" (p. 2). This view aligns well with the "transformative resistance" mode of YPAR that Solozarno & Delgado-Bernal [16] advocated for, where youth seek to address problems of systematic injustice with empowering actions most likely to effect social change.

We see three important dimensions of mobilities of criticality as it ties to equity and participatory engagement in making. First, as Bright, Manchester, and Allendyke [17] suggest, learning always takes place *somewhere,* both in "relation to history (time) and context (place/space)" (p. 749). As the youth in our study move through space and time, the sociohistorical narratives around them shift, reshaping how they inhabit or reinhabit space. Broader sociohistorical narratives around who can be a maker influence how youth come to a makerspace seeing themselves as capable in making. As we consider our work with non-dominant youth in makerspaces, we want to pay attention to how the shifting nature of STEM, making, and community spaces are always under negotiation, resulting in potential in-between spaces as different individuals reproduce and resist the narratives at play there.

Second, from an equity standpoint, a mobilities of criticality framework challenges normative views of what it means to participate in practice within community by making visible the boundaries of formal/informal, novice/expert, and past/present/future, and how these boundaries change over time and across space (Rahm [18]). We are interested in how new routines, ideas, and ways of being become legitimized in practice. Bright, Manchester, and Allendyke [17] remind us that youths' interests reflect their lived experiences and how they navigate those experiences through "localized and contested power geometries" (p. 750), where their multiple identities, (e.g., racial, social-economic, gendered) interact to produce unique oppressions. Youths' experiences can expose and challenge

normative views of making while also building a makerspace community that legitimizes their lives. We are particularly interested in how youth remix and repurpose relationships, tools, and other resources to confront, engage with and address oppressive experiences they are encountering in their lives, in ways that empower and challenge their positionalities as the marginalized "other".

Third, a mobilities of criticality framework is particularly important in making sense of the kinds of learning that happens in making because making is a dynamic multi-practice. To make, individuals are involved in the process of re-authoring and re-mixing practices from a wide range of experiences, both in and out of school. Sheridan et al. [19] suggest that making values multidisciplinary engagement, which manifests itself in both the tools and practices (e.g., sewing and circuitry) and in the questions asked and artifacts made (e.g., e-textiles). Such multi-practice values "historically feminized" practices, such as crafting alongside more traditionally "masculinized" practices, such as electronics (Buchholz, Shively, Peppler & Wohlwend [4].

4. METHODS

4.1 Methodological Approach
Our study was carried out as a critical ethnography over a three-year period. Critical ethnography was selected as our methodology because of its explicit focus on participatory critique, transformation, empowerment, and social justice. Critical ethnography is grounded in the idea that researchers can use the tools of ethnography to conduct empirical research in an unjust world in ways that examine and transform inequalities from multiple perspectives (Trueba [20]). Critical ethnography provided an approach in which to "politicize" the interaction between actors and the social structures through which they act, grounded in the belief that these relationships are never neutral. This approach was important as we attempted to make sense of how youth, who are positioned in particular ways due to race, gender and class, engage in makerspace activities.

4.2 Context
Our study is located in middle school youths' experiences in two different makerspace contexts, Michigan and North Carolina, over the course of three and two years respectively. Participants are summarized in table 1.

Table 1. Youth Participants and Demographics

Year	Location	Participants	Demographics
2013-2014	Michigan	14 youth	2 White 10 African American 2 Biracial
2014-2015	Michigan	21 youth	2 White (both returning) 17 African American (8 returning) 2 Biracial (both returning)
	North Carolina	15 youth	14 African American 1 Biracial
2015-2016	Michigan	17 youth	3 White (2 returning) 13 African American (5 returning) 1 Biracial
	North Carolina	15 youth	15 African American (6 returning)

The makerspaces in both locations are housed in Boys and Girls Clubs [BGCs] (community-based clubs focused on youth development, homework help, and sports) in mid-sized cities, both facing some degree of economic depression. We have worked together with staff at the BGCs to establish these makerspaces, with the primary goals of supporting youth in developing productive identities in STEM, while also learning about making/engineering design in culturally sustaining ways. In both locations, we sought to engage youth iteratively and generatively in maker space activities and in community ethnography as one approach to embedding local knowledge and practice into making and engineering design. In both the ethnographic and in the making work, youth are positioned as partners, not merely recipients or respondents, in the program. Under the theme "Innovations for safety in communities", youth interviewed salient community members (community ethnography) on pertinent safety issues that they could address through making a product to solve these problems. Youth went through iterative cycles of community ethnography, making at the BGC club makerspace, and feedback sessions with community experts. Among the innovations include a rape-alarm jacket for teenage girls, a heat-up jacket for the homeless in winter, a motorized, baby gate for handicapped and elderly care givers, an anti-bully app, and a little STEM library for peers at the boys and girls club. For this paper we select 15 youth project teams to follow more closely in our analysis (see Table 2)

4.3 Data Sources and Analysis
Qualitative data were collected from multiple sources/sites, including participant observations in the two community-based makerspaces (~78 hours/year), conversation groups with youth makers (~36 hours/year/site), and artifact-based interviews. Data analysis was guided by our conceptual framework and member-checked by participants.

Data analysis involved multiple stages and levels of coding based on procedures for open coding and method of constant comparison (Strauss & Corbin [21]). Our first pass involved reading through artifact interviews transcripts (conducted yearly at mid year and end of year) as well as our fieldnotes and the students' sketch-up notebooks kept during the course of their participation. The goal of this initial read through was to surface points and open codes of a) tensions and connections among the various youths' forms of engagement in making, b) critical design moments (e.g., sticking points, changes in direction, etc.), and c) generally how youth talked about and framed what it meant to participate. For example, in trying to open code for critical design moments, we noted times when youth made shifts in design, became deeply frustrated or disengaged, or otherwise more explicitly noted for us (e.g., artifact interviews) when they felt they were stuck or had important turning points. Weekly conversations were held between the authors on these insights as a way to work towards a more "expansive consensus"; that is to say that any differences in view were debated until new meaning was generated as a result of our differences. A detailed list of emergent open codes were kept with analytic memos attached to them, which we then brought to bear on other data sources, such as group conversation transcripts and various student artifacts not included in their sketch up notebook.

Our second pass involved identifying pedagogical moves and practices in support of youth making, in relationship to the previously identified critical events, tensions and connections. With the help of our theoretical framework (mobilities of criticality), we worked to make sense of the relationality between

youth's efforts to move, repurpose or remix the ideas, practices and resources they leveraged within these events and mentor/educators pedagogical practice. This axial phase of coding was used to uncover relationships and connections between the youths' making and the pedagogies that emerged from the data. In developing these coding schemes, we paid attention to how, and where, youth engagement appears greatest and the forms such engagement took, how they move ideas and resources across spaces, the different pedagogical moves supportive or constraining of this work. We took these data points as significant markers of equity – opportunities to access and activate traditional and nontraditional resources and to be recognized for doing so, as important to the making process and outcomes.

The relationships and connections identified in this second stage of coding, in turn, guided our selective coding, and became categories and themes, from which our example cases were selected for a final round of analysis and presentation.

5. FINDINGS

We find that participatory ethnography as pedagogical practice repositioned youth and making, and helped foreground youths' relationality to people, communities, activities and timescales in collaborative, critical and connected ways. In particular, this pedagogical stance centralizes co-making (including the co-production of design problems and solutions with a wide range of stake holders across setting and time). Three pedagogical principles emerge from a close analysis of these two interrelated findings: Participatory ethnography as pedagogy 1) emphasize youth participation, not just as respondents, but as people who contribute to the research by bringing in their concerns; 2) situates knowledge production within local contexts in decolonizing ways, and 3) contributes to the improvement of conditions for youth. We first elaborate on the importance of co-making, what this meant to youth and how it evolved. As we do so, we describe how youths' co-making is collaborative, critical and connected. Then we elaborate on these three pedagogical principles in support of co-making below.

5.1 Relationality and the Evolution of Co-Making

The problems the youth hoped to solve through engineering design in their makerspaces reflected both personal and community concerns or needs that were deeply linked to their community's unique history and context. The problems included "keeping my peers and younger children safe when playing football outdoors in our community" and "helping kids make friends" (Samuel's light-up football), "helping people in my community feel safe on the streets at night" or if you "need protection from the police" (Samuel's phantom jacket), "helping kids or our peers play with scooters outdoors in the late afternoon or evening" (Jennifer and Emily's light-up scooter), and providing peers with "glamour and fashion" and "helping people in our community—including the homeless—live, work, and play outside in winter at night and feel safe and warm" (Jennifer and Emily's heated jacket).

The youth purposefully identified problems and concerns linked to broader, sustained problems that their community members (including themselves) had struggled with or negotiated over time. The problems were entangled in systemic oppression experienced by their community, such as decaying infrastructure (e.g., limited street lighting), police brutality (e.g., need for protection) or economic concerns (e.g., the high number of homeless people and poor families), geography (e.g., harsh weather conditions and

short days) and youth concerns (e.g., fostering positive peer relationships/friendships, bullying, glamour).

As youth moved their projects across spaces through ethnography, they expanded the scales of criticality and connectivity in their work. We illustrate our points with two cases below.

5.1.1 Samuel's Phantom Jacket

In 7th grade, Samuel designed the "phantom jacket" to make sure that he and his peers had safe commutes to school and to each other's houses. His phantom jacket has a noisemaker on it so that if someone tries to bully him, he can press the button on the noisemaker to set off an alarm. The jacket uses wind energy from wind turbines on the shoulders to power the noisemaker. The wind turbines send energy to rechargeable batteries, where the energy is stored for later use. He also made the jacket fashionable with an image of a phantom on the front, a hood on the back, and a sleek black color.

Samuel designed a survey that included both open- and closed-ended questions with his peers during a making session to investigate the safety concerns that people have in their communities. This survey comprised seven questions including "What are some of your safety concerns?" "Where are the areas that you think safety is most important?" and "What are some ideas that can help you solve those safety concerns?" Using an online survey design program (SurveyMonkey) and a tablet computer (iPad), Samuel surveyed 62 people in his community, including peers and staff at BGC, families, teachers, and school friends.

After analyzing the survey data with the help of mentors in the makerspace, Samuel discovered key safety issues that concerned his community, such as "walking" "transportation," "school," "driving," "stealing," and "food" (Figure 1). Further analysis helped him narrow down the problems he hoped to solve using engineering. He noticed that approximately 75 percent of the participants "felt unsafe on the streets" as they commuted to school, home, and other places

> Yeah, people walk and sometimes they say it's not safe to walk, so it's, like, 75% of people that walks and they say it's not safe to walk. So I just thought I'd make the jacket for them. And so it will keep them safe so they don't get hurt when they walk. (Artifact interview, May 13, 2015)

As we can see here, Samuel recognized that a large percentage of people in his community had the same concerns about feeling unsafe on the streets as he did. Samuel decided to design his making project ("phantom jacket") to keep more community people in his community safe.
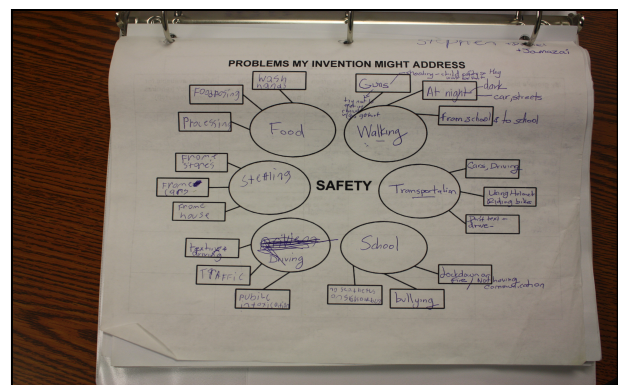

Figure 1 Safety issues in Samuel's community

Using the tools of ethnography supported the youth in understanding their initial design tasks' boundaries, including their criteria and constraints. As we see in the aforementioned example of Samuel's phantom jacket, the analysis of the survey data supported Samuel in understanding the design task's boundaries, including its constraints and criteria. Samuel came to realize that his making project needed to have key functions to protect people from gangs. Thus, his initial jacket design had "a hoodie to hide your face," so that the gang members could not recognize the person wearing the jacket, and "a voice-activated button" to call to nearby police officers. The jacket also had another button that lit up LED lights attached to the jacket so that people could see the wearer if he or she was in trouble under the limited streetlights at night in his city. See figure 2.
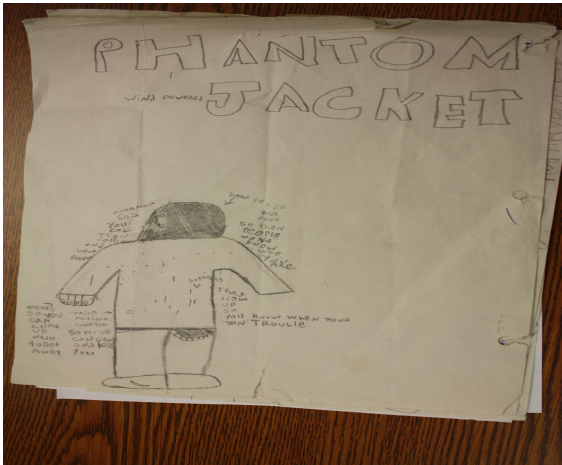

Figure 2: Design Sketch

5.1.2 Kairee and Jaimie's Heated Bus System
Engaging the youth as ethnographers also opened up new and different opportunities to co-make, as the youth drew on, and expanded their social networks. The next example illustrates this point.

For example, two sisters created the "Warm Those Bodies!" Heated Seat & Bus Stop System, as separated by related projects. They became interested in this project because their mom drives the #7 bus in their city, and because they themselves had been riding the bus "since we were babies." They have a deep and personal knowledge base of the needs of bus riders and drivers, including knowledge of how the bus route that runs through their part of the city is underserved, with people having to wait "a long time" for their bus to come. They see this as a community problem in the winter. As Kairee described:

> People need to be warm in the winter because it's cold and people are warm-blooded. Sometimes people cannot afford really warm coats even if they know that is what they need to stay warm. People also use public transportation because they need to get to places. Some people are *not able* to walk very long distances, especially in the winter because of disabilities. Bus stops are cold. We have had to stand at bus stops many times before, to ride the [local] bus that our mom drives. In the wintertime, it is always freezing. If you don't have money, you can't solve this problem. *That's where we come in and save you!!!!!*

The girls decided that they needed to address this problem but they had different ideas for doing so. Kairee wanted to make the bus shelters warmer (she is noted in her quote above – "bus stops are cold." Of her project, Kairee wrote,

> My project is "Heat those Bodies." It's a heating system for the bus shelters. It heats with high-Wattage halogen lamps (radiant light energy) that will be located below the bus shelter's bench, because heat rises. Also, my system includes surface heating elements (like a heating pad) on the bus shelter's bench (conductive heat energy). It's powered by rechargeable batteries, which you can help to recharge by pedaling a foot pedal generator as you sit at the bus stop. This way, heat comes from three directions: bottom, side and side (the radiant energy from the heat lamp comes from underneath the bench, the heating element on the bench's surface heats your body directly, and the heat also comes out from the side walls of the bus shelter, through heated wires. That's important so that your whole body can be warm, and you won't be cold.

Her initial prototype can be seen in figure 3.

Figure 3: Kairee's Initial Working Prototype

However, Jaimie insisted on making the seats in the bus warmer – "My mom always gets cold when the bus door opens to let people in." Jaimie's describes her project as "It's like a seat warmer, but better. Instead of having to always recharge it like they always do and it costs way too much, it gets charged by sun light during the day and the energy is stored rechargeable batteries. When light shines on the bus, it charges it and it saves some of that energy for the night so that it can run at night. It collects the energy from a solar panel on top of the bus. It won't be noticeable, it's going to be flat, not the ones that tilt."

Her project was technically completed. The heated seat was made up of a cushion that has a rechargeable battery, a 26-gauge wire, an AC adapter, sewn into the cushion on the inside. As she said, "It's going to have easy access to it in case it needs to be repaired or something. And it's going to have like a waterproof cover on it so if someone got something spilled on it, it wouldn't go all the way through to the wires and blow somebody's butt up." The wires to the heat adjuster nob were located behind the seat "so that people cannot accidentally damage them or get electrocuted."

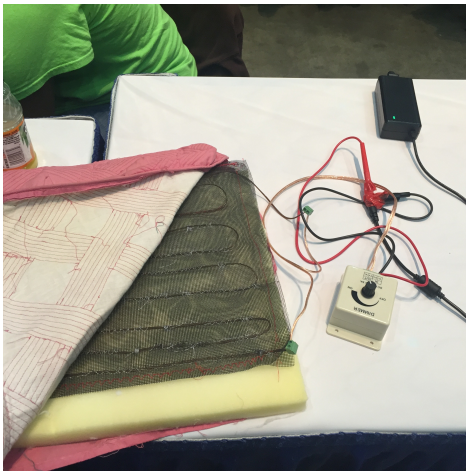Jaimie's initial prototype can be seen in Figure 4.

Figure 4: Jaimie's working prototype

We see the girls engaged in co-making as they collaborated on a joint project that they sequentially worked to weave in contributions from a growing circle of community contributors. These contributions shifted the focus of the project, and provided critical insight into the technical and social dimensions that mattered to them.

For example, as they rode the bus, they began surveying people both waiting and riding the bus. They took careful notes of the number of bus shelters on their route and their conditions, the number of seats on each bus and their condition, and the concerns that riders had. They also talked to people who did not ride the bus and tried to figure out if their project ideas would encourage them to ride the bus. They began to see their project as belonging to the whole community, not just the people who currently ride the bus. As Jaimie explained:

> There are 53 seats on every standard [local] bus. . . Not only that, but several people who do not currently ride the bus told us that they would be interested in riding the bus if they knew that the bus came equipped with heated seats. We know this from a survey that we took around our neighborhoods.

The girls talked with their mom about their project, bringing in her ideas as well. Their mom also provided the girls with contacts within the city management who could provide further insight into their project. As Kairee explained:

> We plan to schedule meetings with the already mentioned transportation specialists so that they are made aware of our services. We're not just doing this for the money, but we do want them to pay us for our services, which includes our hard work and great ideas. It is hard work to make each cushion by hand, when you have to thread in the heating wire by cross threading so it stays secure and the heating wire won't pop off.

We are going to start by calling. *Our mom told us the name of the [bus] CEO, so we already know who we will be talking to first!*

Table 2 summarizes more cases of youth co-making that illustrate the potential of equal participatory partnerships.

Table 2: Summary of Youth Maker Cases

Youth	Innovation	Safety concern raised by		
Makers (age)		**participatory ethnography & translations into making**		
Chris (10)	Anti-bullying app	Crowdsourcing bully "hotzones" at school & specific locales in the neighborhood, layered by type and frequency Connections & Resources		
Stephen (12)	Light-up Football	Lack of healthy peer activity for peers, safe places to play, and concern for the environment. A football made of softer material that lights up with rechargeable batteries powered by a solar docking station, properly weighted and waterproof.		
Stephen & Fall (14, 15)	Little STEM/Maker library	Lack of educational and making resources for peers in local community to learn to read, STEM and making. Expanding free access to books and mini maker kits designed by the youth with materials in their makerspace		
Ariana (10)	Light up Umbrella	Lack of street lights, keeping safe while walking in the rain & conditions of street visibility in local neighborhoods A light up umbrella with lights positioned in beautiful colors and locations.		
Emily & Jennifer (10)	Heated sweat shirt & Light Up Scooter	Keeping warm and stylish in the winter, green environmental concerns		
Mazon & Tarron (10)	The Timmy	Heated, light up boots, stylish and functional, powered by rechargeable batteries		
Kairee and Mirabel (10)	Rape Alarm Jacket	Solar powered alarm in stylish jacket for teenage girls		
Kairee and Mirabel (11)	Heat those bodies!	Human powered heating system for the bus shelters and buses, green environmental concerns		
Jaimie (11)	Heat those butts	Solar powered heated seat for inside the bus, creating safe, warm environment for commuters in the winter		
Anna & Peter (12 & 10)	DIY Videos – For Us By Us	Short fresh videos on making practices (e.g., soldering) and green energy sources (peizo pads) because "the only videos we ever find are not by kids like us"		
Trinity (10)	Cautious cap: Light up cap with alarm buzzer	Children living in homeless shelters and "dangerous" neighborhoods) kinds of hats kids typically wear Dangers that kids can face in homeless shelters		
Peter & Kevin (15 & 14)	Motion sensor activated motorized baby gate	Handicapped relatives caring for young children Kinds of baby gates and materials that are affordable for members of the community Useful suggestions from family member expert about how to take apart tension		

		gate with minimal damage
Sharon & Ariel (both 12)	Solar powered MP3 player hoodie	Lack of resources to procure music for entertainment for peers from low SES and peers' love of music; Peers' preferred choice of outerwear: a hoodie
Tamzin & Ernest (11 & 10)	Light up sneaker	Poor or limited streetlights in residential neighborhoods; friends tripping and falling when walking at night because they could not see the road. Preferred aesthetic elements: What kind of lights and where to place the lights
Lisa & Teena (12 & 10)	Alarm backpack	Bullying in school, danger while walking home alone; How to adapt from an existing alarm backpack available in the market; Suggestions from peers about how they wear their backpacks so as to locate the best spot for the "secret alarm button"

5.2 Emergent Pedagogical Principles: Participatory Ethnography as Pedagogy

Three pedagogical principles emerge from a close analysis of these two interrelated findings: Participatory ethnography as pedagogy 1) emphasize youth participation, not just as respondents, but as people who contribute to the research by bringing in their concerns; 2) situates knowledge production within local contexts in decolonizing ways, and 3) contributes to the improvement of conditions for youth.

5.2.1 More than respondents: Youth as equal research partners

When youth and making club mentors engaged in conversation around problem definition and solution design, youth were encouraged to present as many perspectives and relevant points of view as they deem significant. Mentors were mindful in keeping the relationality focus in these dialogues, which helped attend to inclusivity and sought to broaden perspectives. For example, youth held very different ideas about "safety in the community". The particular target audience for whom youth wanted to design for and the safety problem identified were grounded in particular kinds of relationality. Jennifer and Emily (aged 13) were deeply concerned about the rape-statistics of teenage African American girls their age and innovated a rape-alarm jacket. At the same time, the girls were troubled by the bullying in school when students shop at thrift stores out of necessity, so they strove to make their jackets sleek and stylish. Jennifer and Emily innovated from two nodes of relationality –that of physical danger to society as young Black girls, and another from low SES students singled out for bullying in school by more well-resourced counterparts.

Peter and Kevin (aged 15 and 14) who both had experiences baby-sitting toddler relatives and who also had older, less mobile relatives performing these duties latched onto the idea of hacking a cheap, tension baby gate into a motorized one activated by a sound sensor. They were also adamant that they needed to start by hacking the "cheapest baby gate out there" and not use more costly starting materials. Peter and Kevin operated from specific relationality nodes –their ties as caregivers to young relatives and to elderly relatives who themselves are caregivers, as well as their connections to a lower SES community where thriftiness is a compulsory way of life.

By soliciting for and validating youths' varying nodes of relationality, adult mentors of the making program were able to support youths' agency in framing the community safety problem space for themselves. Instead of merely responding to parameters laid out by adult mentors, the youth, through community ethnography, framed salient safety issues for themselves to investigate and innovate.

5.2.2 Decolonizing Knowledge Production

Positioning youth as equal participatory partners in the ways described above helped to decolonize knowledge production in important ways. Through the community ethnography and making iterative process, youth drew from their local knowledge as "oppressed insiders", and forced attention on typically silenced narratives around low SES communities such as inadequate resources for child care, rape and bullying –narratives that are usually alien to typical public makerspaces. The Boys and Girls club youth makers claimed empowering spaces for themselves by using the tools of community ethnography and the resources and practices in making to bring to the open the particular injustices in which they and their communities suffer.

For example, Kairee and Mirabel invoked and risked new narratives for Making when they prototyped a "rape alarm jacket" for teen girls in their community. While neither girl identified as a "science person," both identified with the community survey results they had collected, where many community members stated that "walking home alone in the dark" as a major safety concern. Kairee and Mirabel connected this last survey response to a local news story they had seen earlier that year about a young Black girl who had been sexually assaulted in their area. An anti-rape jacket positioned the girls with agency and voice over an act meant to silence and dominate. This focus provided direction to the girls in how they might move from a sketched out idea to a workable prototype, and who they needed help from in the process. The new idea drove the girls to conduct research that neither they, nor their mentors, had thought of before. Instead of searching for a jacket that yells for help on the internet as their first step, they began by searching rape statistics of African American girls. They wanted to know who was most at risk for rape. They felt that this data was necessary because it might impact the color, size, and style of the jacket. When they presented their prototype for feedback to members of their community during a more formal feedback cycle day involving community members, local engineers and scientists, and educators, they framed the problem space personally: That girls *their* age "made up 44% of the rapes" in their community.

5.2.3 Improving inequitable conditions

Focusing on youths' relationality during the ethnographic and making process helped usher in youth community maker practices that are critical, connected and collective. The *criticalities* are apparent in the safety issues youth chose to tackle, e.g. bullying and a higher risk of rape often targeted at the more vulnerable youth populations in which our youth have membership. The *connectedness* in their making process was made visible by the relational routes –to particular community members outside of the making program at the club, outside of the club, in their neighborhoods --they traced in mining for information to frame their design challenge. Finally, the *collaborative* nature of their making, from recruiting the help of peers outside of the making program but who are experts in the community safety issue at hand (e.g. The Timmy example) to soliciting help from expert family members who do not necessarily recognize themselves as "engineers" or "makers" but who nonetheless possess relevant

making expertise (e.g. Club mum who taught Jennifer and Emily how to use a sewing machine; Peter's handyman father who showed him what tools to use to dismantle the tension baby gate), the youth challenged the notion of who can be named a "maker", "engineer", "expert". In so doing, they broadened, through participatory ethnography, the boundaries of a "local maker community" to include salient others who might not be tapped as germane resources in a typical maker program.

6. MOVING FORWARD

> To us, a makerspace is a place where you can invent, have fun, and make stuff to save the world… If you don't feel welcome then you won't want to go help people build stuff. If we help people learn about what this stuff is, they'll know. A makerspace is a community because it's all of us there." Ayana (11 years old) & Desiree (12 years old)

Framing youths' making experiences through the lens of participatory partnerships through youth community ethnography and making challenges the field to consider how making – as a practice – is never separate from individual and social histories that unfold across space and time. Who can make and who cannot, whose knowledge matters and whose does not, are all a part of making itself. Every day decisions in makerspaces inscribe not only what counts as authentic "making," but also youth identities as makers, participants, collaborators, community-members, young people *who legitimately belong in this makerspace*, signifiers that endure as historicizing elements shaping the emerging culture of the youth makerspace. We argue that youth making anchored in community ethnography is a productive way to both honor youths' histories while fostering their agency to determine how and where their emerging histories, reified in in-the-moment experiences through community ethnography, can be sought for in more just ways.

7. ACKNOWLEDGMENTS

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