Designing for rightful presence in STEM-rich making: Community ethnography as pedagogy

Extended Abstract†

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ABSTRACT

Making and makerspaces have largely proliferated as an out-of-school, informal activity that mostly self-selects interested participants. To take up equity concerns seriously, we need to consider the ways in which classroom teaching is both an historicized and relational activity, and how classroom STEM teaching and learning, under which making is subsumed, has long alienated youth of color. The construct of rightful presence is one way to consider more systemically how to make sense of the historicized and relational nature of teaching and learning. We show how integrating an equity-oriented design approach, community ethnography as pedagogy, as a part engaging in STEM-rich making, support the emergences of three *making present practices*: modeling ethnographic data, re-performing injustices towards understanding and solidarity, and making change dynamic and visible through engineering practices, all of which reflect the on-going struggle youth face in their lives, write these injustices onto a longer history of struggle in the school/classroom, and allow for a refusal to be victimized.

CCS Concepts

• Social & Professional Topics → User Characteristics → Adolescents • Applied Computing →Education → Collaborative Learning

KEYWORDS

Equity, making, community, intersectionality

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Drawing upon ethnographic data from 6 urban middle school classrooms in two different states during an integrated science engineering/making design unit focused on sustainable communities, we show how the design approach community ethnography as pedagogy fostered these making present practices and the emergence of rightful presence.

1 INTRODUCTION

We built the Occupied because kids were getting walked in on in the bathroom. It's terrible. It's a big problem. . . Our project solves it because it shows everyone when the bathroom "is occupied" (uses his fingers to put the words in quotes). Now you can't just walk in and pretend you didn't know. . . I think this is a good problem to solve. I think it will help our community. Especially boys. The girls usually have someone watch the door, but a lot of us don't. Mateo, 6th grader

In this opening quote, Mateo, a 6th grader, describes an engineering design solution, "The Occupied," he and two peers prototyped over the course of a six-week unit focused on engineering for sustainable communities. The Occupied is a lighting system that allows classroom members to know when the bathroom is occupied. In his school, each classroom has its own individual bathroom located in the corner of the room, but the bathroom does not lock. The Occupied has 3 gumdrop 10mm LED lights in parallel circuit affixed to the wall outside the bathroom door. It uses the bathroom light as a switch to activate the solar panel, which powers the LEDs, connected by 12 meters of copper tape. However, getting to the point of a working prototype was not straightforward for the group. They needed to figure out how to make the design work from a science and engineering standpoint. They needed to garner support from their teacher, Mrs. J., who admitted to being unaware of the bathroom bullying problem, and was skeptical of these particular students' abilities to succeed with such a complex project.

How did the three students, their peers and teacher work towards new understandings and relationships which made The Occupied possible, and which shifted how these youth were positioned and valued within the classroom and school community? If youth – and especially youth from non-dominant communities – are to become welcomed fully and equitably as an

integral part the STEM[1] classroom, we suggest that we need new equity-oriented design approaches that can help promote new forms of relational activity. In this study we build an argument for the importance of framing teaching and learning and its outcomes through a critical justice view of "rightful presence" – a way of being in a place where one is legitimately welcomed even if that means (and especially when it means) undoing the order that currently exists in classrooms and from which dominant groups abundantly benefit. We further argue that one possible way to design for rightful presence is by integrating community ethnography as pedagogy as a design approach in teaching and learning engineering via STEM-rich making. This is pertinent within STEM, and equally critical to the maker/making culture that is fast solidifying along white, male, middle class norms.

Our two guiding questions are: In what ways does community ethnography as pedagogy support new relationalities in the classroom? How do these relationalities challenge traditional knowledge and power structures, working towards a rightful presence in STEM-rich making in the science classroom, for youth from non-dominant communities?

2 THEORETICAL FRAMING

2.1 Equity, making & STEM-rich making in the classroom

The maker movement has been deemed promising in broadening both access and participation of robust STEM engagement [1, 2]. Sentiments around how "anyone can make" [3] and the "democratization of invention" [4] signal hopes that no matter where one is located in the social, economic or ethnic strata, making is readily accessible. A critical look at this assumption reveals that this is not the case.

The maker movement has proliferated in informal spheres, but participants are mostly self-selected, interested parties. Making as a core STEM activity is lagging in formal school science classrooms (versus after-school making clubs). Incorporation of making into school settings, we believe, is a critical aspect of an ecosystem of making that supports equity-oriented goals where broader access to making across demographic groups in ways that value their cultural knowledge and practice is possible [5]. We are particularly concerned that such approaches to design of making programs draw upon the assets youth and communities bring to make – including their rich histories – and the pedagogical approachs which may position such expertise as essential to robust STEM-making [5].

We also take seriously the fact that the long-standing education debt [6] has produced patterns of participation in science classrooms that are oppressive for youth from non-dominant communities (e.g., Who has power in classroom settings, how and why). New approaches to teaching and learning science that are *equitable and consequential* are needed. We use both equitable and consequential together in framing teaching and learning because we seek to purposefully call attention to the importance of recognizing teaching and learning science (and other domains, including making in the context of engineering) as an *historicized* and *relational* practice. African Americans make up only 5% of the engineering workforce in the US – a statistic that has not budged in decades. Studies show that identifying with engineering is critical in the pursuit of engineering careers [7]. Whether one sees oneself as capable and welcomed in engineering, and how one is recognized by others for their engineering expertise impacts opportunities to learn [8]. Even when students are academically successful, many still see engineering as disconnected from their lives and pursuits [5]. Identifying with engineering has been shown to be important in engineering aspirations as early as pre-adolescence [9] This trend continues through high school, college and into the professions, where women and minorities remain underrepresented in engineering. The same concern can be extended to making, especially when making is regarded as a promising platform to democratize STEM education through its supposed appeal to youth from all backgrounds.

2.2 Rightful Presence in STEM-rich making

To make sense of how to design towards equitably consequential teaching and learning, the construct of a "rightful presence" is helpful to consider as a part of teaching all students in science class to engage in STEM-rich making. The framework of rightful presence has emerged from critical justice studies of borderland and refugee communities in welcoming host countries, where the lens of hospitality does not fully capture the on-going social and political struggles for legitimacy by guests in these host settings [10]. Rightful presence challenges the normative guest/host relationships by critiquing the limitations of framing a welcome to place through the "extension" of a static set of rights to newcomers [11]. Instead, rightful presence calls for the disruption of normative power relations, reconfiguring what it means to legitimately belong in a place [11]. Legitimately belonging means more than having the borders of practice opened to new comers (e.g., expanding who has a right to participate within community). It means understanding and seeing moments of social and political struggle as forms of legitimate presence.

One way to think about the on-going enactment of rightful presence is through the *practices of making present* which support it [12]. Making present practices are always a reflection of struggle and foreground relationality, linking places and time. The connections of places and time in practice is central to authoring a rightful presence because it helps to reconstruct place through the enactment of new practice, borne out of minor politics. Such belonging breaks down the binaries between outsider/insider and novice/expert, "not by pursuing inclusion into an already established order; rather, it seeks to assert a new measure of justice even if that means undoing the order we currently exist in and benefit from" [13]. A critical justice view of rightful presence is a powerful frame for understanding equity-oriented teaching efforts in school science. Power dynamics are always at play in science classrooms, acknowledged or not. Students are guests in their classrooms, expected to follow majority (dominant) routines with the threat of disciplinary sanctions for noncompliance. Youth historically marginalized in both science and schooling, even if positioned as a welcomed guest (which is not always the case), are expected to reconfigure themselves towards the majority culture. Their participation is always marked as guest – subject to an uneven power dynamic. This is fundamentally an equity concern for youth from non-dominant communities whose cultural

[1] We use the term STEM to refer to "integrated science and engineering" learning goals and experiences which are an integral part of the science classroom, as identified by the Next Generation Science Standards.

knowledge and practice has historically been marginal to school and disciplinary knowledge and practices.

3 METHODS & CONTEXT

We have been working with teachers in schools that serve non-dominant communities on integrated science and engineering towards the goals of rightful presence. We sought to integrate community ethnography as pedagogy towards increasing the possibilities for enacting making present practices as a part of teaching and learning STEM. This work occurred during an integrated science and engineering unit on "how can I make my classroom more sustainable?" Students were engaged in learning about the disciplinary core ideas of energy transformations, sources and systems, while also exploring the practices of engineering design. As a culminating project, students were given the design challenge to use what they had been learning to develop a design project in support of classroom sustainability. The design challenge was bounded with the following criteria: Students had to innovate something in the classroom in a way that would address a classroom sustainability concern. They were required to use a renewable energy source, such as solar panels or handcrank generators, 10mm gumdrop LED lights, copper tape, and any materials readily available in their classroom.

We supported teachers in integrating community ethnography as pedagogy in two primary ways. First, we worked with the teachers to incorporate community dialog throughout the design process, including observations, surveys and informal conversations. Second, we worked with teachers to plan multiple feedback cycles with different community constituents, and coordinated these feedback sessions with different points in their design cycle.

We used critical ethnography with participatory research and design approaches [14] towards collaboratively working towards new social futures [15]. We seek to understand how students engaged in "equitably consequential" learning in the context of middle school engineering and what tools and practices might support teachers in enacting equitably-consequential teaching. Critical ethnography is rooted in the belief that exposing, critiquing, and transforming inequalities associated with social structures and labeling devices (i.e., gender, race, and class) are consequential and fundamental dimensions of research and analysis [16]

We co-designed our materials with youth and teachers using participatory methods, as an approach to "social change making" [18]. Our research team developed the unit and then co-revised it with youth and teachers first in afterschool settings and then in a summer camp prior to classroom implementations.

Our data sources include: 1) video recordings of a subset of class sessions, 2) conversation groups that occurred at the end of the implementation phase, 3) field notes, 4) artifact interviews with subset of youth about their engineering design, 5) conversation groups with teachers before and after implementation, plus daily informal conversations, 6) the youths' work, and 7) field notes. Data was analyzed in the grounded theory tradition, using a constant comparative approach [17]. The first phase of analysis involved open coding by thoroughly perusing all generated data to surface a) critical episodes of engagement in the engineering design work; b) the knowledge and practices that youth drew upon during critical episodes; and c) how they iteratively defined the problems they were seeking to solve. With the help of our theoretical framework (rightful presence), we then worked to make sense of teacher and student interactions especially around community ethnography and community knowledge; why youth took the actions that they did; and the meanings the artifacts youth produced had for them, individually and collectively. This axial phase of coding was used to uncover relationships and connections between the youths' science and community knowledge and practice, and their efforts to solve problems with their knowledge/practice for themselves and their community.

Teachers and Schools. Mrs. J. & Wilkenson School. Mrs J has been teaching for 33 years. She described the students as "needing more than she could give" and "struggling with so much on top of academics." She clearly cared for her students, but viewed their struggles as something that worked against her academic and social goals. The students love her. As one student says, "she is an awesome teacher."

Wilkenson School is one of the most diverse schools in the city, with 32% white, 28% Latinx, 8% Asian, 22% Black, 9% two or more races, and 1% Native American. It was converted to a "STEM" school 4 years ago in an effort to stanch the flow of students from the district into the local charter system and other districts allowed by state policies. By District's accountability policies, the school does not have a strong reputation for academic success, with only 11% annually meeting passing levels on state exams (compared with state average of 33%). In many ways, the school community rallies around supporting and welcoming all of their students, such as hallway displays celebrating the diversity of its student body, strategic partnering of students, hosting culture nights, and teachers encouraging students to "help each other" often. In other ways, students' multiple identities are not supported by each other and the system within which the school operates.

Ms. D. & Sage Middle School. Ms. D has taught for 12 years at the same middle school in a midsized city in the South, Sage Middle School. She teaches 6th grade Science and Social Studies. and is beloved by her students. One student described Ms. D as, "da bomb dot com!"Sage Middle School serves a diverse population of students with 43% Black, 38% White, 11% Hispanic, 5% Biracial, 3% Asian, and less than 1% each Native American and Native Hawaiian. 58% of the students come from low-income families. The school also serves 21% of students with a range of disabilities. Led by a dynamic school Principal in his second year, Sage won the "Most Improved Middle School" award in the district and the "[Region] Signature School Award" this year, both for most improved test scores. While the school displays overt signs of solidarity and friendship for all, such as "This school serves ALL students" posters prominently in the building, incidences of bullying regularly occur. The school also reported a disproportionate data of disciplining African American boys over all students.

4 FINDINGS & DISCUSSION

4.1 Community Ethnography supporting *Making Present* practices

We draw from two case studies to present our claims.

Happy Box, designed by three girls at Sage MS during the course of their integrated science and engineering unit, is a light up messaging system that reminded all students that they were

welcomed and valued in their classroom, and that social issues that concern students (beyond test scores and traditionally-valued achievements) are relevant. It is powered by two solar panels that lights up a design on the cover of the box with 5 LED lights. The design is of children around a globe, including a transgender child. The Happy Box functions as a classroom mailbox with individualized envelopes for each of the 28 students in the classroom. Teachers and students can use the Happy Box to write encouraging notes. The Happy Box is checked right after morning announcements by the Principal, which typically follows the script detailing upcoming exams, test scores, and school achievements. See Figure 1.

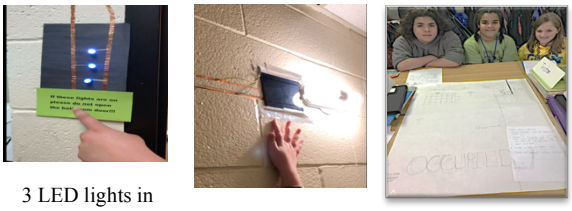
The Occupied involved three students at Wilkenson MS, who designed a lighting system to alert the classroom that the bathroom was occupied. A solar panel, activated by turning on the bathroom light, powered three LED lights in parallel circuit, which were affixed to the wall outside the bathroom by 12m of copper tape. The group went through various tests to determine the most effective solar panel, and its placement vis-à-vis the bathroom light, how many lights effectively alerted the whole classroom, and the necessary power requirements. See Figure 2.

Circuitry inside box lid

Solar panels taped to back of box to be placed against

Classmate who stuck her "happy notes"

Figure 1: The Happy Box.



3 LED lights in parallel circuit. Sign provides direction to classmates

Solar panel affixed next to bathroom light activates circuit

Sketch-up shows technical dimensions and how/why respond to social challenges

Figure 2: The Occupied

We selected these two cases because they reflect different ways of thinking about and responding to classroom sustainability, and come from two different classrooms in two different states. We describe three forms of *making present practices* that emerged as community ethnography as pedagogy was interwoven into the teaching of integrated science and engineering: 1) Modeling ethnographic data, 2) Re-forming injustices towards understanding and solidarity, and 3) Making social change dynamic and visible. We describe how these practices emerged, and show how they worked towards moments that allowed for new relationalities to emerge – restructuring positional and knowledge hierarchies among community, students, teacher and science – conditions, we later argue, necessary for moments of rightful presence to emerge.

Modeling Ethnographic Data. Community ethnography was used throughout the design challenge in numerous ways. As the youth sought to initially determine what problems to solve, they conducted surveys and interviews with school peers and staff as well as community members focused on the community sustainability concerns community members faced, and what those concerns meant to them and why. These data became important resources the youth drew upon to organize their experiences in their classrooms and community. They graphed survey results and conducted content analysis of comments made by the people they surveyed and interviewed. Modeling their ethnographic data in these ways served as a powerful making present practice for these representations made visible both the classroom or school norms and routines which the students found oppressive and they helped to illustrate scales at which they occurred. These representations also positioned the students' experiences as valuable scientific data.

With Happy Box, the youth used graphical analysis of ethnographic data to *make present* their concerns about bullying and lack of fun as current and salient issues to be tackled in science class projects. As Kristen explained: *From the survey we found that 55% of the community members we interviewed felt that school was too stressful and not fun enough. 45% also said that we do not celebrate and encourage the community enough, we only celebrate grades. So we decided to make a Happy Box where encouraging messages and cards can be left for classmates in our classroom so if you have a bad day or you just need some positive words to feel better, you can get that from the Happy Box and know that people care.* The power of the numbers, and their visibility in graphed data, legitimized their own experiences feeling marginalized by this testing oriented culture. The girls also surveyed schoolmates whom they did not typically come into contact with. Learning that they shared stark similarities with their own concerns about their school –too stressful and punitive in tone – further affirmed their wish to address this concern.

Kristen's transformation as a result of the community survey was significant. Ms. D was "amazed" at how Kristen became "totally into the project after the survey." She said: "*Ms. Grumpy (affectionately) right here has just turned into the super I-engineering leader. She made me sit with her during lunch and showed me what she and her group are going to design. The Happy Box. She ran it. She was the leader."* Ms D agreed with Kristen's group that "*it is really hard for kids to transition from whatever turmoil they just endured in their home lives or out of school…and you wouldn't believe what some of these kids have to face each day… and to come to school and be expected to immediately switch-on and be focused*."

With The Occupied, the youth conducted content analysis of open-ended survey items and interviews with community members. These detailed comments offered youth the language to describe their experiences in ways that illustrated how the problems the community faced were much bigger than themselves and their own experiences. When Tryne reported that one of their survey participants indicated that "*people were worried about*

people just barging in our classroom" the group had a way to frame their own experiences with the bathroom.

In both examples, the data provided the language, the visual representation, and the evidence to allow the students to name and push back against the dominant narrative that there were no real injustices that were solvable in the classroom. They also provided a way for the youth to connect problems within classrooms to broader problems within the school and community. Ms. D and Mrs. J were surprised at the social issues revealed by these surveys that they were not aware of and supporting supporting students in survey content analysis helped give the students the words to name those problems to solve in science class.

Re-performing injustices towards understanding and solidarity. As students imagined projects that might solve some of the problems they identified, they used their ethnographic data to re-perform the injustice documented. We see this idea of re-performing injustices towards understanding and solidarity as a second *making present practice*. This practice was particularly powerful in how it involved both teachers and students using hybrid discourses to justify engineering design considerations, such oral testimonies and narratives of personal experience.

As The Occupied group sought to explain how bathroom bullying worked so that they could attend to technical design features, they re-enacted narratives of their experiences of being barged-in upon. In one re-enactment, Sophia walked into the bathroom while Mateo knocked and put his ear to the door. As he did this he narrated: "*See, the rule is that we have to knock on the door, and put our ear to the door to hear if anyone is in there. If we don't hear anything its clear to go in. But, some kids pretend they don't hear nothing, and they walk in*." He then walked in on Sophia, who re-enacted the humiliation of being walked in upon.

These re-enactments served to connect their project to the broader group of students in the class as they garnered attention with their dramatics. Such re-performances, whether dramatic or mundane appeared to crystalize moments of refusal to be victimized. The Occupied had produced a sketch-up of their design, which described the main technical specifications: a 3v solar panel that connected to a single white LED light, connected by 12m of copper tape with a layer of protective electrical tape to guard against wear and tear. The solar panel would be activated by turning on the light in the bathroom. The sketch-up also included one main social specification: To make the light so that people would see that the bathroom was occupied (see Figure 2c).

When sharing their sketch-up with community members in order to solicit feedback, each youth, offered corroborating testimony about how the bigger (and hidden) problem of bathroom bullying were the rumors that bathroom bullies start in school hallways about what they purported to witness in the walk-ins. These rumors, Mateo reported, were what "really hurt" because they were not true. While the Occupied in some ways is humorous, it is also serious. For Mateo, being "walked in on" while using the bathroom represented a safety issue that he and his friends had experienced. This experience had spread out with students' rumors outside the classroom making students to "never [go] to the bathroom during the day anymore."

As the students were encouraged to solicit community ideas as homework, Mateo started bringing in electrician supplies from home, further building on the connections to cultural knowledge and practice that the ethnographic activities opened up. He started role-playing the master electrician, wearing his uncle's electrician shirt, he brought in electrical tape, and began to tell stories of learning to build circuits from the age of 3, with gummy worms as he went on the job with his uncle. His peers enjoyed his stories and they commented on how cool his shirt was. These re-performances, which took the form of dramatic re-enactments, role playing, and testimony, legitimized students' experiences of systemic oppressions as *a part of* engineering design, connecting the power of their experience with what it meant to engage in STEM.

With the Happy Box, such re-performances took shape through the illustrations the girls included in their Box. In their initial sketch-up design, the girls intended to construct two simple circuits, each lighting one LED light, to decorate the front side of the box. They thought that coin-cell batteries might power one LED light for a fairly long period of time before they would have to replace the batteries. However, when choosing a box to work from out of all the recycled boxes available, the girls chose a children's shoe box which had a whimsical design on the box cover. Kristen and Elsa really liked the design and proclaimed it "Happy!" They were particularly drawn to the globe image with children surrounding it in a circle. See figure 1.

Here, the girls sought to re-enact their desire to be happy, and to help others to be happy, by situating it within a playful design. As the design included children around the globe, they sought to further connect their desires to be happy with children globally, signally a concern much bigger than their classroom. They liked that the "children around the earth means everyone is important." Later, the girls spent time decorating the front of the Happy Box by choosing which of the patterns to color in and highlight, to draw attention to specific features. Elsa pointed out: "*See these children around the globe? There are 11 of them. We colored 5 pink for the girls, and 5 blue for the boys, and the one right on top is half pink and half blue, for transgender kids, because you gotta include everybody. Everyone is important. So we want to light up the kids, maybe a few of the boys and girls but definitely (emphasis Elsa's) the transgender kid*."

As this quote indicates, re-performances made visible the struggle of young people to belong in their classroom schools and community. They not only linked places, such as classrooms, with local and state politics, they put in productive tension the oppressions the students sought to flee and their refusal to be victimized. With the Happy Box, the girls specifically gave witness to emotional needs of transgender children. Given that their home state of NC had been embroiled in a bathroom controversy regarding transgender children and bathroom use, this is not a trivial concern. With the Occupied, re-enactments and testimonials allowed the silent bullying to be made problematic – to be laughed at as it lost its power over the youth.

Making social change dynamic and visible through engineering/making. On-going dialogue among students and community members supported critical considerations on whether and how emerging designs addressed the concerns that students cared about. These on-going dialogues gave rise to a third *making present practice*: Making social change dynamic and visible through engineering/making. This was an on-going and iterative practice that not only opened up opportunities for the youths' experiences of historicized injustice to be challenged in the classroom, but it also worked to position the youth as highly capable and creative with their STEM/Making knowledge.

When community members visited to provide feedback to the construction of designs, The Occupied learned that some were concerned that the one LED light would not be visible enough to alert classroom members that the bathroom was occupied. The group decided to add 2 additional lights (forcing a move from a simple to a parallel circuit) and black construction paper as a background. This required the group to test multiple solar panel styles to find one that generated enough voltage for 3 LEDs, and that would not melt when placed so close to the incandescent lightbulb in the bathroom (See Figure 2).

Mrs. J fretted that *The Occupied* would not get their project to work given the new layers of complexity. She admitted to not quite knowing herself, from examining their technical sketch-up and design, whether it could work or how to help them fix it. But Mateo overheard and challenged her, as Mrs. J describes: *"I truly did not think they could pull that off. Never saw them frustrated. They just went right back to work. In fact [Mateo] after he heard me say that said to me, Be honest, did you really think we could not do this?I said in all honesty…I didn't think you could pull it off. I am impressed. He just smiled. He can be difficult but he handled this with a smile almost the whole time. And confidence."* This appeared to be an important moment when Mrs. J eventually recognized what the group could accomplish and what they cared about. She told them that the project would "help the class so much." She noted that seeing this success, and in particular, Mateo with the confidence and smile that eluded him all year, got her to wonder about him and how she might better reach him.

The youth explored and experimented with different technical options so as to *not dilute their social message*: Three brightly lit LED bulbs would literally send a bright message about the fact that the bathroom is in use, and no one should barge in. Leveraging on complex engineering/making practices to send a strong social message was also evident in the Happy Box case.

The Happy Box group wanted to send a clear message that all students matter so they made sure that girls, boys and transgender students on their Box were lit up. This required them to experiment with different circuit types so that they could light five LEDs with one hand-crank generator. However, through community dialogue, the girls decided the lights needed to stay lit when Happy Messages were present to remind people "*everyone matters in our class all the time*" and to not disrupt classroom routines, when a student needed to stand up to crank the generator to power the LED lights. The girls had to change their power source to solar because a handcrank generator, without a capacitor, would not keep lights lit. But this presented the further problem of needing to split the lights into two parallel circuits due to the power demands of 5 lights and smaller solar panels.

They had to rethink their circuitry and energy source, because they "*are not going to use five batteries and keep replacing them, it's expensive*." Julia tried out three different versions of parallel circuits in a circular form. After building three differently shaped parallel circuits because of the positioning of the lights (which had to light up the 'heads' of the figures), the group managed to get 3 of the five lights to light up with a hand-crank. Julia was determined to get all 5 lights to light up and continued to mull over the circuitry with Edna's suggestions. 5 LED lights, with the transgender child's LED in the center, was critical to the girls. The group decided that the LED lights had to be lit continually to show that "*everyone matters in our class all the time*." The class had access to small solar panels, and one would not be enough to power 5 LED lights. After more collaborative work, they settled on the two parallel circuits, one powering 3 lights, the other with the remaining two, and each connected to a flexible solar panel that is taped on the outside of the box.

More than the other two *making present practices* previously discussed, this practice directly linked engaging in dialogue with community members with opportunities to deepen STEM expertise and to be recognized for it. The process of constructing and reconstructing designs as a result of new insights from community dialogue became physical manifestations of historicized injustice and a refusal of victimization, while also reflecting strong connections between classroom, school, and community. These are not minor changes for sixth grade students, but the girls worked through the complexities so that their design attended strongly to the problems they identified.

4.2 How did these practices support a rightful presence in science class?

Making present practices challenged the normative culture of learning and participation in their science classrooms, creating conditions that made moments of rightful presence possible. They also helped to make visible the ways in which intersecting scales of injustice play out in science classrooms, denying students a rightful present there. We believe that as *making present practices* were continually re-enacted and re-created through a range of localized activities and informal encounters, rightful presence emerged, at least in moments. The data suggest that are two intersecting ways in which to think about rightful presence.

First, making present practices restructured positional and knowledge hierarchies allowing moments of rightful presence for individual students, previously marginalized, to emerge. We are concerned with how, and by whom, youth were recognized and valued for their expertise, reifying rightful presence. For example, the making present practices enacted as part of constructing *The Occupied* provided opportunities for students like Mateo to build upon and share the knowledge and practices he brought from home. But, Mateo, like many of his peers of color, for the most part, has been positioned as an outsider to school science – a young boy whose expertise from home and success in his project surprised his teacher. And yet, Mrs. J. cared about Mateo as she cared for many of her students. She worried about his home situation, where he was being raised primarily by his uncle while his father was incarcerated. She often let "his mind wander" because she did not know "what to do with him." She often called him out to stay in his seat, when he roamed around the classroom during instructional time.

During the construction process and as the groups sought to iteratively refine their projects in response to community feedback, Mateo and his groupmates had to walk repeatedly from their desks on the far side of the room to the bathroom to work on their project. As Mateo moved about, Mrs. J. noticed that some of the students began to ask Mateo for help when their circuits were not working. She began to position him as an expert, especially when she got stuck, "*It's wonderful for kids too. I can say, 'I don't get this. Mateo could you look at this." Sometimes you can find student experts*." Not only was Mateo recognized for his expertise, his freedom of movement opened up in the classroom. This is not minor. He is a student whom Mrs. J initially described as a troublemaker with a "sad" background. Mateo's emerging identity as an expert in circuits gained a rightful presence in the

classroom, overshadowing his "sad student" identity that Mrs. J has thus far held as Mateo's sole identifier. Moving as an engineer across the classroom to work on his "site" (bathroom) further solidified Mateo's rightful presence as a classroom electrical engineer.

Likewise, engaging in the community ethnography provided Kristen, Elsa and Julia to establish a rightful presence in middle school engineering, where their concerns about the school's punitive culture that students suffer from became the impetus to engineer. We see how the girls further establish their rightful presence with their Happy Box innovation. Thus, *making present practices* help students bring to bear issues salient to both their everyday lives at school and their science learning, issues that may not be immediately deemed relevant, or even known to exist, by their science teachers.

Second, making present practices made legitimate in classroom culture particular relationalities previously unsanctioned, while creating tangible symbols of rightful presence. Both projects became a part of classroom practice. Each time the bathroom was used in Mrs. J's classroom, The Occupied lit up, a visible reminder of Mateo and his groups' innovation and expertise, and the class had the opportunity to collectively monitor the bullying situation. About a month after the unit was completed, Angie stopped in the classroom to talk with the teacher and stayed to help some students with their work. A student had gone to use the bathroom. Another student tried to barge in on her, at which point, several students hollered in unison "the lights are on!" at the barging student. When we asked a student whether the Occupied always worked so well, he responded, "*We've gotten the bullying problem down by about 90 or 95%. . . The Occupied is an amazing project*."

When 5th grade graders visited Mrs. J's classroom, both visiting teachers and students pointed to the design as important and something they needed for their own bathroom problems. Soon, many teachers were requesting the same system be installed in their classroom. Here we see how these making present practices legitimizing "change" as an important outcome of STEM learning. This is important. We believe this says something about "rightful presence" in how students "should feel" or "behave" or "have the right attitude and ready for learning." Children have complicated lives and many in this community have stressful family situations. Students should not have to feel "bad" about being "sad" and "not ready to learn". Being "cranky" in the sixth grade should be a legitimate feeling that is acknowledged and empathized with, not punished for.

The purpose of the Happy Box is to, in some measure, transform the punitive, un-fun, test-scores-first school culture. Ms. D put the mailbox to work immediately. Both Ms. D and Edna wrote notes to the students. The Happy Box group was able to use their innovation to signal the impending mail, and to pass out envelopes to their peers. Some stuck their notes onto their computer laptops and in their lockers. Therefore, rather than acquiescing to the existing school culture, the girls sought to transform it, and to bring everyone along by being purposefully inclusive. This was evident in the girls' decoration of the box and Elsa's explanation of including everyone in their community, specifically transgender friends as well. This socially-informed design feature caused the girls to take up a more technical challenge than they had previously intended –building a parallel circuit to power five lights arranged in a circle, compared to the initial two simple circuit with one light design. Because they were wedded to the idea of having the different figures representing different students all light up so as to send the message of inclusivity, the girls worked hard at the circuitry.

Also, the Happy Box group was clear that they wanted their box to contain messages of encouragement and solidarity that is shared in the morning when the school day began, right after morning announcements from the Principal that is almost always test-scores related. The girls pushed for the rightful presence of relationality to be acknowledged from the start of the school day: Relationality between friends; relationality between the home, out of school, and school worlds that students are required to traverse and negotiate; relationality between the students, teachers and administrators, about whose voice matters in shaping classroom and school, culture. As it is very clear to the students at Sage, low test scores are not acceptable, the Happy Box girls sought to counter that it is equally unacceptable for a student to feel bad and stay sad because of something that happened at home before they came to school. Walking into the classroom and seeing the lit-up Happy Box is a tangible and visible symbol and reminder of the rightful presence of children emotions, youth turmoil, connected lives, and friendship in Ms. D's 6th grade science classroom.

4.3 Discussion

We have argued that to seriously take up equity concerns in teaching and learning STEM and STEM-rich making, we need to consider the ways in which teaching is both an historicized and relational activity. The construct of rightful presence is one way to consider more systemically how to make sense of the historicized and relational nature of teaching. Whether and how students are recognized and valued for what they bring to learning as well as how they are supported in more expansive outcomes of learning all are shaped by – and shape – the extent to which one has a rightful presence in science classrooms.

Our study shows how designing for community ethnography as a part of engaging in STEM-rich making in the classroom support the emergences of three *making present practices*: modeling ethnographic data, re-performing injustices towards understanding and solidarity, and making change dynamic and visible through engineering/making practices, all of which reflect the on-going struggle youth face in their lives, write these injustices onto a longer history of struggle in the school/classroom, and allow for a refusal to be victimized.

Making present practices opened up new modes of previously unsanctioned relationality among students, teachers, community and disciplinary knowledge and practice. Students had new opportunities and structures for being recognized for their experience and legitimized spaces for doing so. Students were not welcomed as fuller members of the science classroom simply because their science/engineering expertise grew. Other forms of expertise also became important levers in locally important ways. Having multiple forms of expertise and ways to enact it towards solving injustices were the process and product of science learning, a vastly different scenario than in most science classrooms.

Using a rightful presence perspective to lens our work in the classroom settings also revealed four distinct differences from its previous conceptualization. First, the making practices identified in the borderland and refugee/immigrant literature are public and shared by those willing to take them up. What we see as powerful

in our study is that the making present practices enacted by youth were done so directionally; that is, in part, in solidarity with their teacher, a specific point of power in their classroom, and a potentially important ally who may be able to enact more equitable practices, at least at the classroom level.

Second, absent in the former literature in making is attention to the multiple scales of activity upon which guest/host relations take shape. The previous literature calls attention to relationality in terms of time (past, present, future) and place (previous and current home). Attending to scales of activity across time and place mattered in the youths' efforts, too. However, the youth explicitly called attention to *intersecting scales of injustices* in their work – in terms of school, class and science – at both the local and sociohistorical level [18, 19]. The Happy Box has rippling scales of impact, from the immediate (individual students who writes and receives notes) to Ms. D's classroom culture, to the school culture, similarly with Occupied. Further, projects like The Occupied made visible both the immediate problem of bullying in the classroom, and attention to its sociohistorical location as it primarily affected and further marginalized boys of color. One key aspect is that the relationality sought for by students reflect the particular institution of public schooling with existing, historical oppressive structures, manifested in practices that value and normalize a particular ideology –that of test scores, strict discipline, racialized and gendered experiences.

Third, making present practices, as emergent of community ethnography experiences, expanded social networks, increasing more opportunities to broker for rightful presence. Youth and teachers strategically brought new and diverse people into the design conversation, such as their friends, parents/grandparents, teachers, engineers, and also little kids, incorporating the technical and social concerns discussed into their designs. This allowed the youth to advance the technical quality of their innovations while deeply ensconcing themselves as an integral part of their design. The deterritorialization of engineering/making design paved the way to the deterritorialization of other spaces in which youth from non-dominant communities had been historically marginalized).

Lastly, while refugees and immigrants physically flee places of oppression in hope of safety and acceptance in foreign sanctuary cites, the students here are bound, literally and figuratively, to reinhabit their physical school spaces through struggling for rightful presence, through moment-to-moment efforts [18].

Making present practices, while potentially empowering, however, are fraught with risk and tension. For many students, especially for those with whom we most closely work – students of color and students in poverty – a rightful presence in the science classroom is not guaranteed. The current structures of schooling and science actively work against it. We believe that the design tools of community ethnography support the production of making present practices in ways that open up moments of rightful presence. These moments are often transient. Rightful presence is tenuous at best for some youth. Perhaps, optimistically, we can argue that such visibility opens up *moments* of rightful presence, which can and must be built upon. The emergence of making present practices support the youth up-ending standard expectations of what it meant to make, to produce an engineering design and/or a school artifact. In other words, as the histories and geographies of the youth shaped the ways in which they defined the problems and the solutions they developed, the youth disrupt the historically established notion of what counts as STEM/making in school settings and whose knowledge or practices matter in making.

5 CONCLUSIONS

The dominant equity narrative in STEM/Making education is problematic because it does not align with the goals of justice. It positions youth, especially those from non-dominant communities, as inferior and in need of remediation if or when they "lack" how the field has framed what counts as STEM/Making (mostly white, middle class, and male). The youth in these classrooms, through enacting making present practices, pushed back against normative structures in the science classroom. They engaged in design work that leveraged what they learned in their class, bent towards justice but also unpredictable ends, but ends that also opened dialogue around the problems they collectively faced and their capabilities in responding to them.

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REFERENCES

[1] Honey & Kanter, 2013; Design-make-play: Growing the next generation of science innovators. New York: New York Hall of Science

[2] Peppler, K. A., Halverson, E., & Kafai, Y. B. (Eds.) (2016a). *Makeology: Makerspaces as Learning Environments (Volume 1)*. New York, NY: Routledge Danielak et al, 2014

[3] Hatch, M. (2014). *The maker movement manifesto*. New York: McGraw-Hill.

[4] Blikstein, P. (2013). Digital fabrication and 'making' in education: The democratization of invention. In J. Walter- Herrmann & C. Bu□ching (Eds.), FabLabs: Of Machines, Makers and Inventors. Bielefeld, Germany: Transcript Publishers, pp. 1-21.

[5] DiGiacomo, D. K., & Gutiérrez, K. D. (2016). Relational equity as a design tool within making and tinkering activities. *Mind, Culture, and Activity*, *23*(2), 141-153.

[6] Ladson-Billings, G. (2006). From the achievement gap to the education debt: Understanding achievement in US schools. *Educational researcher*, *35*(7), 3-12

[7] National Academy of Engineering. (2010). *Engineering, Social Justice, and Sustainable Community Development.* Washington DC: National Academies Press

[8] Haan, M., Leander, K., Unlusoy, A., & Prinsen, F. (2014). Challenging ideals of connected learning: the networked configurations for learning of migrant youth in the Netherlands. *Learning, Media and Technology.* 39:4, 507-535, DOI:10.1080/17439884.2014.96425

[9] Capobianco, B. M., & Mena, I. B. (2013). Longitudinal Profiles of Children's Conceptions of an Engineer. *International Journal Of Engineering Education*, *29*(2), 415-425.

[10] Barnett, C. (2005). Ways of Relating: Hospitality and the Acknowledgement of Otherness. Progress in Human Geography 29(1):5–21

[11] Squire, V. (2009). Mobile Solidarities: The City of Sanctuary Movement and the Strangers into Citizens Campaign. http://www.open.ac.uk/ccig/news/mobile-solidarities-the-city-of-sanctuary-movement-and-the-strangers-into-citizens-campaign

[12] Ramsay, N. (2009). Taking-place: Refracted Enchantment and the Habitual Spaces of the Tourist Souvenir. Social & Cultural Geography, 10(2):197–217.

[13] Vrasti, W., & Dayal, S. (2016). Cityzenship: rightful presence and the urban commons. *Citizenship Studies*, *20*(8), 994-1011

[14] Cammarota, J., & Fine, M. (Eds.). (2010). *Revolutionizing education: Youth participatory action research in motion*. Routledge

[15] Gutiérrez, K. D., & Jurow, A. S. (2016). Social design experiments: Toward equity by design. *Journal of the Learning Sciences*, *25*(4), 565-598.

[16] Authors, 2001.

[17] Strauss, A., & Corbin, J. (1998). Basics of qualitative research: Techniques and procedures for developing grounded theory. Thousand Oaks, CA: Sage.

[18] Gutiérrez, K. (2012). Re-Mediating current activity for the future. *Mind, Culture, and Activity*, 19, 17–21.

[19] Cole, M., Kaptelinin, V., Nardi, B., & Vadeboncoeur, J. A. (2016). Scale, Agency, and Relationships: The Work of Cultural-Historical and Activity Theoretical Research. *Mind, culture and activity*, *23*(2), 93-94