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Making a Place in STEM:
Latinx Students' Experiences and Trajectories in Community STEM Programs

A dissertation submitted in partial satisfaction of the

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in Education

by

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Making a Place in STEM

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ABSTRACT

Making a Place in STEM:

Latinx Students' Experiences and Trajectories in Community STEM Programs

by

Jasmine McBeath Nation

It is important to understand why Latinx students remain underrepresented in STEM fields despite the confluence of the Latinx population expansion and exponential growth of lucrative and secure STEM careers in the United States. Considering access to these STEM opportunities is an economic and social justice issue, it is imperative that researchers document diverse students' experiences and trajectories, as well as consider new approaches to incite interest and encourage long-term participation in STEM. Therefore, this three-paper dissertation examined Community STEM projects which engaged Latinx students in STEM afterschool activities and provided a bridge for some to pursue high school STEM learning opportunities. I focused on three overlapping groups of Latinx adolescents (12-16 years old, 14 participants total) who participated in two long-term multidisciplinary science and social action projects at a local Teen Center. I employed an ethnographic perspective and examined students' roles and viewpoints by tracing dialogue and multimodal practices across time. I analyzed video records of sessions, field notes, individual and group interviews and student products. I applied the theoretical framework of Cultural-historical Activity Theory to examine the relations of the teen participants with their creations, and how tools interacted with norms, division of labor, and community relationships to affect their understanding of STEM-related artifacts and tools. I also utilized Figured Worlds to explore how participants created and maintained a "world" of Community STEM defined by norms, artifacts,

activities, discourses, and performances. Finally, Bridging Multiple Worlds provided an alternative but complementary perspective into "worlds" as cultural spheres of influence, illustrating how students traversed spaces including the Teen Center but also school, home, and STEM academies. I documented the trajectories of students and their perspectives on challenges and supports in STEM both in and out of school.

In the first paper, I examined a group of seven Latinx young women who displayed data from a community survey in the format of an interactive word cloud. I uncovered tensions in the design process and associated possibilities for youth expression and identity development. In creating and presenting this project, participants constructed identities as youth leaders, community members, and makers. In the second paper, I examined how seven members of "the data team" collected, analyzed, and presented data on local noise pollution. I illustrated how teen participants took on roles such as data analyst, maker, and community scientist, and created signature science artifacts including acoustic panels, maps, and data files. The project reinforced views of self while offering new ways to engage with science content and contribute to the community. In the third paper, I examined STEM trajectories for four Latinx young women who participated in Teen Center activities and later were selected for competitive STEM academies. I illustrated their perspectives on the social and physical environment of the STEM academies and supports and barriers to participation. While the engineering academy provided wonderful opportunities to use authentic tools and engage in the practices of engineers, it was somewhat inaccessible to Latinx families and participants reported mixed feelings about their minority status in the academy. Overall, I outlined supports and challenges in both novel Community STEM programs and high school STEM academies, characterizing patterns of participation and identity development for Latinx students navigating diverse learning environments.

This work is derived in part from an article published in *Mind, Culture, and Activity* in the Special issue on Young People, Digital Mediation, and Transformative Agency from Fall 2019, available online: https://www.tandfonline.com/action/journalInformation?show=specialIssues&journalCode=hmca20

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I. Overall Introduction

Background

Although it is extreme to argue that "the greatest advancements in our society from medicine to mechanics have come from the minds of those interested in or studied in the areas of STEM", STEM can be powerful in terms of local and global economic growth, stability, and quality of life (Langdon, McKittrick, Beede, Khan, & Doms, 2011, p. 6). In the past decade, policymakers have prioritized students having a foundational understanding and interest in STEM, to prepare students for 21st Century studies and careers (Bell, Lewenstein, Shouse, & Feder, 2009; National Research Council, 2011). Even for students not pursuing STEM careers, engaging with STEM content could help them see the value of STEM in everyday life and make informed decisions on health care, technology, and the environment in an increasingly interdependent world (National Research Council, 2011). Additionally, students often find engaging in the STEM practices of problem-solving, inquiry, and experimentation empowering (Blikstein & Worsley, 2016). However, despite the diverse benefits and increased focus on STEM, women and ethnic minorities continue to face significant barriers and remain underrepresented in STEM majors and careers. In particular, Latinx women make up only 2% of the STEM workforce, despite accounting for 8% of the population (NSF, 2017). Latinx middle school girls are unlikely to aspire to STEM careers (Crisp & Nora, 2012), and Latinx women are less likely than other women to earn STEM degrees (Gándara, 2015).

The underrepresentation of Latinx students is complex, but a handful of scholars have delineated barriers including access to high quality academic preparation and viewing themselves as less competent in science and math or less qualified to be a scientist (Crisp &

Nora, 2012; Sorge, Newsom, & Hagerty, 2000). Latinx women in STEM are also challenged by a "double bind" of racism and sexism (Cantú, 2012; Johnson, 2011). To compound the problem, the research on the experiences of Latinx women in STEM is lacking, with very few studies documenting why Latinx women are interested in or pursue STEM majors and careers (Crisp & Nora, 2012; Rodriguez et al., 2017). More Latinx women in STEM could mean personal and community empowerment as well as global innovation and development (Langdon et al., 2011; Wittemyer et al., 2014). Therefore, ensuring that Latinx young women can access resources and develop identities as STEM people should be a priority both for social justice and economic reasons.

The construct of "identity" can provide insight into how Latinx young women navigate educational pathways and develop skills relevant to STEM. Given the exponential increase in research focused on identity (Vignoles et al., 2011), it is safe to conclude that "the age of identity is upon us" (Bucholtz & Hall, 2005, p. 608). Within this trend, there is an emerging body of research on "science identity" or "STEM identity", especially from a sociocultural lens (Varelas, 2012). From this perspective, identity is created and modified moment-by-moment through people's actions, relationships, resource allocation, and culturally and historically defined norms of behavior (Calabrese Barton et al., 2012; Silseth & Arnseth, 2011). People engage in a process of "becoming" based on their STEM performances and others' recognition of them as a STEM person or not (Carlone & Johnson, 2007; Stapleton, 2015; Urrieta, 2007). Examining identity in relation to STEM could help researchers visualize teaching and learning in new ways, understand students' perspectives and negotiation of norms, and push science as a discipline toward social justice (Carlone & Johnson, 2007).

Out-of-school science programs provide an opportune context for examining STEM identity development and intentionally broadening the range of expression for STEM identities (Munley & Rossiter, 2013; Varelas, 2012). Afterschool programs often have more flexibility than school settings, and can promote diverse ways of knowing, blur disciplinary boundaries, and encourage skill building in STEM relevant to STEM careers (Afterschool Alliance, 2015; Krishnamurthi, Ballard, & Noam, 2014; Calabrese Barton, Birmingham, Sato, Tan, & Calabrese Barton et al., 2013). Additionally, afterschool sites are well-positioned to expand opportunities for students of color, considering that African American and Latinx children are more likely to attend afterschool programs than White students (Afterschool Alliance, 2015).

Within the world of afterschool science, there is great potential in "Community STEM." Programs applying what I refer to as a "Community STEM framework" focus not on STEM content but rather how experimentation and youth knowledge redefine participation in community decision-making processes (Birmingham & Calabrese Barton, 2013; Fusco, 2001). Community STEM projects empower youth and promote a deeper connection with science, using inquiry and data collection to build community gardens, host technology faires, or create artifacts that encourage discussion about noise pollution (Balestrini et al., 2016; Birmingham & Calabrese Barton, 2013; Calabrese Barton et al., 2013; Fusco, 2001). These programs can be especially powerful for STEM-underrepresented groups, since they draw from individual and collective strengths, contextualize science learning within community and environmental issues, and position youth as active contributors whether researching about problems or engineering solutions (Balestrini et al., 2016; Birmingham & Calabrese Barton, 2013; Calabrese Barton et al., 2013; Fusco, 2001).

Within the Community STEM framework, I focus on the subtypes of “community science” and “Critical Making.” Community science is a type of citizen science where the community defines the problem, designs the study, collects, analyzes, and interprets the data (Bonney et al., 2009; Wilderman, 2007). In youth-oriented community science projects, young adults and researchers work together to collect or analyze data and disseminate results. Students use science to deepen their understanding of place, to both investigate and impact their communities. Similarly, in Critical Making, students become “agents of change” through designing products or technologies to address inequities in their lives or communities (Cavallo et al., 2004). Critical Making developed from the practice of “making”, where people conduct personally meaningful, creative projects with a variety of materials including digital tools, electronics, and traditional crafts (Resnick & Rosenbaum, 2013; Martin, 2015; Peppler et al., 2016). Critical Making adds Freire’s critical pedagogy orientation (Blikstein, 2008), combining maker activities with action, reflection, and community dialogue to promote social change (Nation et al., in press). Educators can leverage the inquiry-based practices of community science and the engineering design practices of making to learn about local concerns, collect data, define problems, and design solutions.

In this dissertation, I build on the work of the above scholars, intentionally pairing making with community science in youth-oriented projects. Community science and Critical Making are still not typical in schools or even in afterschool science programs, however there is great potential right now for these novel Community STEM approaches. More research is needed to consider patterns of participation in these learning environments and better understand how these programs support or constrain engagement with science. In particular, there is a dearth of research documenting the experiences of Latinx students in

STEM programs of all types, as well as characterizing how Latinx students develop STEM identities.

Focus of study

The overall aim of this work is to illustrate and broaden perceptions of STEM for underrepresented groups, and in particular Latinx young women. I describe a series of projects at a youth-oriented makerspace I helped start four years ago at a local Teen Center in an unincorporated area of Southern California. Maker activities were connected with social action and community science projects, which were embedded in Latinx teens' everyday lives, and valued their resources and funds of knowledge. Our team focused on the creative, expressive, and collaborative side of STEM, and positioned youth as change agents in their communities. STEM content and literacies were not foregrounded, but rather incorporated as needed to accomplish broader social action projects. By partnering with local community groups and the Teen Center leadership and civic engagement group, we helped ensure these projects were relevant to the individuals and their community. In this dissertation, I focus on three overlapping groups of Latinx adolescents (12-16 years old, 14 participants total, 3 male and 11 female) engaged in long-term multidisciplinary science and social action projects. I also consider how participation was a bridge for some to pursue advanced high school STEM learning opportunities.

Overview and Contribution

This dissertation consists of three papers, each paper describing a distinct but complementary research study involving STEM-related activities at the Teen Center. First, I examine two different year-long programs, the Word Cloud Project and Sound Project. I document what the teens accomplished, what maker and science-related artifacts they created, and how their participation was connected to identity processes. In addition to examining these projects, in the last paper I present the long-term identity development for a group of four girls from the Teen Center makerspace program who began STEM-related academies (engineering and health) in high school.

For Paper 1, the Word Cloud Project, I examine how a group of seven Latinx young women displayed data from a community quality of life survey in the format of an interactive (touch capacitive) word cloud with linked sound effects. I illustrate tensions as the youth struggled to master technology tools required for word cloud design and implementation while ensuring clarity of overall message. My objectives include uncovering systemic tensions in the design process and understanding how project participation expanded possibilities for youth expression and identity development.

Paper 2 presents how a mixed gender group of seven Latinx teens collected and analyzed data on local noise pollution, shared their findings with community stakeholders at a Town Hall, and created artifacts such as maps, charts, and acoustic panels. I explore how male and female participants affiliated with project subgroups, performed science practices, created science artifacts, and authored identities as science people. I sought to illustrate the ways in which the youth, especially the young women participants, took up roles while creating community science artifacts, and the key events that supported or constrained engagement with science.

Paper 3 examines the STEM trajectories of four Latinx students who participated in maker activities and afterwards became the first students from their afterschool program to gain acceptance into a competitive engineering academy in high school. I document how their social networks, ideas about values and norms, and the physical environment of the high school STEM academies shaped identity processes and STEM trajectories for these students. Through narrative profiles, I reveal their perspectives on the supports and barriers to participating in the STEM academies and STEM classes and programs in general.

The three papers in this dissertation begin to address the dearth of research on Latinx girls and their experiences in STEM. This research provides concrete examples of STEM-relevant artifacts produced, characterizes distinct STEM trajectories, and draws attention to Latinx youths' experiences, given their reflections on what it meant moment-to-moment or year-to-year to be a STEM person. The work extends the research on afterschool programs that focus on equity, and confront local and global issues through making, engineering, or community science. Additionally, the papers report on challenges and resources for Latinx young women in STEM programs both in and out of school. As a body of work, the dissertation contributes to theory by elaborating on the construct of STEM identity, and contributes to practice by highlighting the voices of Latinx young women and offering insights relevant to program developers, educators, and policymakers.

II. Papers

Paper 1: Word Cloud Project

Home is Where the Heart is: Latinx Youth Expression and Identity in a Critical Maker Project

The Maker Movement offers opportunities for hands-on science, technology, engineering, and math (STEM) learning that can address disengagement with STEM (Honey & Kanter, 2013; Peppler, Halverson, & Kafai, 2016). Educators draw from making's focus on play, authentic inquiry, and engineering design processes (Bevan, 2017; Martin, 2015), leveraging a diversity of activities and expertise to broaden definitions of science (Calabrese Barton, Tan, & Greenberg, 2017). Despite these possibilities, maker sites, their participants, and their practices have been criticized for being socially and culturally exclusive in similar ways to conventional science, serving youths from higher socioeconomic and limited ethnic/racial backgrounds and not considering female-oriented interests (Buechley, 2016; Vossoughi, Hooper, & Escudé, 2016). This version of making could be problematic for young women of color in the United States, limiting participation and aspirations for making and STEM. As it currently stands, by middle school, Latinx young women are the "least likely of any group to have STEM career aspirations" (Crisp & Nora, 2012, p. 7).

I present an example of Critical Making, an approach for action, reflection, and community dialogue in makerspace implementation designed to promote social change (Nation, Sañosa, Duncan, & Durán, in press). In this framing, learners draw on their sociocultural understanding, or funds of knowledge (Moll, Amanti, Neff, & Gonzalez, 1992), challenging normative views of making (Calabrese Barton et al., 2017). Despite the potential of Critical Maker programs, very few sites have employed this approach and only a handful of researchers have examined programs with these aims (Betser et al., 2016; Blikstein, 2008; Calabrese Barton et al., 2017; Cavallo et al., 2004; Faircloth & Tan, 2016). More research is needed to characterize Critical Maker environments and broaden the definition of what it means to make and participate in maker subcultures towards social justice ends. In particular, cultural-historical activity theory (Engeström, 2001) could offer unique insight into complex learning environments such as Critical Makerspaces, revealing dynamics that expand or limit possibilities for collective expression and identity development.

I examined a Critical Maker project undertaken at a youth center in an unincorporated area in Southern California. I utilized Engeström's (2001) conceptualization of cultural-historical activity theory (CHAT) to explore how a group of seven Latinx young women created an electronically-mediated object to represent community attitudes, and how conceptual and physical tools interacted with norms, division of labor, and team members' relationships with the broader community. I considered systemic tensions as opportunities to question and challenge institutional norms, potentially developing new individual and organizational practices (Engeström, 2001). Examining specific contradictions allowed me to consider the evolving activity system, including changing goals, actions, and outcomes, and provided the resources to articulate identity processes. I asked:

1. What systemic tensions arose in the design and implementation process for youth creating a maker project responsive to community attitudes?
2. How did engaging in a Critical Maker project expand possibilities for youth expression and build on participants' identity processes?

In addressing these questions, I considered the typically examined "structural" components of activity systems, as well as the rarely considered "agentive" dimension of identity to present a more holistic view of collective activity (Roth, 2009, p. 53). I illustrated how Latinx young women transformed themselves and their reality through an ongoing process of social mediation and tool use within their cultural and historical reality. I added to an emerging body of research on Critical Maker environments, while documenting the experiences of a group of Latinx young women engaged in both making and community-action. The paper has implications for research and practice, utilizing CHAT to account for identity, elevating the voices of Latinx youth as change agents, and documenting the dynamics of a Critical Maker program and its meaning for participants and their communities.

Theoretical Framework

Sociocultural Approaches to Identity

From a sociocultural perspective, learners are not individuals internalizing "neutral" norms of speaking and acting, and identity is not "a static, inflexible structure of the self" (Penuel & Wertsch, 1995, p. 84). Instead, identity is a complex and ever-changing trajectory constructed by discourse and practices (Kumpulainen & Rajala, 2017; Roth & Lee, 2007; Vågan, 2011; Varelas 2012). Identity is created and modified moment-by-moment through people's actions, relationships, resource allocation, and culturally and historically defined norms of behavior (Calabrese Barton et al., 2012; Silseth & Arnseth, 2011). Socially and culturally constructed ways of being and talking are "living tools of the self" (Holland et al., 1998) or artifacts that influence how people make sense of and respond to the world (Vågan, 2011). Identities can be considered resources for expressing the self, and as representations of "collective interaction and learning" (Kumpulainen & Rajala, 2017, p. 30).

Learning and identity are interconnected (Wortham, 2006), as identity influences how people act and position themselves, while learning transforms who people are and what they are capable of (Kumpulainen & Rajala, 2017). Identity processes take shape as stories people tell about themselves or social performances (Varelas, 2012). People engage in a process of "becoming" based on their performances and others' recognition (Carlone & Johnson, 2007; Stapleton, 2015; Urrieta, 2007). Individuals' roles are dynamic, with people contributing and positioning themselves in ways that change over their lives and community activities (Gutiérrez & Rogoff, 2003; Vågan, 2011), providing opportunities to adapt and learn novel concepts or shared ways of being (Kumpulainen & Rajala, 2017). Although sociocultural theorists foreground the collective, Silseth and Arnseth (2011) argue that sociocultural approaches are also valuable for articulating expressions of individual identity through a "learning self", since learners are collectively and actively engaged in authoring their selves within and across different communities and their contexts.

Alternatively, Penuel and Wertsch (1995) propose a mediated-action framework that bridges individual choices and sociocultural processes. Their framework integrates Vygotsky's developmental ideas with Erikson's identity domains of fidelity, ideology, and work, or "commitments to others whom one can trust, to an ideology that promises a place in the world with a hopeful future, and to a career choice that can actualize those promises" (1995, p. 88). In this paper, I utilize their mediated-action framework to understand how cultural and historical resources expand opportunities for identity development in local activity settings. Penuel and Wertsch advocate for examining contexts where identity is challenged or evolving and studying community groups to understand how people "struggle against dominant discourses of their identity to co-construct a different way of speaking about themselves and develop new forms of action" (1995, p. 90). While there have been debates between Penuel and Engeström on key elements of activity-theoretical accounts (Engeström, Sannino, & Virkkunen, 2014), I believe that Penuel's mediated-action framework (1995) complements Engeström's activity system conceptualization (2001) and helps consider new forms of action and identity negotiation.

Cultural-historical Activity Theory

Cultural-historical activity theory (CHAT) addresses how people learn, act, and negotiate meaning with others (Roth & Lee, 2007). Leontiev (1978) developed activity as a unit to represent human consciousness, building on the work of Vygotsky (1978). In this approach, individual and collaborative actions interconnect to form activities (Barab, Barnett, Yamagata-Lynch, Squire, & Keating, 2002). As a unit of analysis, activity refers to specific sociocultural contexts that involve intentional action guided by participant motives such as play, formal education, or work (Wertsch, 1985). Individuals make sense of the world through interpreting and adopting meaning-making through shared experiences and actions with others, and as such mediation is key to understanding how people think and act. Activity theory characterizes systems as mediated by artifacts but also collectively oriented toward outcomes that are historically situated. Basic representations of activity systems feature *subjects* (individual or group), an *object* (focal point and/or objective), and *tools* (physical or conceptual cultural artifacts the subject uses to influence the object and achieve the desired objective) (Engeström, 1987). Subsequent elaborations of this basic model feature additional components adding to the ecological validity of the approach by considering *rules* (cultural norms for interaction, patterns of verbal and nonverbal behaviors), *community* (people with a shared interest in the objective), and *division of labor* (how tasks and power are distributed, roles of participants), and further can capture the relationships between activity systems (Engeström, 2001; Sannino, Daniels, & Gutiérrez, 2009).

Contradictions. To better understand the activity system, possibilities for expansion, and identity implications, particular attention should be given to contradictions and tensions. Contradictions, or "historically accumulating structural tensions within and between activity systems" (Engeström, 2001, p. 137), cannot be observed directly. Contradictions are made visible by discourse and actions (Engeström & Sannino, 2011), manifesting as breakdowns, clashes, and problems in coordination or functioning of the activity system (Foot, 2014). Engeström and Sannino (2011) present four types of discursive articulations of contradictions. These occur when someone: expresses incompatible evaluations (dilemma), disagrees or criticizes others (conflict), experiences inner doubt in the face of contradictory forces (critical conflict), or feels trapped by reoccurring unacceptable choices in the activity system (double bind). Regardless of which type of contradiction, they are more complicated than competing components of the activity system and cannot be definitively resolved through reaching a compromise or merging different component priorities (Engeström & Sannino, 2011).

While contradictions are inevitable, they should not be viewed as failures or weak points of a system. Instead, they demonstrate the "richness" of the activity system and reveal "the capacity of an activity to develop rather than function in a fixed and static mode" (Foot, 2014, p. 337). Addressing these clashes can lead to innovation, development, and new patterns of activity and therefore examining contradictions enables reflection and transformation within the activity system (Engeström, 2001; Engeström & Sannino, 2011).

It is my goal in utilizing CHAT and considering contradictions to contribute a rich description of a novel Critical Maker setting, providing insight into practices that expand or limit possibilities for expression and identity development. Although there have been recent studies examining identity given an activity theory perspective (Nardi, Gajdamaschko, & Vadeboncoeur, 2017; Reveles, Kelly, & Durán, 2007; Varelas, 2012), there is a relative lack of CHAT-related identity research (Roth, 2009). CHAT can prove valuable in exploring constructs typically studied from an individual perspective (e.g. agency and identity), to characterize collective development and thereby present a more holistic cultural-historic view (Engeström et al., 2014; Roth, 2009). Additionally, maker programs are relatively new and more research is needed to understand makerspace dynamics, including student agency and systemic tensions that constrain or expand possibilities (Hansen, McBeath, & Harlow, 2019; Kumpulainen, Kajamaa, & Rajala, 2018).

Methodology

Research Site

Data were collected at the Teen Center, an afterschool site which provided bilingual programming for over 50 Latinx youth in grades 6-12. The Teen Center was located in an unincorporated town next to a university. Around 20% of town residents were Latinx immigrant families, primarily low-income. However, the majority of town residents were undergraduate students with median family income over $100,000. Improving the well-being of this community has been a serious regional issue over the last fifty years, given its disparities in income, formal education, and need for social services (Burns, 2016).

Maker activities occurred biweekly at the Teen Center, familiarizing students with technology including 3D printing, virtual reality, microprocessors, and robotic kits. Youth learned about electricity, circuits, and input/output or sense-analyze-act as a way bots interact with the environment. In addition to single-day activities, we implemented longer-term projects following a Critical Maker approach. Critical Making draws from the key tenets of making, where students work on meaningful projects, "often freed from a scripted curriculum, empowered to make choices about their own learning, and using technologies to externalize their ideas in sophisticated ways" (Blikstein & Worsley, 2016, p. 65). However, Critical Making adds Freire's critical pedagogy orientation, calling attention to the critical consciousness needed for social transformation (Blikstein, 2008). Youth engage in a critical pedagogy cycle of reflection, action, and community dialogue that interfaces with maker tools (Nation et al., in press) employing science and engineering to solve problems and confront inequities relevant to them (Calabrese Barton et al., 2017).

Project and Participants

As part of a larger social action partnership project at the Teen Center, youths were trained on organizing and designed a survey before polling 300 residents on community well-being. After collecting survey results, youths who were also makerspace participants worked with the data to identify best and worst qualities of their town and created visual displays in the form of a negative and positive word cloud (Figure 1). Youth then created an interactive word cloud poster made up of electronic circuits and touch capacitance sensors activating sound bites (Figure 2). These circuits used a microprocessor tool and conductive ink. Participants chose twelve words from the most commonly cited phrases about their town, and linked representative sounds so they played when someone touched each word. For example, the word "beach" played crashing wave sounds. The youth presented the word cloud at a Town Hall that engaged community members with their data and suggestions.

Figure 1. Negative and positive word clouds created from survey data.

Figure 2. Interactive, electronically-mediated word cloud.

Participating youth were seven members of an all-female, Latinx leadership group at the Teen Center, aged 12-15. Most of the group initially expressed a low enthusiasm for STEM subjects but agreed to do maker projects as part of their commitment to leadership activities. At the time of the study, Katie was a 6th grader, Irene, Malia, Isabel, and Sophia were 7th graders and Valentina and Alexa were 9th graders. (All participant names are pseudonyms). Irene, Isabel, Valentina, and Alexa were more interested in the art and design aspects of most projects, while Katie, Malia and Sophia were more technology and science-oriented. Sophia and Malia were considered "smart" and "good at Math and Science" by their peers while the others admitted more difficulty in these subjects at school and said they were not known for their science or math abilities.

Data Collection

The research-practitioner team consisted of two graduate students, a lead principal investigator, and four undergraduates who led activities and collected data. During the project, I took ethnographic notes on the design process and implementation challenges, tracing dialogic exchanges and multimodal practices across time (Green, Skukauskaite, & Baker, 2012). In developing findings, I examined video and audio from 15 activity sessions and one exit group interview. Five project sessions focused on discussions, preparation, and the larger social action project work, and 10 sessions focused on creating, troubleshooting, or presenting the word cloud artifact. Total video and audio analyzed accounted for 10 hours. Additional data included four undergraduate field notes, 15 analytic memos evaluating goals and participant interactions, and five artifacts created by youth (web postings, brainstorm lists, models).

Data Analysis

I used activity theory as an analytical tool to represent the relationships between participants and objects, as mediated by the activity system components of tools, rules, and division of labor. I applied Engeström's conceptualization of CHAT (2001) to define the structure of each of these components constituting instances of activity. Data analysis occurred in three phases. In Phase 1, I characterized the system by determining operations, actions, and activities for each session and then coding video files according to the core components of the activity system represented by the immediate setting. In Phase 2, I focused on identifying secondary contradictions, by analyzing the intersections of components and noting evidence of "discursive manifestations" of contradictions (Engeström & Sannino, 2011). In Phase 3, I re-coded transcripts according to the identity themes of fidelity, ideology, and work.

Phase 1: Characterizing the activity system. I first utilized methods from interactional ethnography to construct minute-by-minute event maps for each session and transcribe message units to depict micro-level communication (Green et al., 2012). Session maps illustrated participant actions in a timeline, with arrows indicating dialogue that shifted the focus of the current action (See Appendix A Figure 1). After creating each event map, I listed all participant behavior and organized the list according to the categories of actions and associated operations. I utilized Kaptelinin and Nardi 2012's adaptation of Leontiev's hierarchal structure of activity to depict specific activities, actions, and operations including the motive, processes and sub-processes, and tool use performed with minimal conscious effort. For example, on the session where students linked sounds to key words, for the action of route planning, operations consisted of taking notes, drawing and erasing lines on the model and word cloud (See Appendix A Figure 2).

I used MaxQDA software to directly inscribe codes onto video to identify each component of the activity system. I applied structural codes (Saldaña, 2009) for the components of *subject* (values expressed by the young women, undergraduate facilitators, or graduate researchers), *physical tools* (microprocessor, conductive materials), *conceptual tools* (design-based process, scientific models), *rules* (norms within Teen Center, conventions of maker program), *division of labor* (task types within the maker group, roles of facilitators and participants), *artifacts* (word cloud, lists, blog post and associated goals), and *community* (participants referencing community's values). A coding scheme for subcodes was created and refined through group discussion. The codes from the videos were triangulated with text from the analytic memos, field notes, and focus group transcript.

Phase 2: Contradictions. Components within the activity system were examined to determine systemic tensions. I examined the intersection of two or more components by creating a "code relations" matrix in MaxQDA, which revealed the co-occurrence of codes. When an overlap was identified, I examined the associated retrieved segments of coded video and transcripts. I applied Engeström and Sannino's (2011) discursive manifestations of contradictions framework on the retrieved segments to identify contradictions and determine the type. I documented clusters of words and phrases associated with dilemmas ("but", "on one hand", "I actually meant"), conflict ("no", "I disagree", "not true", "accept"), and double bind ("we have to", "let us" and rhetorical questions). I also considered the use of narrative and metaphor indicative of critical conflicts. Next I applied the discursive manifestation framework to the exit interview transcript, counting the number of phrases associated with each contradiction type.

I then organized contradictions according to which two components they were connected to. I identified themes around three main points of contradiction: subject—

community, tool—object, and division of labor—object. In this paper, I describe systemic tensions related to subject—community and tool—object because they had more identity implications than the division of labor—object contradictions.

Phase 3: Identity implications. Since activity systems are at times driven by attempts to reconcile contradictions, I used systemic tensions as a framework to understand what was happening at key points in the overall project. This included warrants tied to expression of claims of identity by participants. I identified key momentary interactions during the program that included two or more discursive cues corresponding with dilemmas, conflicts, or double binds, "that would serve as exemplar of broader course tensions and innovations" (Barab et al., 2002, p. 85). I coded these interactions according to *fidelity*, *ideology*, and *work*. I then organized these codes into themes based on their connection to different sub-groups at the Center and community relationships.

Results

My activity-theoretical analysis revealed that the young women, working alongside undergraduate mentors and graduate student facilitators, used both physical tools like the TouchBoard and conceptual tools such as the design process to create the functional word cloud artifact (Figure 3). They took up art and technology roles, and shifting responsibilities and tasks related to organizing, implementing, and modifying their representations. They responded to and internalized norms related to the Center, and new norms surrounding the practice of Critical Making. They worked with peers and college students, while striving to represent the broader community. Finally, the word cloud artifact led to the outcome of integrated and validated Teen Center and community identities for youth.

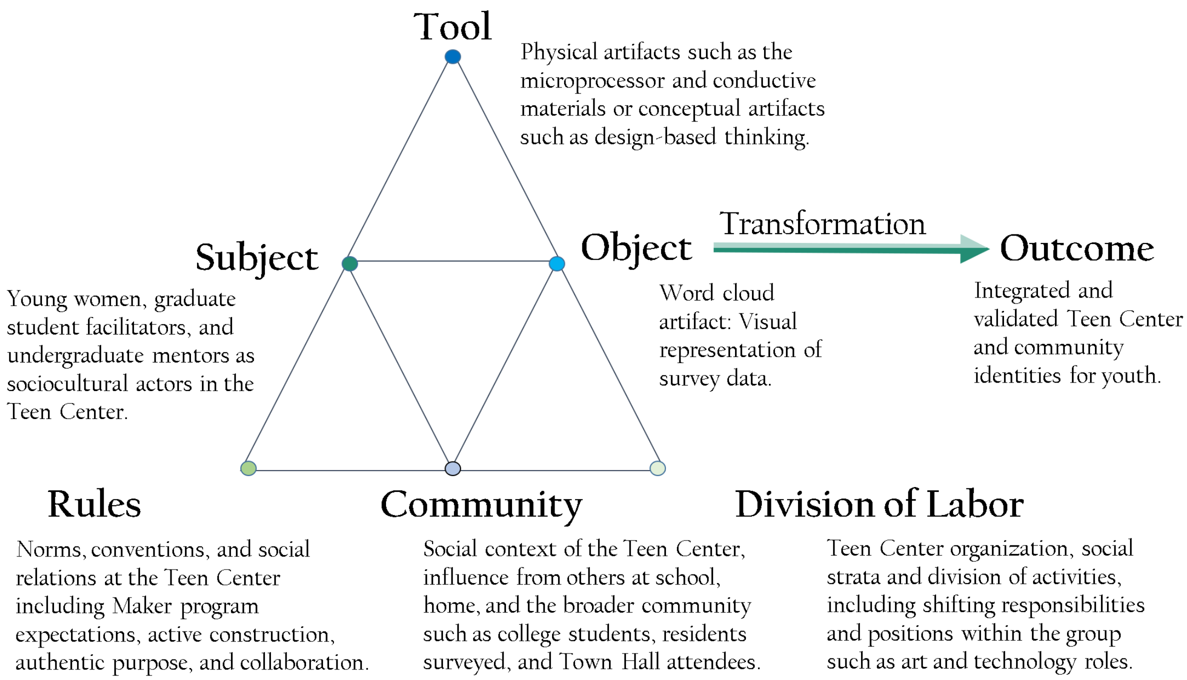


Figure 3. Representation of one realization of the activity system within the Critical Maker project at the Teen Center.

I also found two significant tensions: 1) *Group versus community values* and 2) *Design features versus tool limitations* (See Table 1). I begin with concrete examples from the design process that are representative of each systemic tension. I describe the context, provide segments of session transcripts, then analyze specific actions and their relationship to the overall activity system. I also describe how the young women actively drew from historical and cultural resources to author the word cloud and simultaneously author intersecting identities as makers, group members, and contributors to their community.

Table 1
Contradictions between activity system components

Tensions	**Activity system components**	**Points of contradiction**	**Contradiction manifestation**
Group vs community values	Subject vs community	Overall town perceptions	Double bind
		Designating key words	Conflict
Design features vs tool limitations	Object vs tool	Meaningful yet functional	Dilemma

Tension 1: Group versus Community Values

I describe contradictions between the components of individual and community as the young women negotiated meaning within their maker group to represent their own and other residents' values. I first present examples of the young women grappling with negative reactions to a town they considered home and their decision to gather more information and create both positive and negative representations. I then illustrate the process of key word selection on the multimedia word cloud, and the clashes due to conflicting opinions and values of the group in comparison to other residents.

"My memories live here": Perceptions of the group versus community. A systemic tension emerged when trying to convey meaning that was personalized and relevant to the larger community. At the beginning of the project, Malia asked, "Is [our town] ghetto?" Valentina voiced that outsiders think so, and Malia admitted she asked because her classmates did not want to attend the nearby university because of the town's reputation. Valentina told a story about a teacher asking her if she partied on weekends due to where she lived. Many of the young women expressed dissatisfaction with their town being viewed as "ghetto" or "trashy."

A few months later, the group met to organize and analyze the results from their qualitative surveys of residents. When entering survey data into the word cloud program to create the negative word cloud, Katie and an undergraduate mentor were surprised and confused about many of the negative responses, including "Children run this town," "kidnapping," and "house falling." Other more common concerns included "police", "noise", and "alcohol." Malia, unlike Katie, mostly expected these negative responses, according to her written reflection:

> After collecting the surveys from our campaign, I noticed that our fellow community members had a lot of concerns about living in [this town]. Some examples include: rape, cops, and nudity. We ended up creating a word cloud made up of all of the concerns. I wasn't really surprised at the feedback we got from our community members because I've heard that stuff like that has been an issue in our community for awhile.

The young women discussed the responses recorded by community members, relating to concerns about noise, and adding their own experiences with college students partying and disrupting their studying or disturbing their parents who needed to wake up early for work. They also discussed other issues not represented in the survey, such as with undergraduate housing pushing out long-term resident Latinx families, or the general tendency for the local university to focus on serving undergraduate student needs but ignore secondary-level students. Malia, Valentina, and Irene told emotional narratives, reflecting on their families' experiences with disrespectful college students. While some residents appeared supportive of local families, youth had also seen online commenters posting that if the immigrant families were not happy there they should leave town. The young women asked what could be done, at first rhetorically. They alluded to unacceptable alternatives, expressing a *double bind*, where they lacked a sanctioned voice in town happenings and representations. In the exit interview reflecting on this, the young women commented that they "had to do something" and "came up with our own projects."

The young women agreed that their town had issues, but were dissatisfied with the negative and one-sided picture their survey results provided. Irene expressed, "In my mind it is still my town, my memories live here. This is my home." They recognized the tension between their individual and community representation of their town and questioned what was accepted in the local activity system.

The group determined the survey included a negatively worded free-response question on community concerns but not a positive one. To remedy this, they implemented a follow-up survey to solicit positively worded responses. This prompted a data display of both negative and positive word clouds, and a productive focus on suggestions for improvement while valuing current positive features. Sophia reported “We didn't just want to leave our campaign showcasing the concerns of the residents of [our town]. And so, another part of the campaign was born.” Valentina added, “We wanted to show that, yes, there are some concerning things about living in [our town], but it's also a wonderful place with some beautiful qualities.” The youths’ understanding of their community was mediated by the survey responses and analysis process. The disparity between their group’s view of their town and the community data enriched the project and led to new goals and the creation of a new object, the positive word cloud. The activity system shifted dramatically with the introduction of the multimedia word cloud, new tools including the microprocessor and conductive materials, and altered division of labor required to carry out this new goal of creating a meaningful art piece representing the community’s values.

“I wish basketball was bigger”: Key words for the group or community. When creating the electronically-mediated version of the word cloud focusing on positive qualities of the surrounding community, a contradiction resulted from the interplay of meaning for the participants versus other community members (represented through their survey responses). This contradiction manifested itself as a *conflict* as the young women discussed the number, size, and prominence of various words on the cloud, representing community input. Certain words, such as “basketball”, were chosen as key words because they were important values primarily to individuals in the project while others such as “zumba” were chosen to represent others’ values.

For example, soccer was a common community response and therefore more prominent on the word cloud, however the group enjoyed playing basketball at school and the Center. Malia commented "I wish 'basketball' was bigger", moving her hands across the center of the word cloud as if zooming in and making a "whoosh" sound to indicate enlargement. She communicated that basketball would be centrally placed if it was her personal choice, instead of smaller and on the edge of the cloud. She expressed dissatisfaction with the data as depicting basketball as less important than soccer, which was written in a large font, in the center of the cloud. The young women disagreed but decided to represent basketball despite its size and placement due to the importance in their lives. They downloaded a bouncing ball sound to link to "basketball" and voted not to represent soccer. They did not feel the need to reconcile the mismatch between their values and the community. However, in other cases the young women found various ways to express differing opinions and negotiated meaning in their group when interpreting key words. These conversations and the resulting design process led to deeper exploration and mediated their understanding of community values.

The group chose to represent "zumba" because it was prominent on the word cloud and important to Latinx mothers in the community as part of a weekly exercise class. They first considered zumba from their point of view as an audience. They wanted to communicate the intensity of the class and tried finding sounds of stomping or "heavy breathing." Sophia told the facilitator, "For the zumba we were thinking of putting 'huh, huh, huh'" while Malia raised her arms up to mimic zumba dancing. However, when Sophia asked the group to vote on "heavy breathing" sounds, Irene asked, "What *is* that?!" and Malia said definitively, "Yah, just put music, that sounds weird." Since they were unable to achieve their goal of communicating their experience watching others zumba, they then considered the feeling that zumba invoked for the dancers and suggested work-out songs. The young women agreed with the facilitator's suggestion of Don Omar's "Zumba" considering the genre of Latin pop, chorus of "pégate y zumba conmigo" (come closer and zumba with me) and chants of "zumba!" in the background. The song was much longer than any of the other sound clips, and they often joked about how Malia would set it off "on accident" yet they always let the song play until the end. While listening to the song on repeat and dancing along, they were no longer outside observers to an adult practice. Instead, the young women were immersed in the music and better understood the experience of dancing zumba, reconciling their group's understanding of values with the responses of the broader community.

"It was cool to show them": Identity in relation to community. The young women integrated their childhood and current perceptions with others' views of their town to design their artifact and construct a group ideology. They used their experiences as community members to inform their choices and enrich the project. They had fond memories of visiting places on the word cloud such as Children's Park and the university pool. They mentioned visiting local businesses and recounted phrases used by the "tamale lady" and "el elotero." When considering how to represent "community" or "friendship", they discussed these experiences and asked for opinions from others at the Center. While accomplishing their goals, they discussed school drama, classes, fitness, food, celebrities, and family events. Their interests and discussions influenced what they chose to represent, and the extra time together led to a richer and more embodied exploration of group and community attitudes.

Additionally, using their everyday experiences as residents of their town to relate to and represent community data led to new social patterns. They helped design the project, organize the data, and select key words and associated sound effects. They presented their findings and answered questions from residents at a Town Hall. The girls were positioned as experts, which was intimidating, but also empowering. In the exit interview, Irene reported, "At first I guess I was really nervous because we had to do it again in front of other people but once we kept doing it…It took me like a minute or two just to figure it out." Alexa commented on the Town Hall audience and how "it was cool to like show them and they were like 'oh that's so cool'" to which Valentina added, "They really liked it." The young women were impressed by the audience's positive reception and felt confident about their performance.

Tension 2: Possible Design Features Given Accessible Maker Tool Limitations

In this section, I describe a systemic contradiction that arose from the interplay of tools and object. The young women were determined to create a meaningful artifact, and yet had limited understanding of the microprocessor tools, conductive materials, and associated processes. The young women were challenged by constraints such as not crossing conductive lines between key words, devising innovative solutions to both reach and demarcate key words. I examine the dilemmas that arose while working with the technology and materials to express meaning. I also present examples of how technology was leveraged to enhance rather than detract from the design and implementation.

"Delete park, delete": Meaningful yet functional artifact. When working towards a meaningful yet functional artifact, the young women struggled with the overall vision, key words, and key sounds. Their goal was to create an impactful statement to represent themselves, the group, and the community, however they were limited by the tools. For one, the TouchBoard microprocessor only had 12 electrode terminals, and with one sound per terminal, the group was limited to 12 sounds to represent the entries from over 100 respondents.

The young women often discussed how to use the available technology to enhance rather than detract from the design and implementation, using the linguistic markers of *dilemmas* such as “but”, “we could try this, or otherwise” to express incompatible evaluations. In particular, there was concern about minimizing the appearance of the lines linking the TouchBoard electrode terminals to the key words. The young women considered how to indicate to the user which words were key words with linked sound effects, given the choices of shiny copper tape, thick black paint, and silver ink. They decided on silver ink for the lines to blend in with the background, while black paint to accentuate key words. Multiple iterations of discussion, implementation, and testing made the final product easier for outsiders to understand and allowed community members to interact in a meaningful way with the cloud during the Town Hall.

The group also worked within the constraints of using conductive paint and ink for linking the sound effects to the words. Words that were small and far from the terminals while close to other key words were problematic. When struggling with the three words close to each other but near the bottom edge of the word cloud, the facilitator granted permission to delete certain sounds by announcing, “It's also okay if we can't make one of them work, that's okay.” The young women responded immediately by voting to eliminate “park”:

> Alexa: Park.
> Irene: Delete park, delete.
> Alexa: Park is going to mess up everything.
> FACILITATOR: We can get rid of park. But how do we make the other ones work?
> Alexa: We have everything else. There's no fight.

There was no contest about “park” since it was not as important to the young women compared to “basketball”, one of their core hobbies and associated with fond memories at the Center. However, they soon discovered that removing “park” did not solve the issue with reaching “basketball.” After a long and frustrating session of problem-solving, one of the undergraduate mentors helped map out a new plan, which eliminated basketball but kept the other 11 sounds:

> Malia: But that was going to be “basketball.”
> Sophia: Yah.
> FACILITATOR: Uh, “basketball” doesn't have one now and “park” does.
> Malia: Oh, so “basketball”, we're not doing it?
> FACILITATOR: No “basketball.” ((Pointing to “basketball”, then “park”))
> Irene: Bye bye “basketball”.
> FACILITATOR: So if you want to draw--
> Irene: --Wait, is there another “basketball” somewhere else? Could we just do another “basketball”
> somewhere else? We could just do that instead.
> FACILITATOR: That's true, that would be...
> Undergraduate mentor: I've already...unless there's a mini one like somewhere in here ((points to middle of word cloud))

Initially the young women were not content with this solution. However, no one could devise an alternative plan and there was no other easily accessible “basketball” on the cloud as Irene had suggested. Ultimately, “basketball” was removed to make all the other sounds work without crossing lines. The young women recognized that for their goal of creating a meaningful object, it was more important to represent as many community values as possible, even if that meant eliminating one of their core values. Technology constraints impelled them to adjust their intended meaning in a way that was not considered positive in comparison to the previous example of using certain materials to demarcate key words. In both cases of signaling and eliminating key words, new representations of meaning were decided on and implemented. The affordances and constraints of the tool affected the group’s decision-making processes, shaping the final form of the word cloud and ultimately the way Town Hall attendees interacted with the artifact.

“You’re able to go through with it”: Identity in relation to Maker Group. While grappling with these decisions and tool constraints, the young women developed as a collective of novice makers and designers, referring to themselves as the “Maker Group.”

The new materials, tools, and words used to describe their roles and group norms mediated their experience in the project and helped construct their identities as makers. In their exit interview, the girls reported the project was frustrating at times, but they developed maker traits such as patience, resilience, and collaboration, and built up a sense of self and group related to these dispositions. When asked about maker skills, Alexa responded, “You need to be patient” and Malia elaborated, “Because when it doesn’t work.” Alexa added being “resilient,” because “when you’re faced with hard situations you’re able to go through with it.” Valentina contributed, “Knowing how to work with others.” The young women internalized and later voiced key tenants of empathy and collaboration as well as the process of experimentation, design thinking, learning through doing, and positive response to overcoming failure (Martin, 2015). These norms affected how they participated and viewed themselves as a group and as individuals. The girls realized they were capable of tackling and persisting during difficult projects and that they could depend on each other for support.

They also developed technical skillsets while learning about the design learning process of ideation, problem-solving and iteration. They developed familiarity with basic engineering content and beginning expertise with maker tools. In the exit interview, they expressed a deeper level of understanding of the TouchBoard microprocessor and concepts like electricity and conductivity. More impressively, at the beginning of the year none of the young women had experience with making and did not consider themselves makers. However, the year after this project, three of the eligible girls were accepted into a competitive engineering academy. They realized making could be relevant to their careers and viewed the academy as a pathway to college.

Discussion

In this paper, I illustrated how youth utilized technologies in transformative ways, pushing back on characterizations of young people as uncritical consumers of digital tools, or of technology as primarily a source of harm. Our participants were not positioned as sanctioned decision-making leaders in their town (both as youth and Latinx residents from low-income immigrant backgrounds), however, they demonstrated commitment to transforming their community by leveraging funds of knowledge and an emerging expertise in digital fabrication. Their social action project informed college students about local families and youth, challenging historically and culturally defined norms of participation in their community. Additionally, the word cloud added a visual, auditory, and tactile depiction of the stance and values of their community as communicated by the young women. It functioned as a public artifact that allowed the young women to dynamically question how their town was perceived and express their role as change agents in the community. Other parts of the social action project worked to remedy problems, but the word cloud was meant to celebrate the virtues of their town. The heart-shaped cloud presented their world view and fit into a broader ideology to "provide the foundation of ideas for a hope of an anticipated future" (Penuel & Wertsch, 1995, p. 88). Whether establishing themselves as novice makers, or solidifying their position as leaders, the girls actively explored and projected their identities and civic engagement commitments to others.

My work illuminated conditions that positioned youth as critical investigators and designers, revealing identity processes tied to a specific community project context and time period. Additionally, though I focused on identity implications at the group level, I also considered individual roles and values when characterizing the activity system. In future work addressing expansive learning concerns (Engeström, 2001), I will explore how CHAT could provide insight into both individual and collective development when I consider the flow of action and activities more deeply characterizing the Teen Center as a community learning setting. That said, even considering more layers could not capture all the intersecting, ever-changing identities of these young women, let alone characterize the experiences of other Latinx women. The research documenting experiences and perspectives of Latinx women in STEM is lacking (Crisp & Nora, 2012) and this paper assists by contributing one account. Much more research is needed to document the diverse ways Latinx youth from different contexts use digital technologies and STEM knowledge towards personal and social change.

Despite these limitations, I did present an example of a successful Critical Maker project that could address concerns within conventional approaches to implementing making. Leaders in maker education have begun to consider cultural-historical and social practices connected to making (Peppler et al., 2016), however, have also faced criticism for supporting a narrow view and overlooking constructivist approaches foregrounding ethnicity, gender, and social justice (Vossoughi et al., 2016). Additionally, only a handful of researchers have utilized the framing of CHAT to understand making with these fuller notions of context in mind (Santo, Peppler, Ching, & Hoadley, 2015; Hansen et al., 2019; Kumpulainen et al., 2018).

My findings resonated with research applying CHAT to examine participants interfacing with tools and maker norms in a classroom setting (Hansen et al., 2019; Kumpulainen et al., 2018). Despite my focus on an afterschool context, I found commonalities in how maker activities and participant dynamics presented both barriers and supports to youth learning, and offered possibilities across both setting types. For example, Hansen and colleagues (2019) revealed how students were frustrated yet motivated by the 3D printer print time and size constraints, and I found similarities in how the young women in our project shifted their design and intended meaning based on the limitations associated with the microprocessor's touch sensor. Both groups of students also identified similar affordances, reporting that the groupwork and new maker technologies were compelling and helped prepare them for future opportunities such as college or careers.

Additionally, my exploration of systemic tensions revealed how contradictions pushed the design and system in new directions. Sometimes contradictions prompted direct collective action, such as when the disparity between the group's view of their town and the community data led to new goals and the creation of the positive word cloud. Other times contradictions prompted design that was to the detriment of youth expression, such as when the young women were forced to remove one of their most important pastimes from the word cloud. Overall, I illustrated the dynamics of these contradictions as youth struggled with new technology and yet leveraged these tools to enhance their design and best represent positive associations with their home. The young women reflected deeply on community input and represented the data in a way that demonstrated their capabilities and identities as civically engaged youth and makers.

More research on systemic tensions and intersecting identities is needed to define what it means to make and be a maker across contexts. In particular, more research could prove valuable for educators designing inclusive programming, engaging more students in making and STEM, and foregrounding equity (Vossoughi et al., 2016). The few scholars studying Critical Maker-type environments advocate for authentic designs that address collective problems, promote expertise sharing and multiple perspectives, and bring maker activities to youth-centered sites (Calabrese Barton et al., 2017; Cavallo et al., 2004; Faircloth & Tan, 2016). Like Calabrese Barton, Tan, and Greenberg (2017), I advocate for maker programs that are “forward-directed and transformative for both the self and the community, such that acts of learning and becoming contribute productively to, and help to legitimize, an ever expanding range of ideas, tools, resources, and ways of being in the makerspace” (p. 23).

Paper 2: Sound Project

Community STEM: With our Community, For our Community

Community STEM projects empower youth and promote a deeper connection with science, whether using inquiry and data collection to build community gardens, host technology faires, or create artifacts that encourage discussion about noise pollution. Community STEM therefore offers a powerful alternative to conventional science disciplines, contextualizing science learning within community and environmental issues, and positioning youth as active contributors, researching about problems or engineering solutions (Balestrini et al., 2016; Birmingham & Calabrese Barton, 2013; Calabrese Barton et al., 2013; Fusco, 2001). Community STEM projects help broaden the definition of science, and can be particularly impactful in leveraging the expertise of youth from STEM-underrepresented groups such as girls and students of color (Birmingham & Calabrese Barton, 2013).

Community STEM is still not typical in schools or even in afterschool science programs, however it is gaining popularity as digital and physical advances in technology are encouraging more people than ever to invent (Anderson, 2012), as well as collaborate in collecting, processing, and sharing data (Dickinson & Bonney, 2012). While there is great potential right now for Community STEM, more research is needed to consider patterns of participation in these novel learning environments and how these programs support or constrain engagement with science. In particular, there is a dearth of research documenting the experiences of Latinx students in STEM programs of all types.

Therefore, I examined a Community STEM project undertaken at a youth center in an unincorporated area in Southern California. I utilized the Figured Worlds (Holland, Lachicotte, Skinner, & Cain, 1998) model of identity construction to explore how a group of seven Latinx adolescent participants affiliated with project subgroups, performed science practices, and authored identities as science people. Examining specific tasks and associated artifacts allowed me to consider identity processes as participants performed as and received recognition as certain types of people. I asked:

1. In what ways did participants engage (or not) with science in the program? What were the different patterns of participation for female and male team members, and how did participants position themselves in relation to science? Given my focus on girls' emerging STEM identities:
    - What roles did the girls take up when creating artifacts in a new community science program?
    - What artifacts were produced, and what were their meanings to the girls?
    - What were key events where girls positioned themselves in ways that supported or constrained engagement in science?

This work documents the experiences and identity processes of a group of Latinx youth engaged in a unique combination of making, citizen science, and community-action, adding to an emerging body of research on Community STEM environments. The paper has implications for research and practice, elevating the voices of Latinx youth as community scientists and change agents and documenting the dynamics of a Community STEM program.

Literature Review

Latinx students in STEM.

People who identify as Latinx are the largest minority group at 18% of the American population (Census Bureau, 2018), and this group is expected to triple within the next few decades (Darder & Torres, 2014). However, Latinx people remain underrepresented in STEM degrees and fields. Latinx women make up 8% of the population in the United States, and yet only 2% of the STEM workforce. Latinx men, while faring slightly better, comprise 9% of the overall population but 4% of the STEM workforce (NSF, 2017). While Latinx women are more likely to enroll in college than Latinx men, they are less likely to pursue STEM degrees (Santiago, Taylor, & Galdeano, 2015). To compound the problem, there is a dearth of research documenting the experiences of Latinx students in STEM. Studies tend to focus on predicting degree attainment instead of illuminating interest in or reasons for studying STEM (Crisp & Nora, 2012). Crisp and Nora in their review documented barriers for Latinx students including access to high quality academic preparation and resources. Latinx students in K-12 are more likely to have instructors with less experience with science material or teaching overall. Latinx students also tend to have lower self-efficacy, viewing themselves as less competent in science and math compared to White students (Crisp & Nora, 2012). Even if interested in science, they might have trouble seeing themselves as a scientist due to stereotypes (Sorge, Newsom, & Hagerty, 2000).

More research needs to focus on documenting the supports, obstacles, and experiences of Latinx students in STEM. In particular, despite being the most underrepresented group in STEM, "few researchers have attempted to understand how women of color perceive and experience science and mathematics" (Crisp & Nora, 2012, p. 7). The available research on Latinx women points to the importance of a personal connection or role models in science (Beeton, Canales, & Jones, 2012; Sorge, Newsom, & Hagerty, 2000), and recognition by others as a science person (Carlone & Johnson, 2007). Factors such as family support and institutional advocates are crucial as well (Crisp & Nora, 2012). However, barriers to participation include lack of awareness about science careers, financial constraints, low expectations from others, and lack of relevance or views of science as “a white male profession” (Beeton et al., 2012, p. 72). By middle school, Latinx young women are “the least likely of any group to have STEM career aspirations” (Crisp & Nora, 2012, p. 7).

To better understand this issue, it is helpful to consider feminist research on “science identity.” There is a large body of research that presents students’ perceptions of science as objective, competitive, and impersonal, qualities associated with a masculine identity (Brickhouse et al., 2000). Archer and DeWitt’s (2015) study of 9,000 children described how girls viewed science as “a boy thing” and science people as “clever” or naturally good at school, which made many girls feel that science was not for them even if they enjoyed it. Others have considered how science class has its own “subculture” and what girls need to learn to participate (Calabrese Barton et al., 2008).

Calabrese Barton and colleagues (2008) in their two-year study of middle school classrooms documented how girls engaged with science and took on science identities, including forms not typical for science class. They determined that students created “signature science artifacts”, negotiated roles and were playful with identity performances (p. 81). For example, one of the girls re-wrote a pop song with lyrics about bones during their skeletal unit. She did this in addition to the required assignment of creating flashcards, and performed the song in class, integrating her identity as a singer and dancer and validating this expression of science identity (p. 83). Similarly, Brickhouse and colleagues (2000) presented profiles of four middle school girls that were all interested in science, however received different responses from their teachers. Only the quiet high-achiever and social discussion-leader were recognized and validated for their science identities. In contrast, the other girls had identities outside of the norm, as a problem-solver, rock-collector, or assertive discussant, that were not well taken up in school and led to them disconnecting from classwork (Brickhouse et al., 2000).

While these were conducted at school, many other feminist researchers have considered identity development in out-of-school environments and make similar claims about opening up the range of expression for science identities (Munley & Rossiter, 2013; Varelas, 2012). The flexibility of the afterschool setting allows programs to incorporate diverse ways of knowing, blur disciplinary boundaries, and promote exploration in STEM and skill-building opportunities relevant to STEM careers (Afterschool Alliance, 2015; Krishnamurthi, Ballard, & Noam, 2014). Community STEM programs, incorporating authentic making and citizen science practices for social justice ends, can broaden young people's definition of science and value the cultures of underrepresented students while encouraging them to explore new science-related interests and identities (Calabrese Barton & Tan, 2010). To better understand these complex out-of-school science environments and associated identity processes for girls and students of color, I utilize the Figured Worlds model, a large scale cultural model (Holland et al., 1998) that has been widely used in educational research (Urrieta, 2007).

Theoretical Framework

Figured Worlds.

Figured world refers to "a socially and culturally constructed realm of interpretation in which particular characters and actors are recognized, significance is assigned to certain acts, and particular outcomes are valued over others" (Holland et al., 1998, p. 52). People create and maintain figured worlds with others, co-producing artifacts, activities, discourses, and performances and ultimately outlining norms for participation and recognition in that realm (Gonsalves & Seiler, 2012; Holland et al., 1998). Personal and social identities are constructed through *negotiations of positionality, space of authoring,* and *world making* (Holland et al., 1998; Urrieta, 2007). Individuals are socially identified and offered certain positions, such as "good student", and author a response that negotiates their position (Urrieta, 2007). New figured worlds can also be formed through social or serious play (Holland et al., 1998; Urrieta, 2007).

The figured world framework has been used extensively to understand the authoring of science identities both in and out of school (Urrieta, 2007; Varelas, 2012). Considering a science class as "a complex web of figured worlds" reveals whole class dynamics and norms, small group interactions, and individual student work, which all have identity implications (Calabrese Barton et al., 2012). By studying learners as participants in figured worlds, researchers can uncover the local norms of doing science, and understand "what is possible, right and acceptable for youth to do" (Rahm & Gonsalves, 2012, p. 64). Figured worlds either limit or expand definitions of science, whether young children imagining what type of person they are and want to be in science through "as if" worlds (Kane, 2012), middle schoolers creating new possibilities in science through poetry (Guerra et al., 2012), or graduate students asserting their status as legitimate physicists through different types of competency (Gonsalves & Seiler).

Beyond illustrating existing norms for participation, the figured worlds framework can also reveal how worlds are formed and demarcated. Holland and colleagues (1998) suggest that figured worlds can be "as if realms" or "sites of possibility" (p. 49). People can create new ways of being and doing and ultimately new worlds through "the arts and rituals created on the margins of regulated space and time" (p. 272). Using the "as if realm" framing from figured worlds could provide insight into the new territory of Community STEM programs. The figured world as a "site of possibility" is pertinent in the context of our new program blending science, social action, and art.

Identity.

Given the Figured World framework, identity is made visible through what people do and how that is interpreted, "by the resources they access and activate to do so, and by how they position themselves in relation to others and to the object of the activity while taking particular roles" (Calabrese Barton, 2012, p. 43). Socially and culturally constructed ways of being and talking are "living tools of the self", or artifacts that influence how people experience the world (Holland et al., 1998, p. 28). The self is both rooted in social practice and is "itself a kind of practice" (Holland et al., 1998, p. 28). Identity processes take shape as social performances (Gonsalves & Seiler, 2012), where people engage in a process of "becoming" based on their performances and others' recognition (Carlone & Johnson, 2007; Stapleton, 2015; Urrieta, 2007). Within largescale cultural models of identity, certain ways of talking or doing become recognized and either repeated or rejected, leading to circulation of cultural practices (Wortham, 2006).

Calabrese Barton's (2012) work with middle school girls provides insight into identifying "identity artifacts" that shape and are shaped by cultural contexts (p. 43). Drawings, video clips, and student talk can provide snapshots of how girls position themselves and author their identities. Researchers can use these artifacts to consider how girls engage with science (with who, with what resources), including taking on roles not typical for science class (Calabrese Barton et al., 2008). Identity artifacts taken from different points in time provide insight into how "sense of self in science shifted" and how identities thicken and stabilize across different social contexts and over time (Calabrese Barton, 2012, p. 63). Therefore, following Calabrese Barton's work, I identify "signature science artifacts" (p. 81), as well as focus on the roles the girls take up, the resources of participants and facilitators, and associated discourses.

Methodology

Project and Participants

Data were collected at the Teen Center, an afterschool site which provided bilingual programming for over 50 Latinx youth in grades 6-12. The Teen Center was located in an unincorporated town next to a university. Participants were part of the Teen Center makerspace, where youth learned about electricity, circuits, and input/output or sense-analyze-act as a way bots interact with the environment. In addition to single-day activities, we implemented longer-term projects following a Community STEM approach. Community STEM presents a powerful alternative to conventional science disciplines, capable of building from underrepresented groups' funds of knowledge and broadening the definition and culture of science and engineering (Balestrini et al., 2016; Birmingham & Calabrese Barton, 2013; Calabrese Barton et al., 2013). The science content is typically related to environmental concerns but can also focus on math/measurement (Fusco, 2001), engineering design (Blikstein, 2008), technology use (Heggen, Omokaro, Payton, 2012), or the research process (Ballard et al., 2017). Mostly the focus is not on STEM content but rather how experimentation and youth knowledge redefine participation in community decision-making processes (Birmingham & Calabrese Barton, 2013; Fusco, 2001). Our Community STEM project allowed us to draw from both maker and citizen science literacies, helping participants define problems and design solutions (Peppler et al., 2015), as well as ask questions and carry out investigations (Trautmann et al., 2013).

Our Community STEM project spanned one year, from February 2017-February 2018. Called the Sound Project, it emerged from a community survey project implemented by a partner project with a non-profit specializing in youth empowerment. Fifteen makerspace members, who were also part of a social action leadership group at the Teen Center, surveyed residents and determined that sound pollution was a commonly reported issue, especially for Latinx families. Teens discussed the sound issue, proposed guidelines for collecting data, and recorded decibel readings across town to determine sound levels. Youth participants, as well as undergraduate and graduate facilitators, recorded on their own time according to the collectively devised guidelines. During group data collection days, youth participants split into four groups and surveyed a grid covering a square mile surrounding the Teen Center. A select group of seven participants (three male, four female) analyzed data and presented their findings to community stakeholders at a Town Hall. At the Town Hall, this "data analysis team" also introduced a community maker project, inviting residents and other attendees to make acoustic panels to decrease sound levels in the Teen Center homework room. Youth participants decorated over 40 small acoustic foam squares with fabric, and glued panels to plywood to cover one wall of the homework room. Participants conducted pre- and post-tests of sound levels including the overall decibel level and the amount of reverberation (rate of decay of decibels once sound source stopped). Finally, youth participants analyzed data to determine a statistically significant reduction in reverberation after installing the sound panels.

Four girls (Katie, Jatalia, Araceli, Flora) and three boys (Rafael, Tomás, and Dylan) self-selected into the data analysis team. All participant names are pseudonyms, which were either self-selected or chosen by researchers but approved of by participants. Katie, Araceli, and Flora were in 7th grade, Jatalia was in 10th grade, and Rafael, Tomás, and Dylan were in

11th grade. Before the project started, these seven participants reported varying levels of success in school, but an overall aversion to science courses, especially ones involving math or bookwork. Katie, Araceli, and Flora did not consider themselves science people, but enjoyed working on “hands-on projects”, and received A’s and B’s in their classes. Araceli and Katie commented that children with parents in STEM fields had an advantage, and discussed their own parents’ lack of STEM knowledge. Jatalia did not enjoy school and felt that science was not for her, though thrived in her culinary program. Dylan was struggling in all his classes but enjoyed writing, reflecting, and public speaking. Tomás and Rafael received high grades and were taking AP courses but did not like their science classes. Although they all demonstrated competence and performed well in science and engineering activities at the Center, at the beginning of the year they did not view themselves as scientists or engineers and did not feel that others saw them that way either, demonstrating low “STEM identity” (Carlone & Johnson, 2007).

Data Collection

The research-practitioner team consisted of two graduate students (referred to as lead and co-facilitator), a faculty principal investigator, and three undergraduates who led activities and collected data. During the project, we took ethnographic notes on the design process and implementation challenges, tracing dialogic exchanges and multimodal practices across time (Green, Skukauskaite, & Baker, 2012). In developing findings, I examined video and audio from 21 activity sessions of 1-2 hours each, and four group plus individual exit interviews. Interviews were semi-structured conversations with six of the seven participants in the data analysis team. After the project concluded, participants spoke about what they liked, disliked, or remembered, what they learned, and their successes and challenges. They were asked directly about what they considered their role or contribution, and to define as well as identify with (or not) the roles of science person/scientist, community scientist, and maker. One participant (Rafael) was not present for interviews, so the self-report data on roles includes the perspectives of six of the seven participants in the data analysis team.

Additional data included 21 field notes and analytic memos evaluating goals and participant interactions, and various artifacts created by youth (list of guidelines, pre and post-test notes and map of homework room, PowerPoint slides and Town Hall scripts). Transcripts were generated from the Town Hall, exit interviews, and session interactions. Transcripts followed general conventions in science education research (Varelas 2012) with a word-level transcription, ignoring pauses, exhalation, and pitch shifts included in more comprehensive conversation analysis transcripts. See Appendix D for a transcription template and list of conventions, simplified from Jefferson's work (1984).

Data Analysis

The research design was a qualitative, ethnographic case study, or "an intensive, holistic description and analysis of a single instance, phenomenon, or social unit" (Merriam, 1998, p. 27). The case was bounded by the place and the project duration, referring to the group of youth who participated in the Teen Center's year-long afterschool project to investigate, report on, and address sound levels in their homework room and broader community. I focused my analysis on the group of seven youth participants in the data analysis team, and in particular the four female data analysts.

In Phase 1, I utilized methods from interactional ethnography (Green et al., 2012) to construct minute-by-minute event maps for each session, illustrating participant actions in a timeline. I then used MaxQDA software to directly inscribe codes onto video to identify important components of Figured Worlds. I applied broad structural codes (Saldaña, 2009) for *participant* (presence of each data team member) *role* (social types or affiliation like maker, analyst, blogger), *physical tool* (tools such as ruler or professional sound meter), *digital tool* (tool such as phone application or Excel) *artifact* (participant products such as graphs, acoustic panels, list of guidelines), and *practices* (one of eight NGSS science and engineering practices). The codes from the videos were triangulated with text from the analytic memos, field notes, and focus group transcripts. After coding and creating session event maps, I listed roles, tools, and object artifacts for each session. I performed semantic analysis (Spradley, 1980) to list all artifacts produced and forms of engagement with science throughout the project.

In Phase 2, *positioning events* were identified based on participants' evaluative and affective responses which communicated their "stances", and led to alignment with or distance from others (Bucholtz & Hall, 2005). I transcribed dialogue surrounding positioning events, and coded whether the participant accepted, rejected, or negotiated the position offered to them, and if this constrained, supported, or expanded their perspectives on science. After examining the events and responses for each participant in chronological order, I documented patterns of how they shifted in the way they perceived themselves or others perceived them. I determined "signature science artifacts" (Calabrese Barton et al., 2012, p. 81) for each participant based on their comments and others' comments in the exit interview, the amount of time and engagement level while participating in each activity, and positioning events. Additionally, to triangulate findings on perceptions of self in relation to STEM, two researchers performed emergent thematic coding of the exit interview transcripts to identify project roles and associated actions. When codes conflicted or there was any disagreement, the researchers discussed until they came to consensus on how roles were classified.

Results

My analysis revealed that the Sound Project, embedded within the Teen Center as a whole, shaped participants' interpretation of what constituted "Community STEM" and what it meant for them and others to be considered science people and civically engaged youth. The shared cultural knowledge of Community STEM developed over time and in relation to the afterschool context, meaning participants' understandings shifted from when they started the project, and differed from ideas about "science people" tied to school. Artifacts used to examine sound levels, report findings, and enact change were important to mediating this transformation. Additionally, since figured worlds "divide and relate" people according to certain categories or social types (Holland et al., 1998), roles were helpful in understanding what it meant to participate.

The roles of *scientist/science person, community scientist, maker, organizer, engineer, leader, presenter, data team member*, and *general member/helper* were discussed in exit interviews and triangulated in direct coding of video (see Table 1). Additional roles such as *blogger, note taker*, and *card shark* (skilled card player) were noted in the videos but not discussed by participants in reflections on the project and did not appear as meaningful or relevant to project goals. Roles were associated with distinct practices and tasks often linked to creating or improving different artifacts. These science-related artifacts mediated the thoughts, feelings, and actions of participants. Participants produced 33 object artifacts (See Appendix B, Table 1), including soundwave data displays, geotagged sound clips, vlogs, guideline lists, data spreadsheets, graphs, maps of the homework room or whole town, individual acoustic squares, and group acoustic panels. In exit interviews, participants listed 14 artifacts (See Appendix B, Table 2) as particularly impactful, commenting about memorable or enjoyable activities. 128 positioning events were determined where participants were offered and authored a response when working on these artifacts, and from analyzing these events, one artifact was determined as a significant science artifact for each person (see Table 2 below).

In the next section, I present in broad strokes the social types or roles of *community scientist, scientist, maker, engineer, data team member,* and *presenter*. I illustrate what it meant for participants to affiliate (or not) with these subgroups and the associated practices. Then, I describe in depth the significant science artifact for each of the data analysis girls, considering this artifact and associated discourses to be "living tools of the self" (Holland et al., 1998, p. 28). Examining these artifacts and participants' responses over time provided insight into identity processes and shifting perspectives on science.

Roles

Most participants distanced themselves from the conventional roles of scientist, science person, or engineer, however they were more likely to relate to roles such as maker, community scientist, or helper (See Table 1). Terms like "scientist" and "engineer" were associated more with school and jobs. Therefore, the role of scientist or engineer was constrained by how well participants were doing in these subjects at school or their enjoyment of science class tasks such as note-taking or memorizing key terms. In contrast, youth found diverse ways to characterize a maker, including sub-roles such as designer or helper. Data team member and presenter were sub-roles associated with community scientist. These roles were associated with specific data analysis and communication practices required to carry out and share results from the investigation. Community science and making were mentioned as ways to contribute to something important and make a difference, whether building panels to reduce noise or raise awareness of sound pollution on a neighborhood level. Below I explore similarities and differences between different roles and the practices and performances associated with them.

Table 1
Participant Identification with Specific Project Roles

	Maker	Engineer	Science Person	Community Scientist	Data Team Member	Presenter	Leader	Helper	Organizer
Araceli	√	√	√	√	√		√		
Flora	√				√			√	
Jatalia				√	√	√		√	
Katie	√	√	√	√		√			√
Dylan	√			√	√	√		√	√
Tomás				√	√	√		√	√

Data team member and presenter. When participants spoke about data collection and analysis, they were much more likely to reference specific practices and skills learned in comparison to when discussing other roles. For example, they learned how to use new recording apps, facts about decibels and noise levels, and steps to calculate the maximum, minimum, and average sound levels. However, while everyone mentioned specific skills they developed, not everyone felt like they were a data collector or analyst. Regardless of which tasks they participated in or to what degree, participants related more with data team member more if they enjoyed these tasks more. For example, Tomás reported that his favorite part was "just like going around and recording like in a group sound, like noise." Dylan and Jatalia also had fond memories of collecting data with friends, as well as testing the mini sound rooms and creating graphs or maps. Even though they participated more in the analysis than data collection, they enjoyed the data collection and embraced the role. In contrast, Katie distanced herself from the label of data collector/analyst or part of the data analysis team. Katie reported that, "I never actually did the data thing because I didn't want to…Because it’s boring. And because I don’t want to walk around everywhere…But I did like three.” Even though she collected a similar amount of data points when compared to other participants, she minimized her contribution as well as expressed distaste for the role. She also did not feel like part of the data analysis team, and chose not to help create the graphs or map. Despite this, she mentioned learning similar things about using the app and measuring sound levels as well as “how to calculate and gather information from [our data.]”

Presenting, collecting data, and analyzing data were often discussed together. These were mentioned as important steps in the research process, and presenter and data team roles were perceived as complimentary. Katie, Jatalia, Dylan, and Tomás all presented their findings at a community town hall meeting. Katie considered herself a presenter, however mentioned a few times how she was stepping in for Araceli. Katie grumbled, “I had like three slides because Araceli wasn’t here. And I had to say her parts.” Dylan felt more attached to his role, and reported feeling nostalgic while presenting. He stated, “It was pretty cool overall because it had all of what we did together, and when the presentation was going on, I kind of remembered every single thing we were doing.” Similarly, Jatalia stated “It was fun to hear all the data and pointing the map out and everything. Sharing their findings was not only fun, but meaningful and powerful. Katie felt proud of their work as well, stating “I believe it was good all the graphs and data and everything was processed and calculated perfectly. We had a good presentation.”

Maker vs engineer. Being a “maker” and “engineer” were often discussed together and associated with certain traits or dispositions rather than skills learned. According to our participants, both making and engineering demanded creativity and intelligence. Jatalia felt that both engineering and making demanded creativity and “you have to have a brain to make something.” Katie mentioned similar traits, stating that a maker means “You need to be determined, you need to try and think.” While their definitions were similar, Jatalia did not personally feel like a maker or engineer while Katie did. Katie and Flora both felt strong affiliation with the maker role, with Katie valuing the design elements and Flora wanting to “help out and make different stuff that are useful to the community.” There were other ways participants found personal connections to the maker elements. Dylan felt like a maker, but had a difficult time defining it and seemed to value the collective end product more than his personal contribution. When asked about his experiences making in the project he stated, “I love the idea of how the panels ended up, it just makes it more special.” Katie felt similarly, and valued the collective element of the combination science and art project.

Participants felt more confident about their abilities or identities as makers, compared to engineering. Only Araceli and Katie mentioned engineering or feeling more like an engineer than a maker. For them, the role of engineer tended to refer to computers and coding, but also building the panels and reinstalling the sound panels, which overlapped with references to making. For example, Araceli felt affiliated with “computer engineers” because “I like working on computers, like engineering things, we built the panels.” However, other participants were open to learning more and considering themselves engineers-in-training. Flora said, “Like I would want to learn about the engineering thing and how it’s related to science and things like that and what’s the skills you need for it.”

Scientist vs community scientist. Being a “community scientist” was considered separate from being a “science person” or “scientist.” Although almost everyone felt they were a community scientist, only Araceli and Katie felt like science people. In comparison to other roles, being a science person was associated more with school and specific knowledge or tasks. According to our participants, scientists knew how to code, do experiments, read, think and write. Most of our participants did not feel very confident in or enjoy their science classes at school. Only Katie and Araceli felt like science people, because they were able to code, build, and experiment. Tomás did not comment much on this, but Dylan mentioned feeling competent at science content even though he was not a science person and had failed his science and statistics classes. Flora and Jatalia were very adamant about not liking science and not considering themselves as science people.

In contrast, everyone except Flora felt like community scientists. Katie defined community science as “doing a project that could help, or make something better in your community. And in general just being a scientist, but, doing projects, experimenting and stuff.” Dylan also mentioned the scientific process yet focus on community needs with his definition. He reported that a “community researcher is a person who collects data, analyzes it, and makes a conclusion. And community because we did it with our community for the community.” Although most of our participants did not personally feel like science people or scientists, they recognized that they engaged in scientific practices with the goal of improving their community, and therefore were able to embrace the role of community scientist or researcher. The exception was Flora, who equated community scientists with public servants, and felt that she had not done enough to earn this title. When asked if she considered herself a community scientist she responded, “Not really, I don’t think I made a big difference. I don’t know who I would consider a community scientist. Maybe like police or something? Like help control fires or something?” However, she answered that a community scientist “means they do research of how to help the community in different ways” and agreed when the researcher asked if she had helped the community during the project. She also stated, “I feel we did a really good job on it. I think we really succeeded on it…Because it actually did help.” Similarly, Tomás reported that participating in this project, “made us feel like we actually did something.” Dylan added that he felt “a sense of awareness in the end. Because for people who don't know what it's like to live in [our town] and sometimes like what these problems are. It sets up a visual of the problem and some people can see it." Community science was a way to actively participate in addressing a local issue, by collecting data and raising awareness of the issue.

Overview of roles. There was overlap in the various science roles, with the boys and girls participating in different individual ways. However, everyone participated in some type of making and some type of data analysis, and either identified as community scientists or expressed similar motivations of addressing the noise issue. Only Katie and Araceli related with the idea of being science people but associated this with success in school rather than ability or interest in science content or practices. Only the girls identified with being an engineer, and three of the four girls identified and were able to articulate how they were makers, and spent much more time on this part of the project of decorating and installing the panels. In comparison, Tomás, Dylan, and Rafael sometimes left decorating activities to focus on data collection or analysis and overall spent much less time on making than the girls. Although everyone except Katie considered themselves part of the data team, the boys were more likely to refer to themselves as data team members. It seemed to be that the "data team member" affiliation was less about time commitment or contribution, and more about their enjoyment of collecting or analyzing data.

Participants expressed clear ideas of what it meant to affiliate or not with each role, and the associated practices that defined what it meant to perform as a scientist, maker, or data analyst in different Sound Project tasks. To better understand identity processes over time, I now turn to specific tasks and associated artifacts which allowed participants to perform as and receive recognition as certain types of people.

Artifacts

Each of the participants focused on a significant science artifact (see Table 2) which mediated the thoughts, feelings, and actions of themselves and others. Araceli's significant artifact was the collection of sound clips she recorded on her phone which allowed her to document the noise problem. For Jatalia, it was the interactive sound map she created for families, which displayed sound effects around town. Katie was motivated by the wall acoustic panel with everyone's individual contributions of acoustic squares yet her overall design. Even though Flora also felt strongly about the acoustic panels, her significant artifact was the sound wave print outs because they allowed her to determine that the acoustic panels were successful in dampening the noise in the homework room, making their work valuable.

Tomás' artifact was a graph of sound levels according to day of the week and time of day. For Dylan, the graphs were also important. However, he felt more strongly about presenting the PowerPoint slide with overview information because it helped him conceptualize the project and the meaning of their findings. For Rafael, it was the slide with the top three loudest and quietest sounds which represented that the town could be loud but also a peaceful place.

Table 2
Signature Science Artifacts according to Participant

Participant	Signature Artifact	Artifact Description	Participant Reflection
Araceli	Sound clips	Sound clips recorded on phone app, geotagged and with decibel information	"We just go around IV and just like use the app and also like…we just recorded with an app. Yah and see and collect all the data to see how much loud or quiet it is."
Flora	Sound wave print outs	Print outs of amplitude over time in pre and post conditions, used to estimate reverberation time	"I learned how it worked and how it made a big difference in the room…like how it absorbed sound."

Jatalia	Interactive sound map	Map of town with linked audio, to click on nine areas and hear representative sounds	"It was fun to hear all the data and point the map out and everything…It kinda impacted me because I didn't really realize how IV could be peaceful. I didn't know there's streets or like this side of IV is quieter than this side."
Katie	Wall acoustic panel	Individual decorated acoustic squares installed on plywood and mounted to wall to form large panel	"I'm not sure what the difference is with the acoustic panels. I mean, to me it seems the same they're like decoration on the wall. I guess it could work, if it is I'm not noticing it. The panels worked out good because like people did it."
Dylan	Slide on project overview	PowerPoint slide with information about the project in general and overview of data analysis	"The presentation, yeah it was pretty cool. Overall because it had all of what we did together, and when the presentation was going on, I kind of remembered every single thing we were doing. So that was definitely the part I most remember because it reminded me of everything."
Rafael	Slide on sources of sound	PowerPoint slide with top three loudest and quietest sounds and description	"There's like different locations that we have recorded and that there's also traffic and parties and the decibels range from 27 to 108. We wanted the loudest sounds but we also wanted to record the quietest sounds to show that [the town] could be a quiet place, a peaceful place."
Tomás	Sound level graphs	Graphs of sound levels according to the day of the week and time of day	"We definitely made like graphs and information for other people to use, and like maybe other people can use in studies and stuff like that."

Girls' signature science artifacts. In the next section, I describe Katie, Araceli, Jatalia, and Flora's significant science artifacts and associated performances. While I analyzed artifacts and positioning events for all youth on the data team, the boys' significant artifacts were all data displays, produced from data analysis tasks. In comparison, the girls had a greater diversity of significant artifacts ranging from sound files to acoustic panels. The girls were also more likely to have positioning event responses coded as constraining or expansive rather than supportive, potentially indicating greater shifts in their views of themselves in relation to science. From the beginning of the project, the boys referred to themselves as the "data group" or "analysts", and usually responded positively to facilitators labeling them as "data team members." On the other hand, the girls were more likely to reject labels of "analyst" or "scientist", and took longer to feel a part of the data team and develop ownership over project artifacts. This slower process, with more moments not directly supporting their ideas of science, provided the rationale to highlight the artifacts and associated identities of the girls. Below, I use excerpts from transcripts of positioning events as evidence of the role of the artifact and surrounding discourse in shaping the girls' participation. I discuss associated identity processes over time, including the girls' view of themselves in relation to STEM.

Katie the designer. For Katie, the acoustic panel as her signature artifact (see Figure 1) articulated and solidified her identity as a designer. From the beginning of the project, she positioned herself as a maker and gravitated toward activities that incorporated building, art, or crafting. She created numerous individual acoustic squares and helped others with theirs.

Figure 1. On left, Katie and Flora re-arranging individual squares for installation. On right, panels installed in homework room.

However, after the making phase ended and she took photos to document her recommended order for the individual panels, she expressed uncertainty about why she was needed:

> LEAD FACILITATOR: Alright we're ready! Can you help put them back in the order they were in?
> Katie: Wait, you have a picture of them.
> LEAD: I know.

Katie: You mean help you put them back?
LEAD: I feel like since you're the designer, you'd --want to help
Jatalia: --Katie, just do it!

Encouragement by Jatalia, and direct labeling as the "designer" by the lead facilitator began to expand Katie's idea of herself in the project beyond "organizer" and "maker", roles she mentioned in the exit interview. Katie accepted this positioning and began to supervise during installation. She started instructing Jatalia, "And then you're going to need that one, then purple stripe" before correcting a younger student installing in the wrong order:

Katie: Nope. ((To Paco picking up square out of order)) Starting right here. ((She points and he picks up from other end of the line of individual squares)). Okay, let me make sure. Sun, moon, okay, now we need this one.
Jatalia: See how fast it was Katie?
Katie: Yah, I didn't mind it.

Katie admitted that she enjoyed the new role of guiding others and explained her organizational choices such as avoiding adjoining blue and gray panels "because like the gray, and the purple and the blue are too similar." Although Jatalia teased her, everyone deferred to Katie and her vision. The co-facilitator approved of her color and placement choices, and commented that the design was "modern art," validating her as an artist rather than an organizer. However, when Jatalia asked who designed the panels, Katie first attributed the design to the individuals who created the acoustic squares:

Jatalia: Who did the design?
LEAD: What do you mean?
Katie: Like the people. People decorated them.
Jatalia: No I mean, like, who designed to have it like that?
Katie: Me?
LEAD: Yah, the order. Are you talking about the order it's in? Yah.
Katie: Me!
LEAD: Yah, why? You like it?

Katie initially expressed surprise because although she thought of herself as an "organizer", attributing the artistic vision to individuals. When installing panels she made comments about each square including, "That one looks really cute" or "This is a cool one." When people came over to add their squares to the installation, they asked her permission, positioning her as the overall designer. However, she helped others place their squares, retaining individual ownership even within the overall design:

> Liz: Can I put this one?
> Katie: Yah! Right, here. ((Helps rotate panel/adjust))
> Katie: Here, now you can press on it. ((Katie demonstrates, then Liz pushes on it.)) Santi, come put yours up! ((Katie holds up panel, gesturing for Santi to come over))

Although others were already offering her the position of designer, Katie's stance shifted with Jatalia's clarification of, "Who designed to have it like that?" Jatalia distinguished between the design of individual squares and the overall panel, ascribing the panel and Katie's actions with new meaning and emotion. Jatalia and the facilitator clarified for Katie that she was recognized by others and valued for her position as a designer. At this point Katie related these everyday performances of designing in the Sound Project to her future goals:

> Katie: I might go to the Colorado, what's it called? CU Colorado University --because they have architecture and stuff. Or UCLA or another
> LEAD: --Oh, Boulder? That's a really good school. You know my brother was studying architecture in undergrad.
> Katie: I lo::ve interior design.
> LEAD: You should also consider civil engineering because it's similar to architecture. That's what my brother ended up doing. It depends what you like about architecture. Do you like the building part or do you like more the design?
> LEAD: (Oh both).

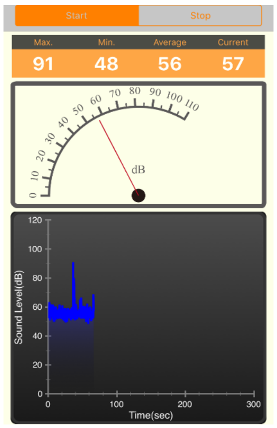
The facilitator expanded the role beyond art to relate back to STEM, and Katie accepted this positioning, saying she was interested in both building and design, and potentially engineering. Interestingly, Katie distanced herself from activities traditionally associated with science and did not appear to care if the panels were functional in the scientific sense of dampening sound. It wasn't until the very end of the installation day, one month after creating the individual squares, that she realized the order was not just aesthetic but that the alternating horizontal and vertical wedge placement mattered for absorbing sound. Even after she made the connection between a music studio and the homework room, she valued the panels as being aesthetic not functional in reducing noise. In the exit interview she stated, “I’m not sure what the difference is with the acoustic panels. I mean, to me it seems the same they’re like decoration on the wall. I guess it could work, if it is I’m not noticing it. The panels worked out good because like people did it.” In this statement, Katie downplayed the importance of science in the project and emphasized the decorative elements, with the evaluative stance that she found the panels successful because they were a collective decorative effort that she oversaw.

While embracing her identity as a designer, she actively distanced herself from the data collection and analysis. In one instance when she declined the invitation to participate the facilitator asked, “Why not? You said you'd **love** to help with the Sound Project.” Katie responded, “It's called sarcasm.” Other times she negotiated her participation, rejecting the facilitator’s request to help with data analysis and instead filming herself or others participating in the project and documenting their work. She reflected on this disassociation in her exit interview stating, “I never actually did the data thing because I didn’t want to…because it’s boring.” She further stated that, “I wasn’t here for the data analysis like average and calculate everything but I’m pretty sure that would be hard for me because I’m not good at math. Even if I’m in math Honors, I still need help…No, I’m horrible, I still need to use a calculator.”

Her view of herself as a competent data analyst was constrained in part by her experiences in school. She commented that her teacher for Honors math had told her that she “did not belong there” and should have been placed in a lower level class. Although she received good grades in her Honors math class after the initial adjustment, she lacked confidence in her math abilities and felt out of place, which affected her participation in the Sound Project. Unfortunately, Katie’s situation seemed representative of a bigger issue at school. Flora, Araceli's older sister, and other peers all commented on teachers' stereotypes of Latinx students who lived in their town and how very few Latinx students were enrolled in Honors classes.

While Katie did not actively participate or enjoy the data analysis parts of the project, she was present for most of the activities and sometimes commented on scientifically accurate ways to do experiments. For example, when measuring the effectiveness of the panels in the post test, she asked, "So did you guys take data from the other time?" She approved the facilitators' decision to do a pre-post comparison and explained, "In science Honors we're learning how to collect data, analyze research, all that stuff." In the exit interview, she revealed that even though she felt removed from math and data analysis, she did in fact consider herself a science person. She preferred the design side of the project, but considered art and design relevant to science and engineering. Overall, the project confirmed her identity as a designer, but did not change her view of herself as someone bad at math yet good at science in both school and the afterschool center.

Araceli the scientist. Araceli was similar to Katie in coming into the project with a clear view of herself as a science person, and favoring certain activities and practices that supported her already formed idea of scientist self. For Araceli, the audio files (see Figure 2) represented a central artifact that connected her to all other parts of the project. Even though she really enjoyed making her individual acoustic square, she said that the most memorable part of the project was, "We just go around [town] and just like use the app to…see and collect all the data to see how much loud or quiet it is." On the first day of the project, she was the most excited about using the app and was the first to rush outside to record sound files and email them to the lead facilitator. She was motivated to participate even though it was “hard to remember every day when we come to the Teen Center to put it on our app”, and had the added difficulty of sharing a phone with her older sister.



Data (125 data points)

Date	Day of the Week	Time	Location Name	Latitude	Longitude	Average Db	Max Db	Min Db
3/16/2017	Thursday	10:18 AM	888 Embarcadero del Norte Dow	34.41342	-119.85533	81	96	68
4/3/2017	Monday	5:23 PM	6701 Del Playa Dr Goleta	34.40938	-119.8626	81	96	69
4/5/2017	Wednesday	5:44 PM	6510 El Greco Rd Ocean Terrace	34.41583	-119.85415	51	96	37
3/15/2017	Wednesday	4:24 PM	888 Embarcadero del Norte Dow	34.41336	-119.85513	83	97	74
3/28/2017	Tuesday	6:43 PM	6571 Seville Rd Downtown Isla V	34.41169	-119.85763	62	97	52
3/12/2017	Sunday	10:14 AM	6796 Sueno Rd Goleta	34.41271	-119.86598	76	98	58
3/21/2017	Tuesday	3:28 PM	961 Embarcadero del Mar Downt	34.41172	-119.8572	71	98	45
3/21/2017	Tuesday	4:17 PM	952–958 Camino Pescadero Dow	34.41175	-119.85862	48	98	34
5/14/2017	Sunday	2:19 PM	?	34.41529	-119.8624	64	98	46
3/28/2017	Tuesday	12:44 PM	888 Embarcadero del Norte Dow	34.41333	-119.85522	69	99	61
3/28/2017	Tuesday	5:06 PM	888 Embarcadero del Norte Dow	34.41335	-119.85531	72	99	57
3/17/2017	Friday	8:17 AM	782–786 Ocean Rd Santa Barbara	34.41567	-119.84769	87	101	79
4/8/2017	Saturday	9:18 PM	?	34.41858	-119.86077	76	101	56
3/23/2017	Thursday	1:23 PM	6517 El Colegio Rd Ocean Terrac	34.41715	-119.85351	79	103	62
5/14/2017	Sunday	5:16 PM	?	34.41942	-119.85797	70	103	44
4/5/2017	Wednesday	5:49 PM	755 Embarcadero del Norte Oce	34.41639	-119.85548	73	104	47
3/24/2017	Friday	8:02 PM	6750–6786 El Colegio Rd Goleta	34.41756	-119.86345	80	105	58
3/22/2017	Wednesday	9:15 PM	6750 El Colegio Rd Goleta South	34.41856	-119.86494	79	106	45

Figure 2. On left, smart phone app tracking sound levels. On right, list of sound clips collected.

Even with her limitations in gathering data, she leveraged this experience and knowledge in other parts of the project, such as testing the sound panels or giving her presentation. When the lead facilitator asked how she could tell if the sound panels were functional, Araceli and her friend Amashi were prompted to make the connection between the data collection around town and the homework room experiment:

> LEAD: Yah, so like the stories we've been telling, that's like one way of saying like "Okay, it seems like it's quieter now than it was beforehand.” What else can we do? What have we been doing with our phones this whole time? With the Sound Project?
> Araceli: We like go around [town] and it's like what are we doing is (getting) the sounds.
> LEAD: Yah, so we were recording sounds in [town] but we could also do that in here right?
> Amashi: With our phones!
> Araceli: We should do it on our time in the homework room?

Araceli’s experience collecting data outside was used to introduce this new phase of making and testing the panels. Her experience with data collection also led her to write presentation notes and organize a slide listing all the sound files collected with times and locations. When she was worried about presenting, she was reassured by her expertise in using the app to collect sound clips. Araceli asked, “What if [the people attending] ask questions and I don't know what to say?" The lead facilitator answered, "I think you can answer a lot. Because you were part of the project from the beginning. Like, if they say, 'Well, what did you use to record?' you can get out your phone and say, 'Look, see here's the app I used.'" Araceli replied enthusiastically, "Yaaas", accepting the position of "data expert", and feeling reassured despite her fear of public speaking. Although she had a conflict on the day of the presentation and Katie had to stand in for her, she said "I feel accomplished" in relation to the data displays and final presentation. Her main role on the data team was collecting data rather than analyzing it, but she recognized the value of her contribution. She prepared Katie to give the presentation on her behalf, and shared her knowledge about the overall research questions and the data collected to answer their questions. She saw herself as a science person in the beginning and her participation in the project confirmed this identity for her, according to her exit interview commenting on her experiences experimenting, working on the computer, and participating in a variety of related leadership activities.

Jatalia the community scientist. For Jatalia, the project and her signature artifact of the map (see Figure 3) offered an opportunity to develop new identities. At first Jatalia felt like she was helping but not central to the project. When she worked on the map of the town the first day, she did not take credit for her contribution:

> LEAD: I really like your map! It looks really good.
> Jatalia: [Co-Facilitator] did all the work. (I was just there).
> LEAD: You gave positive --reinforcement.
> CO-FAC: --It was good feedback. Feedback.
> LEAD: Wait, Jatalia. You want to pick out a song—sound too?
> Jatalia: A song too, yah.
> LEAD: Well I don't know if we have songs. We have all these sounds but... So we have these ones.

However, working on the map and linking the sound effects (including obtaining new sound files not represented by the data) gave Jatalia an excuse to come to the center regularly, and made her feel important to the project. In her exit interview she stated that her role changed over time because at first she was peripheral to the project but by the end she was expected to come as part of the data analysis team. She explained that the other group members would text her saying, “Jatalia, you should come to this science thing because [the facilitator] wants you to come” and that made her feel included and motivated her to come regularly. She felt “recruited” into the figured world of community science at the Center, and she began to take ownership over the map as she personalized it.

Figure 3. Map of town with linked sound effects collected by participants.

Instead of attributing the map as the facilitator’s project, she started to see it as a collective effort. Thinking aloud during a subsequent session, she said, “We will display data on physical or digital map of [our town’s] sound levels. Cause in the picture it shows we want to show a map where the screen shows levels and people can see.” She also took on the related role of presenting the map at the Town Hall, after facilitator encouragement:

> UG: And remember the process and everything too cause you're going to help present this portion. Such an exciting--
> LEAD: --And you got to pick all the…a lot of the sounds on the map.

> UG: Woohoo!
> Jatalia: I'm really nervous about presenting.
> UG: Don't be nervous, miss. You're doing good!
> LEAD: You have the most fun part. ((Jatalia laughs))

Preparing her presentation notes provided the opportunity to reflect on why the project and the map were important to her, transforming the map beyond "the most fun part" of the data displays. She accepted the position of presenter and community scientist offered by the facilitators, but she simultaneously authored herself as a community advocate. When asked for her reasoning for the map, the facilitator helped Jatalia articulate why this was important to her:

> UG: Like, okay, yah displaying the data, (talking about) the research, actual sound levels. But, like, what is the purpose of it? Why would that matter? Would it happen?
> Jatalia: Why...? Because it's, just by looking at it you can see like you don't have to like zoom in to see. ((Pointing around map, gets closer to it, squinting))
> UG: Okay, how would this help someone who was moving to [the town]? Like let's say I'm a family and I want to move here with my family.
> Jatalia: (Don't). I'm just kidding. ((Laughs)) It's like to move closest to like the quiet area.
> UG: Exactly.
> Jatalia: ((Writes on paper. Puts pencil down, claps then drums table triumphantly))

In the Town Hall presentation, she expanded on this idea of the groups' work benefiting families. She stated:

> What we hope to happen in the future, our next steps are we want to go out and get more data points…We want to display data as maps of [town] sound levels, physical or digital. We hope in the future to show on a map where there was the loudest noise and the quietest noise. For example if you are like a family, one who moved to [town], and you want to see where it's quietest and we are hoping later in the future we can have maybe like a red color where it's like the loudest and like quietest would be like blue.

She explained in the exit interview that she felt the map was unfinished and she planned to continue collecting data to make the map more accurate and in particular to highlight loud, party areas for the local Latinx families to avoid. She said, "I feel like the goal of the project was just to spread awareness about the sounds of [the town]…it's not always loud it has its moments when it's quiet and it's peaceful it's like [the town] is not a bad place." She wanted to make sure their data was useful, as an accurate depiction of the noise problem and as a resource for Latinx families to find ideal areas to live.

She also recognized the importance of community members collecting, analyzing, and disseminating this information. She explained that, "A lot of people come in and do science" but it was uncommon for it to be done by Latinx community members like her. She felt that Latinx families rarely benefited from scientific investigations by outsiders because the research questions were not relevant to the immediate community, or because the findings were not disseminated. Community members as researchers offered a way to change power dynamics for Latinx residents who were a minority group living in a "college party town" composed primarily of university students. As both community members and researchers, the data team could ask questions about their concerns such as noise pollution, and share their knowledge of quiet and loud areas to benefit local Latinx residents. Although Jatalia recognized the value of the team practicing community science, it took until the end of the project for her to articulate an identity as a community scientist. In the exit interview, the facilitator asked if she thought of herself as a community scientist after she defined the term. She replied, "Now that I realize, yah."

However, this new identity as a "community scientist" did not influence her view of self as a science person. When asked if she was a science person, she answered, "At the moment, not really", and that "they think that I don't like science at school." She felt that science at school was "just really boring" and that the community science done at the Center was "different in a good way" and "if only science was so easy like this in school I think I would pass any day." Although she used tools like excel and PowerPoint, collected data and conducted experiments, and presented her findings, applying similar scientific knowledge and practices to school science, her view of herself as a science person did not change as it was connected to school and not the project. While the narrative of "bad student" in science persisted, she was able to take on a new role as "community scientist." She felt valued in the project for her contribution, and proud of her potential to help local families in the future.

Flora the helpful data analyst. Similar to the map for Jatalia, the sound wave printouts offered Flora the chance to engage with science in a new way that she found empowering and relevant to her community (See Figure 4). In general, she was motivated by helping others around the Center. In the exit interview she explained that she joined the Sound Project because "I always like to help so, I like that. I also thought it would be useful and helpful…for other people, and myself too." At the beginning, Flora seemed more motivated by helping the graduate facilitators in the data analysis team, however this shifted to helping her community in general as she worked through the data and better understood the project and its goals. Initially when asked by a staff member what she was working on, Flora replied, "I'm just doing this thing. I'm helping with it." She then turned to the facilitator working on the project and asked, "So you want me to do this?" However, by the middle of the session she understood the point of the activity and expressed enthusiasm for performing calculations to demonstrate the effectiveness of the panels. When an undergraduate facilitator later asked what she was doing she responded differently:

> Flora: I'm doing the science project. We're getting all the results.
> UG: O::h, wow!
> Flora: We're doing the averages.
> UG: Oh is it the Sound Project you're involved in?
> Flora: Yah!
> CO-FAC: So, we printed out graphs of the sound levels over time and we tested it by playing a sound in the room and we're comparing before and after we put the sound panels up.
> UG: So you can see what the difference is?
> CO-FAC: That's what we're about to...that's --where the magic is happening right now.
> Flora: --That's what we're going to do. We're doing the average right now.

She realized that she could combine science with service through testing the sound panels, and at the end commented that, “I feel proud that I helped, that I helped in this project because it was very useful.” Her favorite part of the project was “the sound panels because I learned how it worked and how it made a big difference in the room…like how it absorbed the sound.”

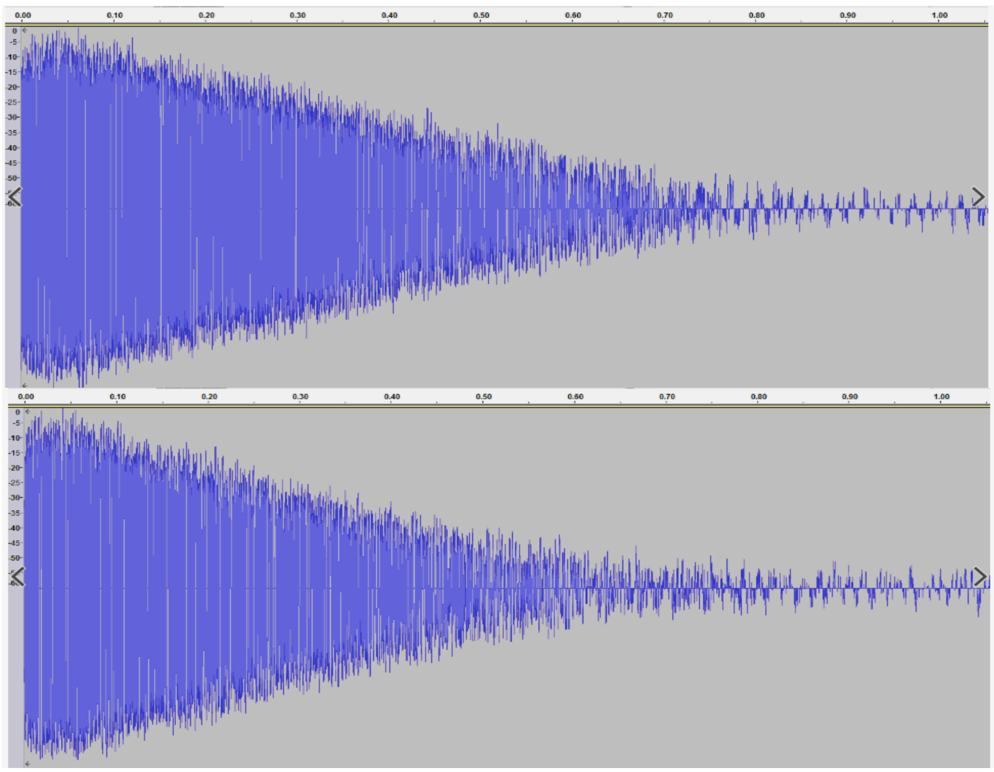


Figure 4. Pre (top) and post (bottom) sound wave print outs that show amplitude over time, or reverberation time.

Flora felt helpful because she worked on a successful project, but also because she was positioned as a data team member and performed as a conventional scientist. She was given a position of relative power on the data analysis team. Initially the facilitators taught Flora how to estimate the slope and x intercept of the sound waves to determine the reverberation time, or the number of seconds until the test sound was inaudible in the homework room. After providing feedback on the first one, Flora and the two facilitators each performed analysis independently but side-by-side, with the co-facilitator saying, “Alright, let’s do a couple right now…I’ll do this one.” Flora was contributing equally to the team’s data analysis as the adults. Beyond working at the same pace on the analysis, her ideas and concerns were taken seriously. For example, when calculating the pre-test mean, she pointed out an intercept data point that was much larger than the others and together Flora and the co-facilitator verified it was an error. In another instance, the facilitators asked Flora how to analyze an outlier that did not fit the pattern of the other sound waves and therefore was difficult to estimate its x intercept:

> LEAD: Is this the weird one? ((Co-fac and Flora laugh)). What am I supposed to do with this?
> Flora: You're smart, you're smart. ((Keeps working on hers))
> CO-FAC: Well, what do you think Flora? What do you think about this one? ((Lead slides the soundwave printout to Flora))
> Flora: ((Puts ruler on page)) You go like, like almost like, follow the line ((traces line with Finger))
> CO-FAC: Yah. Yah, yah. Yah, absolutely, 100% consistent with what we've been doing. That's like how we've been doing all the other ones, right?
> Flora: Yah.
> CO-FAC: Yah. So yah, well, [Lead] why don't you try that, and get a number out of that first?
> LEAD: Where was it?
> Flora: So it was right there. ((Aligning ruler on page))

Flora was positioned as an authority figure as she provided advice and helped the lead facilitator analyze the anomalous data point. In other cases she was engaged in real-time problem solving with adults, including participating in fairly complicated discussions with science vocabulary including “maximum amplitude” and “exponential decay”. In the following transcript, one of the undergraduate facilitators spoke with Flora about how to use an equation for wave forms to calculate the reverberation time in a more precise way than estimating the x intercept.

> UG: So you can make this equation--
> Flora: --It's smaller and then it gets quieter?
> UG: Yah yah. With this equation, basically, this data matches up with this. To simplify it, you don't need to care as much exactly how this is traveling back and forth, all you care about is amplitude right? So you can just kinda set this side to 1.
> Flora: Can you take like the 0,0 and do --like what you got here?
> UG: --Yah. Yah yah yah!

Flora: That's basically how you solved it?
UG: So you get this equation for exponential decay, which should…I don't know, this looks linear so I'm confused. But, I don't know everything about how sound actually decays. So, I might have to work through it. But! You could put this decaying equation into this data. Like, a data point here and a data point here.
Flora: Yah. So basically you do 0,0 and you do what we got here.
UG: Yah. And then you need some sort of (maximum) amplitude.

Beyond discussing calculation methods, she also contributed authentically in confirming that the panels were successful. She determined that it was a success due to the differences in the pre and post means, and announced, "it did work" to which the co-facilitator responded, "we proved it, it was a success." Then the facilitator offered her a new position by asking her to share their finding with other adults at the Center. The explanation was collectively constructed instead of given solely by Flora, but she was recognized and praised by others for her work on the data analysis. Proudly sharing the results also led to the expectation that she would present the results to the public in the next Town Hall:

Flora: It's for the room…And we got the averages. This one we did first (and this was a different one).
UG: And so, what are the results?
Flora: Um, well this one is 0.76 and this one is lower at 0.67.
UG: So was it, is it louder in there still, or is it quieter?
Flora: Quieter.
LEAD: What is the "s"? So this I'm guessing was for --seconds?
CO-FAC: Oh, --seconds. So it's the amount of time it takes to go to 0, the time it takes to decay.
UG: O::h
LEAD: So it seems confusing, the less time (the better).
UG: So it's a success? Yay!!! ((Lead laughs)) This is so good! ((UG laughs))
CO-FAC: We proved it with science.
UG: Yah! You should, what's it called? Present this!
LEAD: Oh yah! ((Co-fac laughs))
UG: <u>You</u> are our presenter! ((Addressing Flora))

Despite feeling empowered and helpful through the data analysis work, Flora regularly commented that she was bad at science and rejected the position of "scientist" or "community scientist" offered by the graduate facilitators. She commented that she disliked her science class and teacher, felt it was useless, and made comments such as that she was "probably going to fail this week's test." She had accepted the narrative that she was bad a science and not a good student in science class, even though she recognized she had applied what she learned that year in school about how to conduct an experiment and use excel to calculate averages. Her distaste for school science transferred to the science activities at the Center, and at the beginning she expressed surprise that the community science work was still science since it felt different than what she had done before. After initially reviewing the pre and post data for the sound panels she exclaimed, “Sciiiiiience! This is science!” to which the facilitator said, “This is science. You’re a citizen or community scientist.” However Flora replied, “Uhhh. Not the best one.” While she seemed to consider the community scientist role, she never accepted the position of “scientist” offered by the facilitators. The transcript below occurs right after the co-facilitator praised her for double checking and correcting errors as a scientist. Flora rejected this positioning:

> Flora: Thank goodness, I'm never going to be a scientist.
> CO-FAC: ((Laughs)) Wait, you have all the skills though.
> Flora: What skills? I have no skills.
> CO-FAC: These are skills. This is like half of what a scientist does.
> LEAD: You're a critical thinker, and you're good at problem solving.
> Flora: Oh, no. I said I (don't have skills at science). I hate science.
> LEAD: You can hate it, but you're still skilled at it. ((Co-fac laughs))
> CO-FAC: Yah, that's true.
> LEAD: That's okay to hate it. It's okay to not like it but you can't deny that you're good at it. I can tell that.

Flora saw how science could be relevant and authored a science self which connected science practices with her valued identity of helper. By assisting the data team, and by proving that the overall project was useful, she was helpful on multiple levels and felt successful. However, while she realized connections between science class content and the project, and felt competent as a data analyst and a helper, she still did not see herself as a “scientist” or “science person.”

Conclusion

In the new figured world of Community STEM, participants considered what it meant to be science people and civically engaged community members. At different moments, participants accepted, rejected, or negotiated offered positions as makers, engineers, data analysts, presenters, science people and community scientists. Participants began to accept the label of community scientist, expanding possibilities for a new way of "figuring" the activity of science, who did science, and how science fit within larger social and personal contexts. The project provided the space and impetus for both girls and boys to create personal and collectively meaningful science-related artifacts with others, disrupting perceptions of science as objective, competitive, and impersonal or associated with a masculine identity.

Artifacts played a significant role in presenting possibilities and constructing identities. Araceli used sound clips to relate to different aspects of the project, and develop confidence in her skills as a scientist while documenting the noise problem. Jatalia's sound map displayed the data but was also a potential resource for families like hers. The acoustic panel for Katie both united individuals' contributions and positioned her as the overall designer. Flora's analysis of the sound wave print outs demonstrated the success of the acoustic panels and proved to her and others the value of her contributions. Although not examined in depth in this paper, the boys felt strong connections and associated identities with artifacts as well. Rafael, similar to Jatalia, felt empowered as a community scientist. He found meaning in creating a list of sounds for the map, and reported at the Town Hall on areas that were relatively quiet and peaceful and argued against oversimplifying the town and its problems for families. Tomás and Dylan felt proud of their graphs and presentation slides because they depicted their findings as data analysts. They also recognized their role in overseeing and synthesizing findings from the collective effort of their peers in the project. Overall, the artifacts required longer-term participation with peers and facilitators, becoming focal points and promoting reflection on the noise problem, potential solutions, and their role in the project and larger community.

Discussion

The figured world of Community STEM functioned as a new world of science possibilities, centered on playful, artistic, personalized activities that expanded the definition of science conventionally found in school. The program supported students developing expanded views of STEM, positioned them as co-learners with adults, and provided ample choices for activities and roles. Participants were able to find personally meaningful reasons to participate and explore deeply given their interests in specific artifacts. Like in other Community STEM research, our project was able to draw from both maker and citizen science literacies, and increase understanding in key content areas (Trautmann et al., 2013; Vossoughi & Bevan, 2014) such as the physics of sound, and promote contextualized understanding of real-life applications such as the effect of noise pollution on local families or the benefit of installing acoustic panels in the homework room. According to their exit interview reflections, our participants developed dispositions other researchers have documented in relation to making or community science projects such as resilience and creativity (Sheridan et al., 2014) and decision-making and "optimism coupled with realism" (Schusler & Krasny, 2008, p. 274). Additionally, the long-term nature of our Community STEM project, coupled with the complexity of an authentic scientific investigation, encouraged participants to develop unique roles and expertise within the project. Similar to Ballard and colleagues' (2017) findings, the Sound Project promoted diverse roles and practices in order to accomplish the data collection, analysis, and communication. Participating in the data analysis and presentation were compelling to participants as they viewed themselves as authentic contributors. Additionally, the flexibility of the project allowed for new roles that might have initially seemed unrelated to science. Rahms and Gonsalves' (2012) description of a girl who expressed distaste for science but enjoyed writing science poetry in the afterschool program resonated with my findings about Katie, who actively avoided data analysis tasks and instead focused on making and design. While the girl in the newsletter program became a science poet and "artist-in-residence", Katie became a "designer." They both carved out new places for themselves in the projects and expanded disciplinary boundaries. Expanded forms of participation are especially relevant to Community STEM programs, as these are "as if" worlds of imagination, play, and discovery at the margins of preexisting figured worlds of science (Holland et al., 1998; Kane, 2012).

However, even the most involved participants that constituted the data analysis team differentiated between "scientist" and "community scientist" and at the end of the project did not feel like scientists. This potentially contradicts findings from other Community STEM or citizen science programs that encouraged more students to pursue science by breaking down stereotypes about what it meant to be a scientist (Trautmann et al., 2013). Our project opened the range of expression for science identity to include many diverse roles, but while constructing new identities as "community science experts" (Calabrese Barton et al., 2013), most of our participants did not see themselves as "real scientists" or "science people."
It is worth further consideration how to bridge science in school as a type of subject matter to the real-life application of science. Participants' lived experiences and how they made sense of their world outside of class contradicted with the way that science was portrayed as a field of study in school. This issue raises questions about the alignment between science in school and out-of-school, and adds nuance to the barriers for youth seeing themselves as a science people or feeling efficacious in science, especially for participants from STEM-underrepresented groups. Given that Latinx students tend to have lower self-efficacy and

view themselves as less competent in school science and math compared to White students (Crisp & Nora, 2012), how can afterschool contexts construct counternarratives that are meaningful within school and beyond? Although programs can open up the range of possibilities to practice science, it is worth exploring the meaning of these identities if they do not transfer to other contexts, and if students continue to feel excluded from the figured world of school science.

Katie, Flora, Jatalia, and Dylan had all failed STEM tests recently or had teachers express doubt in their science or math abilities. In response, Katie and Jatalia avoided math-related Sound Project activities, while Flora and Dylan countered facilitators' statements about their science skills by bringing up school failures or other perceived inadequacies. Participants dismissed being characterized as "real scientists", however they recognized they were performing science and math practices relevant to what they had covered at school, and acknowledged that the facilitators took them seriously in their roles as scientists. Even though only Katie and Araceli considered themselves science people and engineers, most of the participants did seem more open to considering these possibilities in the future. For example, Flora expressed interest in learning more about engineering and even applied later that year to a high school engineering academy. And although Jatalia replied, "at the moment, not really" in regard to being a science person or engineer, her exit interview response was still more open to the possibility than her initial stance when starting the project.

Participants did not express definitive shifts in how they viewed a "science person", but their new identities as "community scientists" seemed powerful. Participants constructed intersecting identities as Latinx youth, scientists, and community members that seemed richer than traditional school science as defined by being good at certain tasks like memorizing or taking notes. Artifacts were helpful in highlighting the “multiple sites of self” (Holland et al., 1998, p. 28) and the intersection of identity and power. Jatalia and Dylan were motivated by helping local Latinx families, who were sometimes not privy to the research dissemination or related decision making by university or researcher investigations, as low-income immigrant residents and non-college students. They recognized the relevance of their intersecting identities as local residents and Latinx youth while constructing new identities as community scientists and activists. All of the youth had stories about the noise issues and the power dynamics of loud college students and children trying to study or parents needing to get up early for work. Their intersecting identities, including minority status, motivated many individuals from the data analysis team to participate in project activities and produce community science artifacts.

Future work will include more analysis on the positioning events and signature science artifacts for the boys on the data team. I also plan to examine all 15 participants in the broader Sound Project to better understand patterns of participation for both the seven members of the data team and the less involved members of the overall project. These analyses would provide further insight into the diverse perspectives, experiences, and trajectories for Latinx participants in our project. Additionally, I could make comparisons based on both gender and data team versus general member status.

Despite focusing more on the girls from the data team, this work is still meaningful in extending the research on afterschool programs that focus on equity, and confront local and global issues through making, engineering, or community science. I presented a broader view of making and science based on posing and solving problems in ways that encourage individual expression and community action for populations underrepresented or undervalued in STEM. More research is needed on these types of programs, including documenting long-term implications and identity trajectories. This research could help characterize distinct STEM pathways for different students, drawing attention to the moments that expand or constrain Latinx students' participation in and perspectives on STEM.

Paper #3: STEM Academies Project

Heck Yah! I'm a Doctor: Experiences of Latinx Girls in STEM Academies

Latinx people account for 18% of the United States population, making up a larger share of Americans than any other minority group (Census Bureau, 2018). The Latinx population is also younger on average than other racial groups, accounting for a quarter of all K-12 students and more than half of students in states such as New Mexico and California (Gándara, 2015; Lopez, Krogstad, & Flores, 2018). Although this population is one of the youngest and fastest growing demographics (Lopez et al., 2018), there is a lack of literature about the contexts that influence Latinx students and their educational pathways (Darder & Torres, 2014). The research does show that the "number of immigrant, ethnic minority, and low-income youth who continue through school shrinks disproportionally, and troubling gender gaps appear" (Cooper, 2011, p. 6). Even though Latinx youth are graduating high school and college at greater rates, 20% of Latinx young adults are unemployed, and Latinx young women are disproportionally categorized as "disconnected", not in school or working (Darder & Torres, 2014). Unfortunately, much of the research focuses on deficit models, and scholars sometimes attribute poverty to poor decision-making rather than systemic issues (Darder & Torres, 2014; Rodriguez & Morrobel, 2004). It is important to consider the structures in place and strategies youth use to navigate and forge productive pathways (Cooper, 2011).

One area that deserves exploration is how Latinx students, and in particular Latinx young women, develop skills and identities relevant to STEM. STEM is aligned with power and access, considering that STEM fields are growing twice as fast as non-STEM fields, and a STEM worker on average makes 26% more than a non-STEM worker of comparable education (Langdon, McKittrick, Beede, Khan, & Doms, 2011). Despite the possibilities in

STEM, Latinx men make up only 4% of the STEM workforce while Latinx women account for only 2% (NSF, 2017). Latinx women are more likely to enroll in college than Latinx men, however are less likely to graduate with a STEM degree (Santiago, Taylor, & Galdeano, 2015). Compared to other women, Latinx women are the least likely to major in STEM, earning only 3.5% of undergraduate STEM degrees (Gándara, 2015). And although great strides have been made, with a 74% increase in STEM credentials earned by Latinx students between 2010 and 2013, these graduates are more likely than their White counterparts to gain employment in lower paying professions, becoming assemblers or technicians rather than engineers or computer scientists (Santiago et al., 2015). In general, Latinx workers in STEM make up a larger proportion of the service or health professions in comparison to careers related to math, computer programming, or physical sciences (NSF, 2017; Santiago et al., 2015). This is problematic due to the lower pay of these professions, but also because these service-oriented careers are projected to grow at much smaller rates than the professional STEM occupations (Santiago et al., 2015)

The underrepresentation of Latinx people in STEM is complex, but a handful of scholars have delineated barriers including access to high quality academic preparation and resources (Crisp & Nora, 2012). Latinx students in K-12 are more likely to have instructors with less experience with science material or teaching overall. Latinx students also tend to have lower self-efficacy, viewing themselves as less competent in science and math compared to White students (Crisp & Nora, 2012). Even if interested in science, they might have trouble seeing themselves as a scientist due to stereotypes (Sorge, Newsom, & Hagerty, 2000). At the college level, needing to earn money to stay in school or support family can be a deterrent for pursuing often time-intensive STEM degrees (Crisp & Nora, 2012).

For Latinx women in STEM, “the barriers are multiplied” as they encounter racist and sexist conditions, including stigmas and low expectations from others (Beeton et al., 2012; Cantú, 2012, p. 481; Johnson, 2011). Other barriers include lacking awareness about science careers and viewing science as “a white male profession” (Beeton et al., 2012, p. 72). To compound the problem, there is a dearth of research documenting the experiences of Latinx women and illuminating their reasons for studying STEM (Crisp & Nora, 2012; Rodriguez et al., 2017). The available research on Latinx women points to the importance of a personal connection or role models in science (Beeton, Canales, & Jones, 2012; Sorge, Newsom, & Hagerty, 2000), and recognition by others as a science person (Carlone & Johnson, 2007). Successful women of color studying STEM in college were motivated by using science to help others and were politically active in causes related to race or gender (Johnson, 2012). Factors such as family support and institutional advocates are crucial as well (Crisp & Nora, 2012).

However, still more research is needed on what Latinx women consider supports and barriers to their participation in STEM classes and careers, and how they draw on resources to confront challenges and construct identities as STEM people. Therefore, over a period of three years, I worked with a group of Latinx young women who were the first students from their afterschool program to gain acceptance into a competitive engineering academy in high school. I utilized the Bridging Multiple Worlds (Cooper, 2011) model of pathways and the practice-linked model of identity (Nasir & Cooks, 2009) to explore how these four young women leveraged resources present in an afterschool teen center and STEM academies to define their goals, maintain motivation, and learn STEM content and tools. I further considered how their social networks, ideas about values and norms, and the physical environment of the high school STEM academies shaped identity processes and STEM trajectories for these students. I asked:

- How did these Latinx young women take up opportunities in science and engineering and construct STEM identities while negotiating other identities?
    - What were supports and barriers to entering and staying in the STEM academies?
    - How did the girls draw on ideational, material, and relational resources in the academies?

Accordingly, in this work I documented and analyzed the experiences and identity processes of a group of Latinx young women as they accessed diverse resources from their communities to confront challenges related to pursuing STEM classes and careers. The paper adds to an emerging body of research on educational pathways for underrepresented students and illustrates overall and STEM-specific supports and challenges for youth. The paper also presents the experiences of four Latinx young women in a way that highlights their voices, interests, and goals rather than reports on degree attainment.

Theoretical Framework

Bridging Multiple Worlds

Bridging Multiple Worlds (BMW) provides insight into how culturally diverse youth navigate through school and beyond. In this framework, "world" refers to a sphere of influence, such as family, friends, church, or sports. BMW research studies how youth take up opportunities, confront challenges, and use resources to make sense of themselves in different worlds and form connections across worlds. In particular, researchers are interested in youth staying in school, and how adolescents construct identities or develop aspirations about college and careers (Cooper, 2011; Cooper et al., 2015). According to Cooper and colleagues, adolescents they interviewed were aware of both the resources and challenges offered in each of their worlds, whether in the realm of family, peers, schools, or community programs (Cooper, Gonzalez, & Wilson, 2015). Youth participants reported that their parents helped them stay on track and plan for their future, as well as assisted with homework and provided moral guidance. Teachers helped youth with math and staying on track for college. Peers and teachers, while offering support and resources, were also the "greatest source of difficulties" (Cooper, C., Cooper, R., Azmitia, Chavira, & Gullatt, 2011, p. 56). Social networks provided practical and emotional support while school and afterschool programs promoted a "college-going culture" (Cooper, 2011, p. 91). Although relationships with others were important, Cooper and colleagues foreground the role of adolescents' agency in relationships. Students were successful academically when they utilized their resources from numerous worlds and confronted, or even felt motivated by, challenges (Cooper et al., 2011). College pathways were realized when students had resilience and self-efficacy and were able to integrate various identities into their academic identity (Cooper et al., 2015). In summary, "Opening academic pipelines rests on integrating multiple identities--not only students' academic and racial-ethnic identities across their cultural worlds of families, peers, teachers, and community members, but also institutional identities of schools and universities in supporting pathways from childhood through college" (Cooper et al., 2015, p. 313).

The five dimensions of the BMW framework are: *family demographics*, *youth aspirations*, *academic pathways*, *challenges and resources*, and *research partnerships.* In this paper, I utilize the framing of the second dimension of *youth aspirations and identity pathways*. I consider students' general aspirations and expectations for themselves and of others, however focus on how these intersect with STEM identities. I also look at the BMW fourth dimension about *challenges and resources* across worlds of families, peers, schools, and other communities to identify the resources and challenges along these STEM trajectories.

Practice-linked Identity

To better conceptualize “identity pathways”, I followed the framing that identities are developed in social and cultural activity (Nasir & Cooks, 2009; Holland, Lachicotte, Skinner, & Cain, 1998). People make sense of themselves and develop ways of being as they move through spaces that are culturally formed (Gutierrez & Rogoff, 2003). Identity is made visible through what people do and how that is interpreted, “by the resources they access and activate to do so, and by how they position themselves in relation to others and to the object of the activity while taking particular roles” (Calabrese Barton, 2012, p. 43). Within largescale cultural models of identity, certain ways of talking or doing become recognized and either repeated or rejected, leading to circulation of cultural practices (Wortham, 2006).

Nasir and Cooks (2009) built on these ideas to propose an identity resource model, or “practice-linked identity.” In their model, resources within a space can be material (physical parts of the setting), relational (connections to other people), or ideational (ideas about participation, values, norms, and place in the world). Material resources include the space as well as tools, for example equipment, art supplies, and technologies, as well as the physical workspace like the Teen Center or STEM academies. Relational resources include connections with peers, facilitators, and staff at the Teen Center, as well as teachers and classmates at the STEM academies. Ideational resources include how students refer to themselves or others, such as if they call themselves “makers” or “art people”, as well as norms such as productive failure, or collaborating with others. I used Nasir and Cooks (2009) framework to better conceptualize “STEM identity” and to depict identity development in the STEM academies over time. Therefore, I examined how the young women accessed and activated material, relational, and ideational resources relevant to performing STEM practices and perceiving themselves as STEM people.

Methodology

Context

As a researcher-practitioner, I worked with participants at a local Teen Center makerspace across a three year period. In Year 1, I coordinated the makerspace program designed to engage Latinx students in conducting meaningful STEM activities. In Year 2, I worked with Teen Center staff to encourage and support junior high students with the application process for admission to competitive high school STEM academies focused on engineering or health. Students attended info sessions, received informational packets, and met with current students in the engineering academy. They also received assistance with their applications and training on interviewing, including individual help and a mock panel interview. These activities were provided at the Teen Center, and were not done in collaboration with the high school academies. In Year 3, students were asked for feedback about the application process and were interviewed about their experiences in the high school STEM academies.

Participants. Participants were in 7^{th} grade when they joined the Teen Center makerspace, and were interviewed in 8^{th}, 9^{th}, and 10^{th} grades. All participants were from low-income immigrant backgrounds, and identified as girls and either Hispanic, Latina, or Latinx. The girls all lived with their parents and siblings. They had grown up or spent most of their lives in a “college town” in California where families accounted for only a quarter of residents. They were strong students who received A’s and B’s in their classes and were part of an Advancement Via Individual Determination (AVID) elective that provided college readiness preparation for students underrepresented in higher education. They attended the Teen Center almost every day after school with their siblings or cousins. They were committed to improving their local community and held various positions on the leadership board of the Teen Center throughout junior high and high school. In 7th and 8th grade, the girls expressed a disinterest in science classes at school and (other than Isabel) did not feel like science people. Zuleyma and Isabel expressed more interest in art-oriented activities, while Malia and Sophia gravitated toward the technology-oriented activities in the Teen Center makerspace.

All four applied to the engineering academy in 8th grade. Zuleyma, Malia, and Isabel were accepted, but Sophia was initially rejected before being told she was waitlisted and then accepted. Isabel, Zuleyma, and Malia decided to attend the engineering academy and started in 9th grade, becoming the first group of students in the history of the Teen Center site to attend. Sophia decided not to attend the engineering academy and instead applied the following year and was accepted to a health academy at a different high school.

Academies. At the time of the study, the engineering academy was a four-year program within a public high school that provided project-based learning in STEM. According to their website, the academy's mission was to make learning relevant, business-oriented, team-based, and engaging, so students developed critical thinking skills but were also well prepared for college and careers. In the first three years, students took classes in art, computer, machine shop, and physics. In the last year they learned industrial design while interning with an engineering company and developing interactive museum exhibits. The program was very selective, with an intensive application process and 30% acceptance rate. The academy had an equal number of female and male students, but was not ethnically representative of the high school student body population which was 45% Latinx (Educational Data Partnerships, 2018).

The health academy was a selective three-year program (10-12th grades) located at a different public high school. Based on a partnership between a local community college and hospital, the health academy prepared students for entry-level jobs, or admission to college or technical schools. According to their website, the health academy's mission was to provide the foundation necessary for employment in health care industries, so attention was given to students acquiring problem-solving skills relevant to real-world settings. In the first two years, students took classes in health careers, medical biology, communications, and psychology, and in the last year chose between a nursing or pre-med internship with options to work in certified nursing, kinesiology, or sports medicine. The academy was career-oriented with guest speakers, research projects, internships, and service-learning opportunities. The health academy consisted overwhelmingly of female students, however was representative of the overall high school population which was 55% Latinx (Educational Data Partnerships, 2018).

Research Design

Research was conducted by a team consisting of a graduate student, a faculty principal investigator, and three undergraduate research assistants. The research design was a "holistic case study with embedded units", or an overall case with sub-cases of individual participants (Yin, 2003). This group of Latinx girls was selected as a "unique or atypical case" (Merriam, 1998, p. 33) as the first students from the Teen Center to gain entry to the competitive engineering academy. Atypical cases like these are valuable because they can express a range of experiences often not captured by statistical or large-scale data reports

(Merriam, 1998). Within the overall case, I compared the “subunits” of individual students to perform cross-case and within case analysis (Merriam, 1998; Yin, 2003).

Results were based primarily on ethnographic interviews of the four Latinx girls over a period of three years. Interview transcripts were coded based on Nasir and Cooks’ (2009) practice-linked identity model and as well as the BMW framework (Cooper, 2011). Narrative profiles were developed for each student, and narrative analysis was used to identify both unique and shared themes about students’ pathways and goals (Durán & Chaidez Ubaldo, 2016), utilizing comparative case study methodology of within and cross-case analysis (Merriam, 1998).

Data collection. Data collection consisted primarily of interviews about students’ views of themselves and program experiences. During Year 1, I collected ethnographic notes on students’ participation in an afterschool makerspace. In Year 2, I collected field notes and artifacts related to the application process for the STEM academies, and began interviews. In Year 3, following admission and enrollment of the four students in a STEM academy, I conducted follow up interviews about students’ experiences in the STEM academies. All told, individual interviews were conducted at four different points in time: fall before applying (8^{th}), fall right after starting (9^{th}), spring of first year enrolled (9^{th}), fall of second year enrolled (10^{th}). For Sophia, I conducted an additional interview in spring of 10^{th} grade since that was her first year in the health academy.

I followed Spradley’s guidelines for conducting an ethnographic interview (1979). In face-to-face semi-structured interviews of 20-40 minutes each, I asked questions about interests and perspectives in STEM and career plans, and later their experiences in the STEM academy. Targeted prompts from Bridging Multiple Worlds included questions about student *worlds*, *expectations, educational aspirations, career identity,* and *resources and challenges.*

Interview sections included grand and mini tour questions, with grand tour questions providing overall directions while mini tour questions followed up with probing questions to elicit more detailed explanations (Spradley, 1979). See Appendix D for interview protocols, transcription template, and list of conventions, simplified from Jefferson's work (1984). Transcripts followed general conventions in science education research (Varelas 2012) with a word-level transcription, ignoring pauses, exhalation, and pitch shifts included in more comprehensive conversation analysis transcripts.

Diagrammatic activities or handouts were used to prompt thinking about interview topics such as students' *worlds, expectations,* and *career aspirations* (Durán & Chaidez Ubaldo, 2016). These handouts included "Compass Points", "What are Your Worlds", and "Career Pyramid" (See Appendix E). The Compass Activity (Harvard Project Zero, 2015) was administered in the second interview and was designed to help students evaluate a new proposition, in this case starting a STEM academy. The modified prompt asked students to write out their thoughts and feelings next to the four points of a compass (N=Need to Know; E=Excited; S=Stance or Suggestion Moving Forward; W=Worrisome). Follow up questions were designed to elicit what students felt were the advantages and disadvantages of the academy, what they hoped to learn, what parts would be easy or difficult, and expected challenges. In the "What are Your Worlds" activity (Cooper et al., 2011, Appendix 1) administered in the third interview, students were asked to circle the "worlds" or communities and activities they were a part of, such as school, friends, internet, or sports. Then they were asked to write expectations of others next to these worlds, based on a list of positive expectations such as *work hard* or *be honest* and negative expectations such as *be lazy* or *drop out of school*. Next, they were asked questions about who helped and who caused difficulties related to planning their future, doing schoolwork, understanding STEM concepts, dealing with problems and staying on track for college or careers. The final interview included a modified Career Pyramid activity from the BMW toolkit (Dominguez et al., 2001) that asked students about their goals in high school and college, as well as to list the resources and challenges in achieving these goals.

Data analysis. I followed Merriam's (1998) two stages of analysis of "within case" and "cross-case" analysis. First, I utilized MaxQDA software to code the interview transcripts in alignment with Nasir and Cooks' practice-linked identity model. First round coding included the categories of *ideational, relational,* and *material* dimensions for individual's "STEM identity" and "academy identity" and the BMW constructs of *aspirations* ("hopes or ideal choices"); *expectations of self* ("more realistic or accessible options"); *expectations of others* ("goals, values, expectations important people have"); *resources and challenges* (who helps or hinders); and *career identity* ("exploration and commitment to their career plans") (Cooper et al., 2011, Appendix 1). Emergent sub-codes such as *mindset, future concerns,* and *career motivation—economic stability* were developed and refined through group discussion with the research team. Interviews were then coded separately by all members of the research team, reaching an intercoder reliability of 93%.

Next, narrative profiles were constructed for each of the four students and used to compare within and across cases (Merriam, 1998). I constructed individual profiles first by pulling quotes from transcripts associated with perspectives on STEM and supports and barriers to participation. The research team then reviewed these profiles and added information from diagrammatic prompts not covered in interviews. Individual profiles included participants' worlds, aspirations, supports and challenges, and perspectives on themselves as science people, makers, and engineers. I then used MaxQDA's "retrieved segments" function to sort all coded responses for individual participants according to the overarching categories of *supports, challenges, academy identity,* and *STEM identity*. I created charts to document supports and barriers (Appendix C, Tables 1 & 2) as well as ideational, relational, and material resources according to STEM identity (Appendix C, Table 3) and academic identity (Appendix C, Table 4). These tables helped organize data and allowed for more detailed analysis.

After I analyzed each case individually, I performed a cross-case analysis. I reviewed the retrieved transcript sections and charts to compare across participants and develop themes, which were refined during group discussions by the research team. This phase of the analysis highlighted the unique perspectives of each respondent while providing insight into commonalities and producing generalizations about STEM identity development.

Results

In the following sections I describe how the four girls constructed intersecting identities in the STEM academies and Teen Center makerspace. First, I present narrative profiles detailing the girls' worlds, school experience, and career and college aspirations. Then I briefly compare supports and barriers. Next I present their trajectories in relation to STEM, describing their feelings about science, math, and engineering in and out of school as well as how they identified with labels such as science person, community scientist, maker, and engineer (See Table 1). Finally, I analyze across cases to understand their overall academy experiences and how they drew from ideational, relational, and material resources to affiliate with or distance themselves from STEM ideas and careers.

Individual Profiles—Worlds, Aspirations, and Educational Pathways

Malia. Malia was known for being intelligent, meticulous, and thoughtful. In junior high, she was often quiet and did not joke as much or insult her peers during Teen Center activities. As she progressed into high school, she maintained her reputation as a dedicated student, but also became more outgoing, sporty, and community-oriented. Her “worlds”, or cultural spheres of action and influence (Cooper et al., 2011), included the Teen Center, school programs and clubs, family, school, friends, sports, and herself. Throughout middle and into high school, she was very involved in school and afterschool activities, participating in AVID, playing on the junior varsity basketball team, and serving on the Teen Center leadership board. Malia felt well-connected with her peers at school and was able to depend on friends and family for emotional and social support. When she needed tutoring or homework help, she could go to her teachers and the Teen Center for assistance. However, she was clear that it was ultimately up to her to succeed. Malia elaborated, “They’re there for support if anything, but yeah like I have to put in a lot of effort, a lot.”

Throughout junior high, her favorite classes were math and social studies which she found challenging but enjoyable. She did well in her classes overall, noting she was tough on herself academically and felt frustrated when she received her first B+ in science. This mindset continued through high school, where she was committed to maintaining her high grades and wanted to graduate with the highest honors. In 10^{th} grade, she joined the cheer team, continued with basketball and AVID, and was President of the Teen Center leadership and civic engagement group. She was hopeful about attending a California State University, though expressed financial concerns and needed to secure a job and her own car to support herself.

After college she envisioned herself working in a people-oriented career. In 8^{th} grade she stated, “Well my dream job is a counselor of any type, working with people.” In the beginning of 9^{th} grade she was considering the “teacher kinda route” and by the end of the year stated that she had previously wanted to be a teacher, architect, and pediatrician and was not sure anymore but still loved kids. She was also considering majoring in engineering in college, though partly because that was what others expected of her from being in the engineering academy. She reported enjoying engineering and was open to a number of majors and career options: “That’s something I always switch up, there’s not one thing that really stands out to me.”

Zuleyma. Zuleyma was known for being disciplined, inquisitive, and creative. In junior high, she was very studious but also had a sarcastic sense of humor. According to Zuleyma, her worlds starting high school were family, neighborhood, friends, church, culture, music, school, and “kinda” sports. She was involved in AVID, church, and track and field but was also dedicated to doing well in classes. She felt well supported by friends and family, could ask teachers for help, and relied on her mom for advice and emotional support. She described how, “[My mom] pushes me to do my best. I’ve had some teachers influence me too. Kind of the whole community here like the people I’ve met, they’ve all impacted my life somehow.” Even with all the support, she felt she ultimately had to depend on herself to stay on track for college or careers.

In junior high, her favorite classes were math and English. She was a very dedicated student and tended to receive all A’s. In high school she took AP classes and continued to hold high expectations of herself. By the end of high school she wanted to earn the community service certificate, make new friends, and pass her classes with the highest possible grades. She was very aware that being Latinx, and from a low-income immigrant family, presented challenges to reaching her goals. She said the biggest challenge was, “Probably being a minority and the lack of knowledge my family knows to get to college, cause I’m a first-gen, so I’m the one that’s supposed to know everything.” She was the oldest in her immediate family and none of her cousins had attended college so she felt she needed to forge a new pathway for herself and for her younger siblings. She found this motivating but also stressful. She reported, "My parents expect a lot from me so if I start failing, they'll be like 'No you can't, you're an example for your brother and sister, you can't just start slipping' and it's hard."

Throughout junior high Zuleyma wanted to be a doctor, but by 9th grade she was considering criminal justice and "working with kids in the system" or even becoming the President. Zuleyma wanted to attend a University of California campus but had pressure already from her parents to attend a community college considering financial constraints:

> [My parents] support me but at the same time they like remind me, "Oh we don't have money, you can't just choose any college you want to go to. It has to be something we can afford. And if not, then you have to go to CC" and not that CC is bad, it's just not an option. Like I would, it's like the last thing I want to do.

Zuleyma worked extra hard to both ensure she could attend a four-year university and to set a strong example for her younger siblings.

Isabel. Isabel was known for being bright, reflective, and rational. According to Isabel, her primary worlds starting high school were family, the Teen Center, music, school, and herself. She also designated friends, neighborhood, church and the internet as "half worlds" of slightly less influence. She was not involved in very many afterschool activities but was a regular at the Teen Center and had a strong group of friends there. Teen Center mentors, teachers, and peers all helped her with homework. Her family supported her in other ways; planning her future, staying on track to get into college, career help, and dealing with problems in general. When considering how to get to college or secure a good job, she relied on "my family, because they support me in whatever I'm going to do." She did not feel like anyone or anything made it difficult for her to do schoolwork or plan for her future. However, she saw a challenge in "classes and grades."

Her favorite classes in 8th grade were math and English. She had liked math throughout junior high and stated, “People say I’m good at math.” In high school she struggled much more with English and reported failing a few tests in a Shakespeare unit. She found high school challenging, and reported it was much harder than middle school, “cause you actually have to try. Like after that you have to go to college—or if you’re going to go to college you have to make sure you have good grades.” However, she continued to excel in science and math and overall in high school.

In 8th and 9th grade, Isabel wanted to be a lawyer, crime scene investigator, or member of the Supreme Court. When asked what interested her about this path she replied, “You get to go to the White House.” She also commented that, “People have told me they think I would make a good lawyer” but that she needed to work on public speaking. She was partly interested in this career track because her cousin was a lawyer and told her it was interesting. Her family supported her goals, but she worried that maintaining her grades could be an obstacle to getting to college or becoming a lawyer. By 10th grade her views had shifted and she reflected, “I wanted to be a lawyer, but then I don’t know anymore. I kind of want to be a pediatrician…or like a pharmacist, like there’s a lot of things I want to do.” She wanted a job that made enough money but also fulfilled her goal of helping others. She reported being motivated by “just having a good job, and having enough money to live, financially stable” but added, “I want to be able to help people and I also kind of want to be a pediatrician, like work with little kids cause I like little babies.”

Sophia. Sophia was known for being innovative, thorough, and playful. According to Sophia, her primary worlds starting high school were family, her grandma's house, her dog, and the Teen Center. She was also part of a guitar club and journalism club, and took French classes. She looked up to her older sister and cousins, who helped her envision her future in college and a career in medicine or business. She depended on her family for help with schoolwork, while the Teen Center staff helped her deal with personal problems. Her dad and grandmother supported her goals regardless, while others in her family were more concerned about her attaining future financial well-being and stability. She said her mom and cousin recommended she become a doctor because “that’s the only thing that they know makes a lot of money. And I think that’s all my mom cares about. Money. Yeah, she’s like, ‘I don’t want you to be like me.’” However, she joked that taking care of her dog was a bigger issue because he distracted her from homework as she was in charge of petting and walking him.

Her favorite classes in junior high were math and English, though in high school she enjoyed history. While she often joked and minimized her achievements, she had high standards and worked hard. For example, she complained that receiving a B meant she was “sucking” at science and added, “That is not okay.” Monotony and lack of interest were reoccurring challenges for Sophia. She felt that school was a challenge because “It’s boring! I hate studying…It’s literally the same thing every day. Oh I hate it. And then getting tired from work to work.” She felt that her “laziness” was her greatest challenge to reaching her goals of passing classes and making new friends.

In junior high, Sophia expressed an interest in many diverse careers including becoming a mechanical engineer, teacher, chef, or architect. By 9th grade she was no longer interested in being a mechanical engineer stating, “I don’t want to be an engineer, I think it’s totally lame…I just feel like it was fun for that time but now it’s different for me now, I don’t see it as fun anymore.” Instead, she was interested in medicine and exploring how the human body worked. She mentioned combining her previous interest in engineering with medicine and had discussed biomedical engineering with her cousin, but ultimately saw her future self as a pediatrician, obstetrician, orthodontist, or dentist. Sophia joked that as a dentist her "slogan" would be, "Ya'll could have perfect teeth like me!" She was also excited about the possibility of being an obstetrician because, "It's like you're delivering life!...I'll be like 'Today I delivered a baby!' Like imagine how cool that would be." She expressed an interest in working with children and "just helping people, honestly." Yet, by 10th grade she was no longer interested in working with people and instead desired a flexible schedule with enough variety to maintain her interest. Sophia had trouble envisioning life after high school and said, "I don't know, that's too much in the future. Umm I see myself sleeping, probably going to CC." She explained she wanted to go to a community college because it was "the easy way." She would probably study business, but she mentioned how she had always wanted to open her own restaurant and that her mom had agreed to be the chef.

Comparison of Supports and Challenges

There were more commonalities than differences in the supports and challenges for the four girls (See Appendix C, Tables 1 & 2). Programs like AVID and the Teen Center provided mentoring, opportunities to plan for their futures, and tutoring or simply a quiet, supportive space. These elements were all important for succeeding in general but also in the STEM academies. Additionally, friends helped the girls tackle difficult STEM homework and provided emotional support, but at times were stressors due to fights or other relationship issues. The girls felt both supported and challenged by the high expectations of academy teachers, and recognized that the academies provided easier access to college due to their elite status and opportunities for college credit completion and skill building. However, the work was rigorous, time-consuming, and stressful, and their academy was not always accessible to their families. Family helped in diverse ways, but parents' English language barrier, lack of experience navigating educational pathways, and financial constraints created hardships for Malia and Zuleyma. Finally, the girls listed themselves as both a resource and a barrier to succeeding in the STEM academies. Although they acknowledged a type of "whole community" support, Zuleyma and Malia depended on themselves to stay on track for college, and felt significant pressure to succeed. Sophia felt she was a resource for herself, but also a barrier to reaching her goals due to her problems with procrastination and lack of motivation.

These findings align closely with other work from Bridging Multiple Worlds on youth aspirations and educational pathways for students of color, though are new in the context of navigating STEM academies. For examples of how each participant felt supported or challenged in their worlds of family, friends, teachers, and programs, see Tables 1 and 2 in Appendix C. In the rest of the paper, I will explore supports and challenges interwoven with identity processes according to the framework of practice-linked identities (Nasir & Cooks, 2009). I begin by describing the individuals' trajectories in relation to STEM overall, participation in the engineering or health academies, and views about themselves as STEM people (See Table 1).

Table 1
How Participants Affiliated with STEM Labels Over Time

	Malia			Zuleyma			Isabel			Sophia		
	8th	9th	10th	8th	9th	10th	8th	9th	10th	8th	9th	10th
Science person		√			√		√				√	
Community scientist	√											
Maker	√	√	√		√	√	√	√	√	√		
Engineer		√	√		√	√			√	√		

Individual STEM and Academy Identities

Malia—"Learning about becoming" a scientist or engineer. Malia consistently expressed mixed feelings about science and herself in relation to STEM. She felt that STEM was "really important like that's how you find out stuff" and that scientists and engineers "create," "invent," "make things easier," and "do everything pretty much." She reported that she was not very familiar with scientists or engineers, but she had learned about Latinx scientists in AVID. Despite recognizing the importance of STEM in general, she did not consider herself a science person and felt that science classes were "okay but it's kind of hard for me to learn." When reflecting on herself as a science person she explained, "Maybe in a couple of years, I mean right now I don't know." She viewed the ideal science class as focused on experimenting but also note taking and review, describing, "A lot of science experiments, I guess more note taking instead of just talking…yeah and maybe more repetition, go over it more than once."

While not a science person, Malia thought of herself as a maker and community scientist in 8th grade (See Table 1) due to her participation in Teen Center projects. She liked presenting findings at various Town Halls and sharing her family's views on noise pollution on a Spanish-language radio show. She also enjoyed creating maker artifacts, such as an illuminated map of her neighborhood. During her first year she thought that making and community science were normal practices, but then realized the uniqueness of their community-oriented technology projects. The most important thing she learned was "just seeing how much you can do, what we can do for our community."

In 9th grade when asked if she was a science person she responded, “Not right now. Not really. More like learning about becoming, I guess.” She believed she was not an engineer or scientist because she did not have a degree, however, she felt more like an engineer due to her experience in the engineering academy. She reported, “They are teaching us things engineers do. Yeah, like the physics part about it, the art part about it, everything about it.” She also commented that her teachers thought of her as an engineer, stating, “One came up to me one day and they were like, “You’re an engineer.” By 10th grade, she expressed confidence in her position as “engineer-in-training”, adding, “I feel like every little thing I learn now will help me if I ever, I don’t know, do like, major in engineering or do anything in engineering.” At that point she thought she was both an engineer and maker and equated the two responding, “When I think maker I think engineer.” She still enjoyed the detail-oriented, organized, notetaking part of science and the engineering academy but also enjoyed project-based learning and developing expertise with complex tools. She felt well-supported by engineering academy friends and teachers, appreciated the academy’s high standards, and valued the opportunities to learn new skills (See Table 2).

Table 2
Summary of Malia’s STEM and Academy Identities

STEM Identity	Academy Identity
• Known by others as science person • STEM as way to broaden opportunities and world view • Latinx role models in STEM • STEM identity aligns with conventional/school science, notebooks and science vocabulary	• Initially unsure but aligned with college-bound goals • Relevance of Latinx identity • Enjoyed work • Well-supported by peers and teachers • Open to engineering as college major

Zuleyma—“Gaining skills to use in future careers” in STEM. Zuleyma consistently lacked confidence in her STEM skills but felt that STEM was very important because “whether we notice it or not, we use it every day. It’s the root of everything.” She explained that scientists and engineers do "research and experiments" and considered her science teacher and "people that come here to the Teen Center" as scientists she knew. She seemed to have a good understanding of different kinds of science, differentiating between math, physics, and biology's aims.

Despite participating in Teen Center STEM projects, at the end of 8th grade she did not feel like a community scientist, maker, or science person, and reported that no one else saw her that way either (See Table 1). She defined making as "creativity" and said she liked making because "You could put a little bit of thought into it or a lot of thought it. And the outcome is what you want it to be." While she was artistic and enjoyed making, she had participated mainly in shorter-term activities in the Teen Center makerspace and did not feel a strong affiliation with the term "maker." She did not have a clear definition of community science but reported enjoying parts of the project, including presenting findings at a Town Hall. The same year, she won an award for her science fair project where she analyzed data on peers' eating habits and stress levels. She did not see herself as a scientist, but recognized that she was developing research skills in and out of school.

In 9th grade she was more open to considering herself a science person, stating, "It's not my preferred subject but I can get along with it." She considered herself both a maker and an engineer due to her participation in the engineering academy. This view of herself which continued into 10th grade, when she added she felt like a maker due to her programming experiences. She explained she was an engineer-in-training "because we're learning, we're gaining skills to potentially use them in our future careers." She was not sure if she wanted to pursue engineering or not but felt her experience with engineering was "pretty cool." She was also considering other STEM-relevant careers such as being a doctor (See Table 3).

Table 3
Summary of Zuleyma's STEM and Academy Identities

STEM Identity	Academy Identity
• STEM as way to broaden opportunities and world view • Driven by breaking stereotype as Latinx • STEM career as way to be a role model for family, develop financial security	• Initially unsure but aligned with college-bound goals • Relevance of Latinx identity • Enjoyed work • Open to engineering-relevant careers

Isabel—"Feeling good about making it look good." Isabel felt somewhat open to considering a STEM identity even though she valued STEM at "a 6 out of 10." In 8th grade she considered herself a science person, because she liked physical sciences and math. No one else referred to her as a science person though others said she was good at math. She was also open to thinking of herself as a maker. She defined making as "learning new skills…just learning how to use new tools, like programming." Her favorite part of making was "designing" but she found programming to be challenging. She enjoyed how making allowed her to "actually get to build stuff." She was not very active in the Teen Center community science project and did not consider herself a community scientist.

In 9th grade, she still felt like a maker because she enjoyed designing and applying "a lot of art, making it look good" to her projects in the engineering academy. She also made connections between art and science, saying she paid more attention to color schemes in architecture. Still, she did not feel like a science person or engineer (See Table 1), partly because she struggled with the academy's physics and machine shop classes. By 10th grade, she felt more confident in her academy classes and math abilities, and when asked if she felt like an engineer-in-training responded, "Yeah, I actually kind of do." She continued to feel like a maker, justifying, "cause I made my [mobile] project. I made something. It feels good." She did not label herself a science person, but realized that she liked science the most when it had practical applications (See Table 4).

Table 4
Summary of Isabel's STEM and Academy Identities

STEM Identity	Academy Identity
• STEM as way to broaden opportunities and world view • STEM subjects linked, importance of math abilities, art interests • STEM as hobby/skill building opportunity, not career	• Initially unsure but aligned with college-bound goals • Enjoyed work • Considering intersections of art and engineering

Sophia—Being "just a natural" in STEM. Sophia always enjoyed the hands-on exploration and discovery associated with science and making. The best parts of science for her were "doing projects or like mixing chemicals together." She enjoyed making because it was about building and figuring out how things work. She always wanted to build more complex robots than the makerspace had to offer, and joked about designing a robot that "could attack the whole world." Overall, she felt that STEM was important because "we use it for like everything" and asked, "without engineering or science how would you know how things work?"

Despite her interest in science and engineering at the Teen Center, and recognition from teachers and peers for excelling in science and math, Sophia did not feel like a science person. She also did not consider herself a community scientist, even after taking an active role in Teen Center science and maker social action projects. She did consider herself a maker and engineer though (See Table 1), and gave a demonstration of robots and other tech tools at a local Maker Faire. She liked "how the little kids would be like 'Oh that's so cool!' and I would be like, 'Yeah it is.'" Maker projects helped her learn from her mistakes and get over the feeling of "Oh my god, I can't do this."

In 9th grade, Sophia felt like a science person, reporting "I'm just a natural. You know." However, Sophia no longer felt like a maker because she had been rejected from the engineering and afterwards had worked on fewer maker projects at the Teen Center. She still considered making as a hobby, and was excited about building more robots. In 10th grade, she started teaching younger students at the Teen Center about social action, leadership, and making in her position as the Change Maker Chair. She also started courses in the health academy. Her friends and teachers thought of her as smart, hardworking, and good at science but she did not consider herself to be a science person because she hated science, considered it boring, and felt she did not know enough (See Table 5). By the end of 10th grade, she expressed dissatisfaction with the health academy but lightheartedly responded that she felt like a health-person-in-training. She exclaimed, "Heck yeah! I'm a doctor. Because I know about the human body."

Table 5
Summary of Sophia's STEM and Academy Identities

STEM Identity	Academy Identity
• Known by others as science person • Interest in computers, robots for engineering and human body exploration for medicine • Making as important hobby • Shift of world view from STEM important to her to STEM important to others	• Initially excited for engineering academy • Resentful after engineering academy rejection • Initially excited for health academy, aligned with family's expectations • Disliked work, disillusioned with career options • Still considering a career in medicine

Comparison of Academy Experiences

Malia, Zuleyma, and Isabel were all similarly hesitant about joining the engineering academy since it was not well-aligned with their career goals and was not something anyone in their family or social network had done before. They were convinced by Teen Center staff and older siblings to apply and then join once accepted. Sophia was the most excited of the group initially, as she had expressed the greatest affiliation with making and engineering.

However, her initial rejection then later acceptance made her resentful and she considered it a barrier for pursuing engineering. Below is the transcript from her interview at the end of 10th grade:

> INTERVIEWER: Yeah, and what about engineering? I know for a while you were interested in that.
> Sophia: Yeah, and then I decided it's not for me.
> Interviewer: Why not?
> Sophia: Because engineering academy shut me down first, big mistake. ((Laughs))
> INTERVIEWER: They missed out, I'm telling you, you would've been great.
> Sophia: They probably doubted it, and then I just gave up on that goal.

Sophia switched her career goal to focus on health, which aligned better with her family's interests. She was excited about the health academy but also tempered her expectations by saying, "I'll just go with the flow, I mean if I don't like it I can get out of it." Unfortunately, by the end of her first year she was disillusioned by the format and content of the health academy, complaining about the amount of busywork and the lack of interesting health-related career options.

While Sophia felt progressively less connected to science and less sure of her career options, Zuleyma, Malia, and Isabel started to see themselves more like STEM people and open to different STEM-related careers (See Appendix C Table 3 for comparison). The three girls expressed pride in being able to operate complex tools, create their own projects, and learn from teachers and peers. In particular, they felt empowered reflecting back on their first-year project and how they were able to personalize the mobile in a way that represented them. Zuleyma and Malia also felt the experience broadened their view of what they were capable of, including potential college majors or careers. Malia expressed that she had new goals and was considering different careers because the engineering academy was "opening more ideas, like of course like what, last year, I wouldn't think about of joining the engineer academy and learning how to do torque." Zuleyma echoed similar ideas when defining engineering design. She explained it as:

> Just the opportunity to learn something you wouldn't be doing in the norm. It's pretty cool. Just opportunities, doors that are open. Cause if maybe it's something you like, and you're like "I want to do this for the rest of my life." Or it's just like "I have a new skill" and you may use it in life and you may not, but you have it.

Zuleyma and Malia's experience of the engineering academy "opening" ideas or doors appeared in contrast to Sophia's experience of being "shut out" of opportunities or closed off to previously appealing pathways both in engineering and health (See Appendix C Table 4 for comparison).

Overall, the girls showed identity shifts in relation to their participation in the STEM academies. They viewed themselves as more or less of a scientist and drew from ideational, relational, and material resources in different ways. In the following sections, I detail how the girls managed academy expectations, developed positive relationships that increased their connection to STEM practices, and utilized tools that legitimized their experience as scientists or engineers. First, I illustrate how the girls drew on ideational resources, internalizing academy norms, responding to high expectations, and negotiating their privileged position in the academy.

Ideational resources. ***"Break those rules": Internalizing academy norms.*** The engineering academy was academically rigorous with tough grading and high standards. The work was "challenging", "very stressful", and demanded they "get everything just like perfect." Students were expected to be "overachievers", "skilled", and "smart." In the transcript below Zuleyma described her interactions with teachers:

> They're like "We expect a lot" and "You're in the academy for a reason" like, "We really expect you to give us your all" and we were like "…Yeah!'"

Malia relayed how the art teacher told her and Isabel, "You guys always work so hard. You guys are like overachievers" in a way that was positive but also looking out for them and urging them to not to work themselves to death. Despite the high standards, the girls felt the work was at an appropriate level, and was manageable since they learned by completing each step of their project. They all appreciated the lack of tests, homework, and busywork. Malia, Zuleyma, and Isabel described how teachers helped set the norms of the engineering academy, such as learning through doing. Malia further explained that teachers "encourage us to break those rules" associated with the rest of school. Teachers urged them to take charge, allowing students to "do whatever we want", "make it, like ourselves", and bend the rules a little on project deadlines.

The health academy was also academically rigorous and had high standards, however prioritized memorizing science knowledge. Sophia reported needing to "memorize a lot of phrases and medical terms", with four hours of homework a day and many difficult tests. Students did not work on projects and class consisted of busywork, lectures, and movies. In comparison to the engineering academy, the health academy had strict rules and encouraged conformity, including maintaining a certain grade point average in non-academy classes.

While relying heavily on coursework, the health academy also valued longer term career exploration. Zuleyma, Malia, and Isabel did not comment much on explicit career exploration in the engineering academy, but Sophia described meeting health professionals in class and volunteering at a senior center. These activities were designed to help students find their place in the health care world, however Sophia felt more disconnected after visits from an x-ray technician, dentist, physician's assistant, and nurse. Her ideas about herself and her career shifted during these guest speaker talks because she did not resonate with any of the careers. For example, she commented, "Dentistry seemed kind of cool but then we met a dentist and I was like, no thanks…The man seemed so boring, he looked like he hated his job. It was a lot of work and I was like, I'm not up to that." Sophia sounded disillusioned with the health academy, and distanced from their current focus and long-term goals.

Sophia did not feel well aligned with the academy's orientation due to the lack of creative opportunities and their focus on "boring" health careers. In comparison, the engineering academy did not introduce students to engineering professionals, but provided opportunities to develop as novice engineers. The three girls enrolled in this academy learned the norms, values, and practices of engineers through authentic experiences designing, building, and refining their own projects. In response, the girls reported feeling like engineers-in-training and considered engineering as a possible major or career.

"Other people could be in your position": Privilege but anyone could succeed. Malia, Zuleyma, and Isabel reflected similar views of the norms and values of the engineering academy, and felt the experience was "special," "unique," and a "privilege." Despite the elite status and high standards, the girls all reported that anyone who worked hard would succeed, expressing values surrounding participation in the academy. Zuleyma stated, "It is like a privilege to be in it and be selected. It's also like say if it's just a class, like anyone can do it, anyone can be an engineer, and it really just requires a lot of your attention so you can get it." They had mixed feelings about their place in the academy because they appreciated the opportunity but were also aware of others that could be equally successful but were barred entry. Zuleyma expressed frustration that some students "just fool around" in the academy and reported thinking, "You know, other people could be in your position, that really want it." She explained how her friend was "really bummed when she didn't get it" while academy peers complained "'Yeah I'm in here but I don't like it' or they're just messing around and they don't care."

Sophia felt that students outside the academy felt envious or inadequate. She said peers compared themselves to her and felt "I'm over them, but they don't wanna say it…Yeah, like I'm better than them or something. Which I'm not but…" Sophia felt that anyone could succeed in the health academy if they put in the hours. She described how her health academy peers were “good students” but also “average” in the scheme of her high school, or “just basic students.” All the girls reported having these conversations with friends and that they felt they were no more qualified than anyone else because for them success was more dependent on hard work than intelligence or selection into the academy.

Peers played other important roles in shaping their perspectives and experiences, as did family and teachers. Therefore, in the following section, I describe how peers and family provided practical and emotional support, while teachers positioned students as scientists or engineers-in-training. I also detail how the girls constructed intersectional identities as Latinx young women and academy students.

Relational resources. ***“We all snapchatted each other crying”: Peers as source of practical and emotional support.*** All four girls reported that they received project or homework help from peers. Malia and Sophia described close friendships and their reliance on peers for emotional support. For Sophia, peer support was important considering the intense workload combined with her disinterest in the content. She reported that she would not have survived her first year of the health academy without a group chat where they all “ranted” about the teacher. She struggled with the coursework but depended on her friends for relief. She said, “I talk to all my friends and it’s the same. Yah and then we all snapchatted each other crying, it was the best.” The group chat provided an opportunity for connection and defined her as a member of the health academy community. Similarly, Malia greatly appreciated her friends’ support in dealing with problems and mentioned that they became “so close” over the year. She also received academic support from peers. She gave an example of her “really good [machine shop] partner…she knew how to do a lot of things” and helped Malia finish her nodes in time. Zuleyma and Isabel echoed that peers were helpful in finishing projects, but they tended to be less outgoing in the academy setting and reported making fewer friends than Malia or Sophia. Isabel even listed, “I’m shy” as a barrier to achieving her goals of making new friends in the academy and high school in general.

“I can’t be myself, precisely”: Latinx students in the STEM academies. The girls also commented on friendships with each other and other Latinx students in the academies. For most of the girls, positive relationships with other Latinx students increased their connection to STEM practices. However, Zuleyma and Malia expressed mixed reactions about the engineering academy’s decision to place Latinx students from the Teen Center in the same rotation group their first year. Malia appreciated the support but also did not want to feel they were receiving special treatment. She stated:

> I’m not gonna say I’m mad about it. Cause, you know, I’m with my friends. But like in a way I don’t want them to like baby us. I don’t know. Like, they tried really hard to make sure we got in and now it’s like, I don’t know. I don’t wanna take it in a bad way cause I know they just want to make sure we’re comfortable.

Similarly, Zuleyma felt there “was nothing wrong with” their rotation group, but worked extra hard to prove that she belonged. She explained that she was never “belittled” by anyone but felt extra pressure to succeed as one of the handful of Latinx students in the academy. She said, “Like say I dropped it or something, it’s like ‘Oh yeah she wasn’t ready for that.’ But saying it is (pretty wrong).”

In addition to feeling like they needed to prove themselves, the girls expressed that their “minority status” in the academy (in comparison to in their high school where Latinx students made up approximately half the student body) made it more difficult to connect with their peers. Zuleyma reported that sometimes she felt different and left out. Malia relayed how “everyone else seems to have things in common” and added, “I can’t be myself precisely." Both Zuleyma and Malia explained this was a school-wide issue, with much fewer Latinx students enrolled in any advanced classes, including academy classes but also their Honors and AP courses. While a significant problem, both girls expressed some degree of appreciation that the academy was trying to recruit more students of color. Zuleyma stated, "I like that they're being like, trying to include more people of color, I guess. And it's a good thing." Malia reported that "the academy tried really hard to make sure that all my friends go, yah because you know they want that diversity I guess." They had very positive experiences and felt welcomed into the academy, but simultaneously expressed their position as outsiders. After making the above comment, Malia added, "But it still feels weird since there's not a lot of us" while Zuleyma said, "But I still see the majority of people, you know, not being people of color." Being and feeling different motivated the girls to work harder but also distanced them from the engineering academy community.

In contrast, Sophia and Isabel both felt that being Latinx did not have an impact on their experience in the academies or high school in general. The only comment Isabel made was that she felt slightly better being grouped with other Latinx students because "we have something in common, I feel comfortable cause I know them." Sophia said she felt normal and like all the other students in the health academy, who were mostly Latinx. None of the girls felt that being female had any impact, though Sophia did state that it was possible the boys felt differently since there were only a few boys in the health program.

Teachers' positioning as scientists or engineers. Teachers were equally important as peers in shaping the girls' experiences. Zuleyma, Malia, and Isabel all appreciated their teachers' efforts to support them in learning, working with them during lunch hours or being flexible about a project deadline. Malia reported a "closer bond" because she could depend on the engineering academy teachers. Everyone reported that teachers were supportive, set high expectations, and helped them understand STEM content. Additionally, the engineering academy teachers acted more like guides or mentors, helping students achieve their goals on their own. Zuleyma described one engineering teacher as not "a *teacher* teacher, more like she's a guide" and Malia echoed the sentiment with the comment that, "They're not just my teacher, they're a tutor…And yeah they just make sure you got everything down." Teachers guided students through their projects, positioning them as novice engineers rather than traditional students in a class. Additionally, teachers used explicit labels to develop community and legitimacy, referring to students as engineers or sometimes "dragoneers" due to the Komodo dragon mascot of their robotics team.

In contrast, Sophia did not have very positive experiences with health academy teachers. While she felt that her main teacher for 10^{th} grade cared about her and wanted her to succeed, she complained about her teaching style and the homework she assigned. The teacher did not provide opportunities to explore as a real health care practitioner and did not refer to students as scientists or doctors. Despite this lack of connection, Sophia still felt like doctor-in-training due to the academy's focus on preparing health professionals and her connections with peers.

"They're proud, but confused": Family support and ideas lost in translation. Everyone mentioned the importance of family support, whether helping with homework, setting goals, or encouraging participation in the academies. Zuleyma depended a lot on her mom for support and advice, but Isabel and Sophia depended more on their family as a network. For Sophia, a few family members had enrolled in the health academy previously and it was considered more "the norm" for her family. She stated, "It's just a basic thing that all of us are in, so they don't care. It's normal for us." Her aunt, grandmother and cousins all encouraged her to apply, were familiar with the health academy's format and expectations, and offered advice about the academy and potential career paths. For Zuleyma, Malia, and Isabel, their parents were supportive as well, but the engineering academy was foreign to their families. Additionally, their parents spoke mostly Spanish at home, and it was difficult for the girls to describe the STEM content or tools or projects to their parents. Malia and Zuleyma also described how their parents often had to work and were unable to attend academy events such as informational sessions or open houses. Zuleyma explained that her parents "don't really understand it" and that her dad would ask, "What are you doing there? What's the point of that?" She added, "They're proud, but confused." Despite not being able to come to events or fully understand the girls' projects, everyone's parents were supportive and proud of them and their accomplishments. Isabel said she could not explain everything to them but she showed her parents her projects. Similarly, Malia stated, "They are proud of me and try helping me with everything they can."

While teacher, family, and peer support was key for maintaining motivation, the girls also drew heavily on material resources to construct STEM-relevant identities. In the following section I document how mastering physical and software tools helped Zuleyma, Malia, and Isabel to feel like engineers, while Sophia struggled with the lack of material resources available to her.

Material resources. ***"Proud of everything": Space and tools legitimize position as engineer.*** For the three girls, the space of the engineering academy felt very different, "like a private school" within their public high school. Malia described the space as "pretty", with comfortable chairs, interesting design elements including "cool art hung everywhere and cool machines", and "more techy, engineering stuff." These elements defined this specialized space and in particular supported Malia's view of herself as an academy member.

Additionally, all three of the girls expressed surprise and satisfaction in being able to operate the engineering academy tools. Malia appreciated how the tools allowed her to create her mobile project, when she initially thought she was "never going to learn." Zuleyma similarly articulated, "I never would've thought that I would be using solidworks, the software that we use in CAD. I mean like using the machines in machine shop. And cutting things and just also the end product, what we made." Both Isabel and Zuleyma felt "proud of everything" when reflecting on what they had accomplished that year. Mastering the tools supported the girls' connection to the discipline of engineering and allowed them to move through the academy with expertise and ownership.

"It just represents me": Final project as manifestation of knowledge and self. The three girls spoke extensively about their experiences creating a wire mobile project during their 9^{th} grade year. The mobile was an important artifact for the girls, as it was a physical manifestation of their knowledge developed throughout the year. Isabel reported she was proud of "how it turned out." Malia detailed the process:

> There's a lot that goes into it…learning how to do certain stuff, like the node you learn for like a couple weeks, and then how to wrap wire around something. Then the physics part about it, like how to find torque, and things like that. And then watching it all come together, that's pretty fun.

It was also a chance to express their personalities and interests. Isabel chose travel as a theme and created an airplane and outlines of Mexico, Portugal, and Spain because she had always wanted to visit those countries. Zuleyma created zodiac signs, but wished she had chosen loteria (a Mexican bingo game) for a theme because she felt it would have been more fun and represented her better. Malia's mobile (see Figure 1) featured symbolism from the Farm Workers Movement, Civil Rights Movement, and famous Latinx activists, artists, and scientists.

Figure 1. Malia's 9th grade mobile on display at the Teen Center.

She explained: "I'd never seen a mobile like this and it just represents, you know, me." She reflected on her mobile design:

> The bottom tier, I did an outline of Cesar Chavez and then the Aztec eagle that's you know, on the flag when he boycotted and everything. I feel like that impacted my family for sure cause my dad started as like a farmer worker and all those laws they had, or, low payment jobs were affected and so. And Ellen Ochoa on the other tier with the moon, she was one of the first Latinas engineers to go to the moon, to go to space, I think to go to space, yeah. And like you know just, seeing a Latina do that just seems cool. And then on the top, the two have the freedom fists, or now people call it like the black power fists, but others it's just like a yeah, freedom fist. So, I like, that's just a symbol I really like doing. And then Frida Kahlo, you know, she just stood up for a lot of Latina rights and women's rights.

Teachers told Malia they had never seen a mobile like hers, and she was proud that it could both express who she was and serve as an example for other students. Malia's mobile was displayed at the Teen Center, while Zuleyma's was displayed in the engineering academy. Overall, the three girls were proud of their mobiles and felt they represented themselves as individuals, makers, and engineers.

In comparison, Sophia did not have access to the same range of material resources at the health academy. She mentioned one activity studying organs that she enjoyed, and an off-site volunteer opportunity, but usually complained about the lack of hands-on sessions or projects. She described how "we would walk in and [the teacher] makes us do a 'do-now' of random stuff, and then she just goes off a PowerPoint the entire time and that's it…We didn't do any labs, the entire year we just sat and listened to her PowerPoints." While the three girls in the engineering academy expressed surprise and pride in their newfound abilities in creating complex mobile projects, Sophia described her frustration with busywork and memorizing information from PowerPoints. In the Teen Center makerspace, Sophia found the project-based learning and exploration with new technologies compelling, but unfortunately she did not have access to this type of material resource in the health academy. Considering her passion for building and experimenting, the lack of material resources in the health academy reduced her connection to the practice of science and was not conducive to constructing an identity as a science person, maker, or engineer. However, she did still feel like she was receiving training as a health professional, and on her way to possibly becoming a doctor.

Conclusion

All four girls reflected deeply on their experiences, and referenced various ideational, relational, and material resources they drew from to construct identities as STEM people. Echoing the results of other studies from the Bridging Multiple Worlds framework, the girls integrated multiple identities and tended to reframe challenges as a source of motivation (Cooper, 2011; Cooper et al., 2015). Malia saw possibilities in STEM, and embraced identities as a scientist, engineer, and maker according to the activities she participated in, whether in the Teen Center or the engineering academy. She found inspiration in the stories of Latinx activists and drew upon support from her family and friends to navigate new, often intimidating experiences in STEM. She recognized her shifting interests and aspirations and considered STEM to be one possibility of many in her "process of becoming." At the same time, Zuleyma initially did not think of herself as a maker or scientist though always had dreams of becoming a doctor and slowly shifted to take engineering more seriously. She was keenly aware of many challenges but drew from a community-wide network of support, all the while working hard to prove herself and realize her goals. Malia and Zuleyma constructed "in-bound identities" (Nasir & Cooks, 2009) where they moved closer to the heart of STEM practices, reflecting deeply on the engineering academy norms, developing strong relationships, and leveraging new, complex tools. Isabel also appeared to be developing an in-bound identity, slowly considering herself more of an engineer due to developing competence with the tools and science content. Her view of herself as a maker stayed fairly stable due to her ability to keep creating things that mattered to her, including the mobile. She commented less than Malia or Zuleyma on the possibility of engineering as a major or career, but was considering other STEM professions by the end of her sophomore year.

Sophia in comparison appeared to have a "peripheral identity" (Nasir & Cooks, 2009), where she became less connected to the academy's values and goals as time went on. She had fairly negative experiences with both academies, dampening her initial passion for making and reducing her interest in health. By the end of her sophomore year, she was disillusioned and disconnected from STEM content and careers, but continuing with the health academy due to her peer connections and longer term goal of attending college.

Sophia was positioned as a future health professional rather than a current science person, scientist, or maker, and this led her to no longer see a clear future in STEM. In comparison, the engineering academy students were positioned as current novice engineers, or "engineers-in-training" through their work and teachers' comments. Zuleyma, Isabel, and Malia felt more like engineers not because the program expected them to become engineers but because they learned the skills and tools of engineers in their day-to-day work.

Discussion

There is a dearth of research on Latinx women and their educational pathways (Darder & Torres, 2014; Gándara, 2015), even though estimates predict that Latinx women will constitute a third of the female population by mid-century and "thus, the future of the nation is very much tied to the future of these women and girls" (Gándara, 2015, p. 5). Latinx women are "the linchpin of the next generation", considering their potential for personal success as well as their impact on their children's education and living conditions (Gándara, 2015, p. 6). Ensuring that Latinx young women can access resources and successfully navigate educational pathways should be a priority both for social justice and economic reasons. Accordingly, this paper detailed identity development for four young Latinx women navigating STEM academies. It outlined supports and barriers as a way of documenting narratives of "becoming" and to provide recommendations for educators.

Some of the structures in place at both academies helped confront barriers consistently associated with Latinx young women in STEM. These challenges include low self-efficacy, lack of awareness about STEM careers, and poor expectations from others (Beeton et al., 2012; Crisp & Nora, 2012). In both the engineering and health academies, students were positioned as smart, dedicated students. Teachers had high expectations, which they expressed verbally but also communicated through the demanding workload. This finding about teachers' expectations aligned with research about the overall importance of teacher support (Cantú, 2012; Cooper et al., 2011). Teacher validation also appeared vital to the girls identifying as engineers-in-training. Malia told a story about an academy teacher calling her and Isabel "overachievers" and later "engineers", Isabel fondly described the label of "dragoneers", and Zuleyma mentioned how teachers motivated her by saying she was "in the academy for a reason." Even though peers, family, and Teen Center staff commented regularly on the girls' intelligence and abilities in STEM, the academy teachers' labeling appeared especially meaningful. Others have reported similar findings on teacher validation as an important component of students of color recognizing themselves as STEM people (Carlone & Johnson, 2007; Rodriguez et al., 2017).

The teachers at the engineering academy took their students seriously, with high expectations but also by providing access to real tools and authentic projects. The girls became engineers as they thought, felt, and acted like engineers. This finding resonates with work by Rodriguez and colleagues about female Latinx STEM majors, who reported thinking and feeling like scientists. In their study, Latinx undergraduates recognized themselves as STEM people due to their enthusiasm for learning STEM content and having a certain worldview involving thinking critically, innovating, and expressing curiosity about how things worked (Rodriguez et al., 2017). All three girls at the engineering academy expressed interest in the curriculum, while Malia and Isabel commented on how it had opened their eyes to new ways of understanding the world. They were both thinking more critically and expressing curiosity after lessons on art and design, considering how these played into the everyday decisions of engineers and architects. In comparison, Sophia did not feel like a science person or engineer, and part of this disconnection was due to the lack of opportunities to act like a scientist. She did not have avenues to express her curiosity, and the curriculum focused on memorization prevented her from thinking critically, innovating, or experimenting. For students like Sophia, adding more project-based learning and internships earlier in the academy curriculum could provide much needed relevance and motivation. Malia's mobile provided a strong example of how students, when encouraged to create and personalize projects, can build on cultural assets and communicate values relevant to them and their communities. However, it is worth noting that while the positive effect appears clear for the girls in the engineering academy, it is difficult to predict the possible impact of the health academy for Sophia. Even though the health academy did not provide the hands-on activities Sophia had hoped for, she was still accessing academy resources on careers, still excelled academically, and ultimately was still considering a career in medicine.

Additionally, while the girls felt very supported in the engineering academy, there were challenges. One significant issue was that Latinx immigrant parents had trouble understanding the content and purpose of the academy. An academic STEM space can be an "alien world", with foreign practices and overwhelmingly white, middle-class participants (Cantú, 2012). The academy norms for events, at limited times and locations and in English, exacerbated the disconnection. STEM academies such as the engineering program could benefit from connections with community centers that Latinx students and families frequent. An official partnership with a community program could ensure continuity in STEM identity development as the staff and educators from both organizations learn how each program works and how they could complement each other. However, developing this partnership is a significant ask for any publicly-run STEM academy with various priorities and would require a focus on equity. There is a distinct possibility that STEM academies lack the cultural and linguistic capital to create this bridge, and would require a significant amount of community support or additional funding. Therefore, the following recommendations are not intended as a quick fix but suggestions along the way of ongoing efforts toward relationship building.

With a committed effort, partnerships could help recruit more Latinx participants and inform families about the academy format and goals. For example, the academy could host an open house at a local community center, ask a guest speaker or teacher proficient in Spanish to attend a youth or parent event, or work with Center staff to streamline the recruitment and application process. Students of both programs could work to create materials accessible to their communities, such as short videos or podcasts in Spanish. These videos could let viewers tour the academy or hear students' experiences in a way that attracts new students, introduces parents to the space, and helps children and parents discuss projects more easily. These recruitment efforts could help support current students as well. While Zuleyma and Malia did not experience the overt racism or sexism commonly reported by Latinx young women in STEM (Cantú, 2012; Rodriguez et al., 2017), they encountered the effects of structural racism and sometimes felt different, lonely, and pressured. Perhaps if they were actively involved in recruitment efforts, they would feel less conflicted about their privileged status as academy students in comparison to the majority of their Latinx peers. They could offer insight and advocate for other hardworking students that would succeed if given the opportunity. Hopefully they could become mentors or role models for incoming students, building relationships and changing the academy's culture to be more inclusive. Ideally these efforts, whether with recruitment or mentoring, would be student-driven but endorsed by the program. Although more Latinx families appeared aware of the health academy's format and goals than the engineering academy, probably most STEM academies could benefit from networking better with community partners and actively engaging families in the recruitment process.

Additionally, while this paper focused on STEM identity, it is important to recognize the diverse aspirations and educational pathways of the young women. STEM careers were of particular interest due to their alignment with power and access, however the other careers the girls considered were also on the "upper end of the employment ladder" (Gándara, 2015). For example, careers in law or business tend to offer significant financial security and leadership opportunities, and yet Latinx women remain underrepresented in these professions (Gándara, 2015). Although these young women's experiences and voices are needed in STEM professions, they could be equally impactful in their intended careers as lawyers, judges, educators, architects, presidents, or business owners. While I focused on STEM identity and associated career options, there are endless ways to be successful and self-actualized beyond the limited number of STEM options. The girls' multi-faceted and ever-shifting feelings about STEM and associated supports and barriers were only part of the girls' intersecting identities as Latinx youth, learners, and community members. Additional limitations include the focus on only four sub-cases, and reliance on interview data which did not fully represent the young women's experiences. I also constructed representations that reflect my positioning as a researcher-practitioner, and a White woman.

That said, by documenting and sharing the stories of Latinx young women in STEM, scholars are "creating roadmaps and marking pitfalls and routes of success" that communicate the current reality for students but also help provide guidance for others (Cantú, 2012, p. 483). These narratives help better understand decision-making processes and what leads students to pursue STEM interests and careers. Students' narratives can supplement statistics on recruitment and retention and provide recommendations for educators and policymakers on how to better support Latinx students in STEM. By becoming more aware of the realities for Latinx students, general programs and specialized academies can remove institutional barriers and help students access resources. Hopefully, by elevating the voices of these current young women in STEM, future students will be better equipped to integrate multiple identities, leverage resources, and transform challenges into motivation and resilience.

III. Overall Discussion

Over the past decade, there has been a larger focus on students having a foundational understanding and interest in STEM (Bell et al., 2009; NGSS Lead States, 2013). STEM is considered a "high-status arena" (Johnson, 2012, p. 176), as STEM-related industries grow exponentially and STEM jobs offer comparatively more security and higher salaries (Langdon et al., 2011). Despite the opportunities, women and ethnic minorities continue to face significant barriers and remain underrepresented in STEM majors and careers. Beyond the social justice issue for individuals, society suffers if a portion of the population is excluded from solving problems, discovering new cures, and inventing novel technologies. In particular, the Latinx population is the largest, youngest, and fastest growing minority group in the United States (Darder & Torres, 2014) and the choices, opportunities, and trajectories of these students will greatly shape the future of the country. Researchers and educators are being asked to consider new approaches to incite interest and encourage long-term participation in STEM for diverse students.

In response to this call, my dissertation described three research studies involving STEM activities at a local afterschool Teen Center. I documented what Latinx students accomplished in their Community STEM projects and how their participation was connected to identity processes in and out of school. Across the two Community STEM projects, I examined how participants took up various roles while creating STEM-relevant artifacts, and the key events that supported or constrained engagement with science and pushed the activity in new directions. In the final paper, I reported on the Latinx young women's perspectives on the supports and barriers to participation in the STEM academies but also STEM programs in general. In the next sections, I describe conclusions and theoretical contributions before covering the importance of this research for researchers and practitioners.

Contributions to Theory

Characterizing Community STEM programs. This work presented a comprehensive account of two different Community STEM programs, with a focus on how Latinx students perceived and responded to opportunities and constructed identities as both STEM people and community members. It added to an emerging body of research on Community STEM programs, and supported previous research about the importance of valuing youth and community knowledge (Birmingham & Calabrese Barton, 2013; Calabrese Barton et al., 2013; Fusco, 2001). Through moment-by-moment positioning of others and authoring of selves, youth defined their roles as different types of STEM people, including makers, data analysts, community scientists, and engineers-in-training. The projects provided the space and impetus for participants to create personally and collectively meaningful STEM-relevant artifacts with others, disrupting perceptions of science as objective, competitive, and impersonal. The artifacts, including graphs, maps, acoustic panels, and word clouds, became focal points and prompted reflection on problems and solutions in their community. Ultimately, the work expanded the activity system and "figured" the new activity of community science or Critical Making, shaping how science fit within their social and personal contexts.

The new STEM roles also provided opportunities to construct different types of identities as community members. By leveraging their funds of knowledge and an emerging expertise in digital fabrication, participants became critical investigators and designers, and were positioned as experts in local quality of life issues. They were recognized as contributing members of the community due to their experiences with data collection and analysis as well as designing displays such as the interactive map and word cloud. Considering they were often excluded from formal decision-making in town as children and minority residents, their Community STEM work challenged historical and culturally defined norms of participation.

Conceptualizing intersecting identities. ***Identity frameworks.*** Further, this work contributed to literature on identity development, especially regarding "STEM identity" or "science identity." Cultural Historical Activity Theory provided insight into the process of social mediation, tool use, and changing goals, actions, and outcomes. However, the first paper of this dissertation pushed CHAT applications in a new direction, as researchers tend to focus on structural components of activity systems rather than agentive components such as identity (Roth, 2009). I employed a relatively novel approach by applying a mediated-action framework (Penuel & Wertsch, 1995) and using discursive manifestations of tensions to identify and understand key momentary interactions, and in turn draw identity conclusions. For example, examining tensions revealed how specific instances grappling with design challenges and tool constraints helped the young women develop skills, dispositions, and ownership as a collective of makers.

My analysis also revealed how participants carved out new places for themselves in the projects and expanded disciplinary boundaries (Rahms & Gonsalves, 2012), defining the norms and practices within the figured world of afterschool science (Varelas, 2012). These Community STEM programs appear to be "as if" worlds at the margins of the preexisting figured worlds of science (Holland et al., 1998; Kane, 2012). In all the projects, participants were playful and artistic while communicating their understandings of science, pushing the meaning of "scientist" in new directions. They integrated various identities including community member, scientist, youth, artist, and maker, and created artifacts that represented their place in this new figured world. The map and word cloud acted as representations of both their current reality and future aspirations for their community. The map displayed current noise issues, but was meant as a future tool and represented Jatalia's goal in helping families choose quiet places to live. The word cloud displayed residents' perspectives, but also expressed participants' vision for celebrating town positives while working to resolve issues. Analyzing these projects complemented previous identity research conducted in afterschool science programs but illustrated and legitimized additional ways of engaging with STEM. Additionally, interactions and interviews provided insight into both student actions and reflections to best characterize what their participation meant to them in relation to the project and STEM.

The work also supported previous research done within the Bridging Multiple Worlds framework, where participants integrated multiple identities and often reframed challenges as a source of motivation (Cooper, 2011; Cooper et al., 2015). However, I examined more specifically STEM identity development, adding to the limited research on STEM trajectories for Latinx students. Both in the engineering academy and Teen Center, mentors or teachers had high standards and took students seriously, teaching them to use complicated tech tools and expecting them to create real, meaningful projects. The girls performed these authentic practices in and out of school, drawing on material, relational, and ideational resources. Similar to work with Latinx undergraduates majoring in STEM (Rodriguez et al., 2017), the girls felt like engineers due to thinking and performing as engineers in their work. However, despite numerous advantages of the STEM academies, there were still challenges for participants. They struggled with the previously well-documented concerns including peers, financial constraints, and navigating institutional systems (Cooper et al., 2011).

However, there were also more STEM-specific challenges, such as difficulty in translating and explaining novel STEM practices and tools to parents who spoke primarily Spanish.

Becoming scientists or engineers. Students usually did not consider themselves "real scientists" from their work in Community STEM programs. They equated scientists with professionals, and felt that "science people" needed to be very knowledgeable and successful at science subjects in school. However, the projects provided opportunities to build their skills and develop self-confidence, which appeared to expand their views in relation to STEM. The third study provided insight into transfer across worlds and longer-term identity development that occurred after the projects ended. The girls reported that their experiences in the Community STEM projects increased their confidence, and that they would not have considered applying for the STEM academies if they had not participated in the Teen Center programs. For Isabel, the academy felt less daunting due to her experiences with maker tools and practices at the Teen Center. For Sophia, making helped her deal with mistakes and failure, and feel more confident that she would be successful in future endeavors. The Teen Center bridging activities, including application and interview support, were crucial to all the girls in ultimately deciding to attend the STEM academies. In numerous ways, the Community STEM projects were an integral part of the process of "becoming" scientists or engineers. Often Community STEM activities were the beginning of the trajectory, where the girls envisioned possibilities in STEM and took chances in applying to and starting the somewhat intimidating STEM academies. But the Teen Center program continued to offer opportunities to explore and construct STEM-relevant identities beyond academy support. Dylan, Victor, and Alexa published a peer-reviewed article describing the work in the Sound Project; Katie, Araceli, and Flora attended a technology conference and performed in a local STEAM showcase; and Katie, Alexa, and Sophia travelled across the country to present their work about singing and dancing robots at an international conference. The Community STEM projects led to further opportunities, and the resulting diverse patterns of participation demonstrate that there was not a singular way to be successful in STEM. This resonates with work about avoiding a focus on school outcomes or a STEM "pipeline." The pipeline way of conceptualizing success can create dualisms in referring to people as either "in" or "out" of the pipeline, while trajectories convey more diverse patterns of movement through branching pipelines (Guerra, Calabrese Barton, Tan, Kang, & Brecklin, 2012).

Recommendations

Recommendations for future research. This dissertation helped characterize novel Community STEM programs, contributed to the literature on identity development, and documented supports and barriers relevant to Latinx students pursuing STEM. However, there is still much work to be done in all these areas. For one, it would be helpful to have similar long-term ethnographic research on students' participation in STEM classes in school. This type of data could provide additional insight into the figured world of school science beyond participants' interview reflections, and could complement the rich characterization of the out-of-school Community STEM projects. Knowing more about both the school and out-of-school worlds of STEM could help draw connections and make more substantial identity claims. Additionally, it would be valuable to track participants over a longer time span, in particular following students through high school and into college. Research on STEM-underrepresented groups is often focused on either the experiences of elementary and middle schoolers in afterschool science programs or recruitment and retention of college students. More research needs to be conducted on the time period leading up to college (Rodriguez et al., 2017). Therefore, it would be impactful to continue my longitudinal study on the girls in the STEM academy. Following them through high school and into college could result in more compelling identity conclusions, as well as help connect the research on STEM identity in afterschool environments to identity development in college.

Additionally, the Teen Center makerspace offered primarily mixed gendered activities, and future work will focus on identity development for male Latinx students as well. For one, I plan to consider in more detail the boys' signature science artifacts and momentary authoring of selves, since I focused on the roles and perspectives for everyone in the data team but only examined in-depth the girls' authoring and artifact creation. I will also follow up on preliminary findings that girls appeared to take longer to feel like contributors to the data analysis team.

Focusing on the gender comparison and longer-term trajectories could add clarity to the body of research on STEM identity development. While building a strong STEM identity has been proposed as a solution to recruiting more underrepresented groups into STEM, the concept is still relatively new and challenging to investigate and operationalize (Carlone, 2012). Considering the range of characterizations of science identity as a concept and its novelty as a research topic, research should continue to explore this topic, especially with STEM-underrepresented groups.

Recommendations for practitioners. ***Community STEM practices.*** These findings are relevant to practitioners by providing best practices for designing afterschool STEM programs and successfully connecting informal and formal science contexts. For one, these findings highlight productive practices for educators working with students from STEM-underrepresented groups. These include enacting elements of Community STEM such as drawing from individual and collective strengths, contextualizing science learning within community and environmental issues, and positioning youth as both the producers of science content and community artifacts (Balestrini et al., 2016; Birmingham & Calabrese Barton, 2013; Calabrese Barton et al., 2013; Fusco, 2001). Encouraging experimentation and drawing from youth and community knowledge can help redefine what it means to participate in both community decision-making and science as a discipline (Birmingham & Calabrese Barton, 2013; Fusco, 2001). These projects empower youth and promote a deeper connection with science (Balestrini et al., 2016; Birmingham & Calabrese Barton, 2013; Calabrese Barton et al., 2013; Fusco, 2001). Ideally, community members need training and technical skills, realistic expectations, and a variety of data collection tools and methods (Balestrini et al., 2016). Youth can benefit greatly from community partnerships with local experts that result in a sharing and blending of expertise (Calabrese Barton et al., 2013) as well as support from government, nonprofit, and industry partners (Balestrini et al., 2016). Educators and program designers should consider these components, and could benefit from resources such as Pandya's (2012) culturally responsive community science framework. The framework provides guidance on how to align research aims with community priorities, value local STEM knowledge, and involve community members in the whole process from the design to the dissemination of findings (Pandya, 2012).

One valuable approach, especially when working with marginalized groups, is a focus not on interest-based projects but projects that address systemic inequities in their lives (Calabrese Barton et al., 2017). At the Teen Center, students were motivated to learn STEM content or practices because they worked on issues that mattered to them and participated in activities that had the potential to change the status quo. STEM was not foregrounded and topics were not introduced as "the physics of sound" or "calculating perimeter" but instead presented with the aims of "documenting noise pollution" or "reducing noise by installing sound panels." Similarly, Calabrese Barton described how their team introduced science and engineering content right when it became relevant. We found great utility in this practice of "just-in-time STEM" (Calabrese Barton et al., 2017). Numerous times in our projects students asked incredulously, "This is science?" Some students felt this way because the work was relevant to them and they excelled in this type of science or math when they struggled at school. Others enjoyed the practices not typically associated with school science such as making. For participants like Flora, it was because they were surprised that science or engineering could be helpful to their community.

Community STEM framing is important because it offers opportunities to explore, build skills, and promote emerging STEM identities. In our program, participants used new tools like microprocessors and familiar technology like smart phone apps to collect, analyze, and display their findings in empowering ways. Projects like these have the power to change the status quo on numerous levels. In the context of our projects, students developed self-confidence, skills, and dispositions that expanded their views of themselves and their capabilities as science people. They also learned about new possibilities for college or careers and envisioned their future in new ways. Finally, students were more willing to try new opportunities in science and push themselves further even after these projects ended, including enrolling in STEM summer camps, conferences, or school academies.

Partnership support. The Community STEM makerspace program at the Teen Center, including the application support for the STEM academies, would not have been possible without a strong partnership with Teen Center staff and leaders. We followed recommendations for successful Research-Practice Partnerships, including building a relationship based on trust, regular communication, and goal alignment between partners (Bevan, 2017; Penuel, 2017; Penuel & Gallagher, 2017). It could help other educators to understand principles for how Research-Practice Partnerships build partnership relationships, support partners' goals and capacities, and use research to inform local action and form broader conclusions (Henrick, et al., 2017).

However, Teen Center staff and our research team could have done more to partner with local schools, including the STEM academies. While we capitalized on the youth-oriented nature of the afterschool site, where the teens felt comfortable and connected with peers and community members (Calabrese Barton et al., 2017), we rarely connected Community STEM content to their schoolwork. Our shortcoming is representative of a significant issue in STEM education. Educators from both formal and informal sites need to recognize the value in bridging these contexts and commit resources towards this aim. While it seems sensical to better connect school and afterschool science, and many educators have advocated for this, there is a "serious lack of contact between these contexts" (Fallik, Rosenfeld, & Eylon, 2013, p. 69). Connecting these two worlds can help students feel more motivated to learn science, integrate and deepen their content knowledge, and build new skills. Fallik and colleagues (2013) recommend that partners develop an awareness of each other's curricula, work together to design learning experiences, and communicate regularly about student work or progress. Fallik's bridging model (2013) could be used as a conversation guide to help reduce challenges associated with creating partnerships between informal and formal sites and decrease the effort needed to maintain partnerships (Penuel, 2017; Penuel & Gallagher, 2017). Partnerships between informal and formal educators would undoubtedly help students learn science content better, feel more motivated, and strengthen their views of themselves as science people.

Conclusion

The three papers in this dissertation begin to address the dearth of research on Latinx students, and in particular Latinx girls in STEM classes and careers. Through documenting a group of Latinx students' experiences in maker and community science projects and their perspectives of STEM over time, I revealed how these projects influenced their views of themselves and futures. I examined how these young women made sense of themselves in relation to STEM activities and careers while also developing intersecting identities tied to peers, their leadership group, the Teen Center, and wider community. Finally, the research characterized distinct STEM trajectories for different students, drawing attention to both the challenges and resources for Latinx young women in STEM.

This work is timely, given both the underrepresentation of Latinx people in STEM fields (NSF, 2017) and the dearth of research documenting Latinx women's experiences in STEM classes and careers (Crisp & Nora, 2012). More researchers and educators need to consider how to help students make a place for themselves in STEM. To most effectively increase the knowledge base and advance society, scientists should be recruited with "the widest possible pool of experiences" (Johnson, 2012, p. 176). Investing in women and students of color will have a great impact on their lives, as well as the future of our country.

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V. Appendices

Appendix A: Paper 1 Data Representations

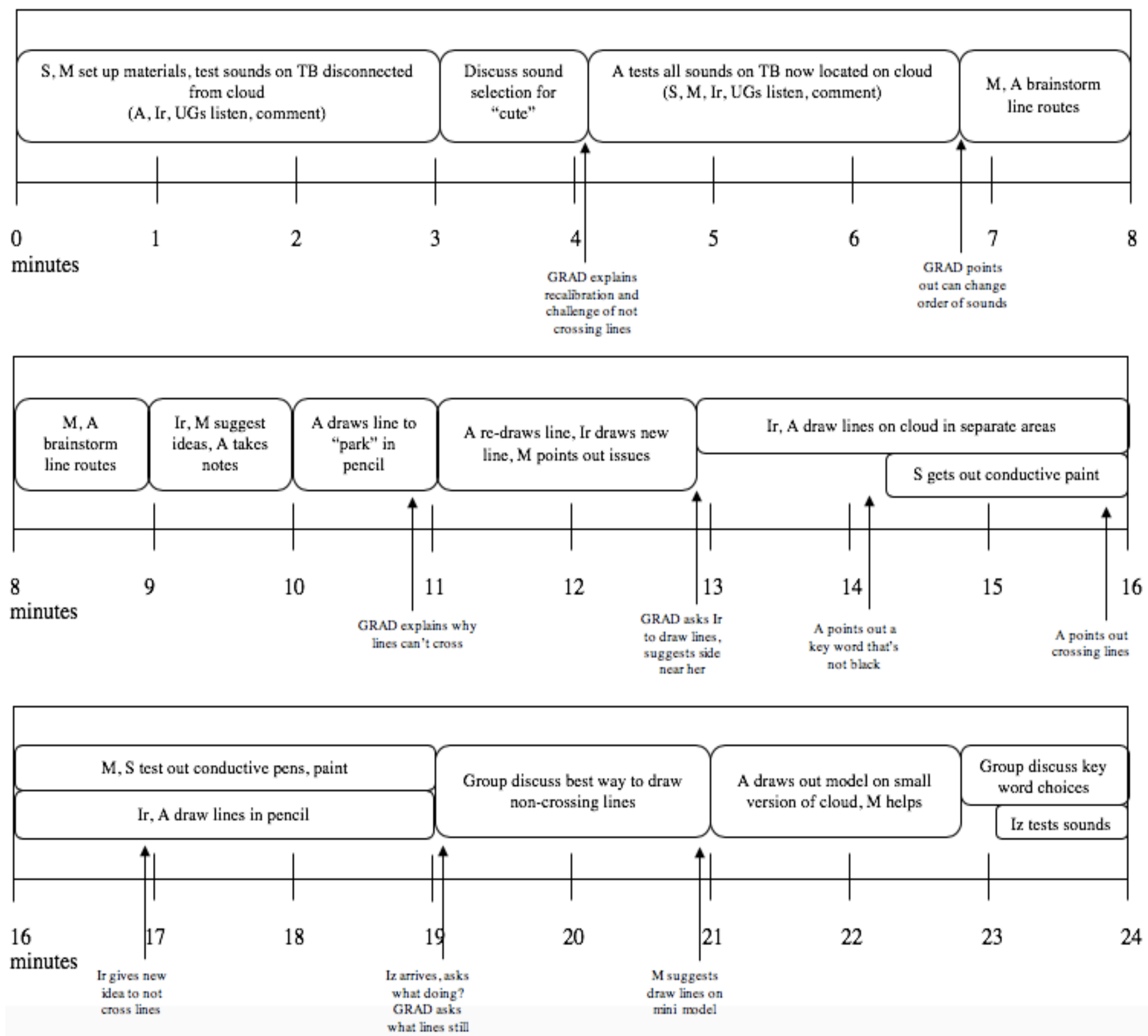

Figure 1. Event map for session focused on connecting key words, indicating patterns of activity and roles.

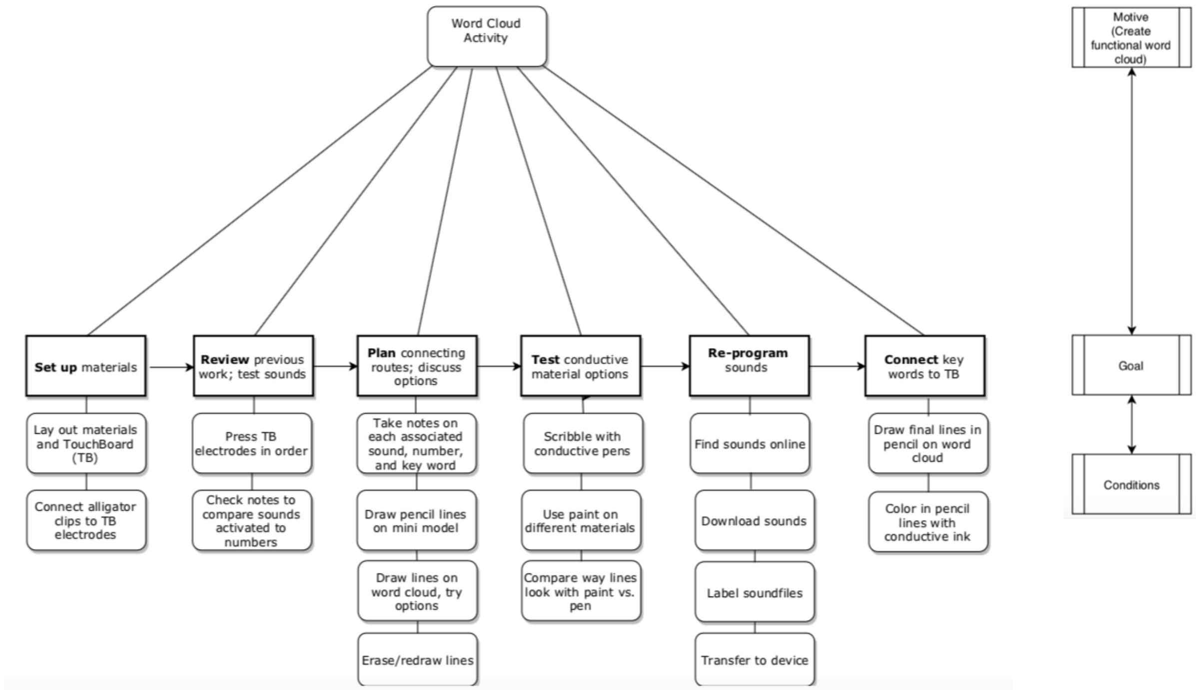

Figure 2. Hierarchal structure (adapted from Kaptelinin and Nardi, 2012), indicating activity composed of actions composed of operations for session focused on connecting key words. Levels of activity on left correspond to motive, goal, and conditions indicated on right.

Appendix B: Paper 2 Artifact Lists

Table 1
Complete List of Object Artifacts

1. Sound wave data display on smart phone (Araceli, Katie, Dylan, Tomas, Jatalia)
2. Sound clips with geotags sent to email (Tomas, Araceli, Jatalia, Katie (on J's phone)
3. List of guidelines for recording sound data (Tomas)
4. Graph of *Day of the Week Loudest* (Tomas, Dylan)
5. Graph of *Sound Levels Week vs Weekend* (Tomas, Dylan)
6. Graph of *Time of Day Loudest* (Tomas, Dylan)
7. Spreadsheet with data organized (Araceli, Tomas, Dylan)
8. List of research questions/brainstorm and answers (Tomas, Dylan, Araceli)
9. Sketch of map (Tomas)
10. List of important sounds, notes for map (Jatalia, Rafael)
11. Sounds sorted by max/min with qualitative description of top three sounds (Rafael)
12. Map edited from google maps, in word doc (Jatalia)
13. Map in PowerPoint with interactive sound files (Jatalia)
14. PowerPoint slide listing data (Araceli, Katie)
15. PowerPoint slide on community science & project beginnings (Dylan)
16. PowerPoint slide on data collection (Katie)
17. PowerPoint slide on research questions (Araceli, Katie)
18. PowerPoint slides with graphs (Tomas)
19. PowerPoint slide on sources of sound (Rafael)
20. Individual decorated acoustic squares (Araceli, Katie, Dylan, Tomas, Jatalia, Flora)
21. Mini rooms with cardboard or foam paneling (Jatalia, Tomas, Dylan)
22. Vlogs covering sessions on making or data analysis (Katie, Araceli, Tomas)
23. Graph and chart from professional sound meter (Flora, Katie, Dylan, Tomas)
24. Headbands and bandanas from extra fabric not used in acoustic panels (Dylan)
25. Map of study room and notes on room set up for pre and posttest (Tomas)
26. Directly installed acoustic panels on wall (5x7) (Tomas, Dylan, Katie, Jatalia)
27. Photo note documenting order of panels (Katie, Jatalia)
28. Plywood panels with individual panels glued on (Katie, Flora)
29. Pre measurements of study room (Flora)
30. Post measurements of study room (Flora)
31. Sound wave file print outs (Flora)
32. Chart of averages for pre and post sound in room (Flora)
33. Formula and final calculation that showed significant difference (Flora)

Table 2
Impactful STEM Artifacts for Boys and Girls on Data Analysis Team

Artifact	Description	Person	Reflection from Exit Interview
Graphs	Graphs of sound levels according to day of the week and time of day	Dylan Tomas	"It was fun today, to know which places in IV were more louder and which places were more quieter." "Like data analysis and like the little graphs we did." "We definitely made like graphs and information for other people to use, and like maybe other people can use in studies and stuff like that."
Individual acoustic squares	1x1 squares of acoustic foam decorated in fabric, ribbons, and buttons by each participant	Araceli Katie	"I decorated the panels" "I feel accomplished." Liked "that I can decorate them? Because I'm 'creative.'" "I decorated the fabric on the panels, and installed the panels helped.
Interactive sound map	Map with sound effects linked so it was possible to click through different areas and hear representative sounds.	Jatalia	"When we went to go collect the data too, it was fun to hear all the data and point the map out and everything." "I feel like I really wanted to get the noises I think that's going to be a challenge now too, to get the noises from IV" "It was okay once again I feel like we should have had more spots, especially partying, and I feel like we should have gone towards campus like maybe we could have heard the bikes." "It kinda impacted me because I didn't really realize how IV could be peaceful. I didn't know there's streets or like this side of IV is quieter than this side."
List of guidelines	Group guidelines for collecting sound level data, such as collect for 1 minute each time.	Dylan	"It was kind of fun, kind of easy I think. It was kind of hard when we were supporting how to collect the sound. And that's when I guess that when we're together like we all help each other plan and organize our stuff so we can do this. I guess we all help each other...All of the Teen Center Leadership Group."
List of sounds	Sounds sorted by max/min with qualitative description of sounds.	Rafael	N/A
Mini rooms	Mini "rooms" made of crates covered in either cardboard or acoustic foam to model the larger room.	Jatalia Dylan	"Like my favorite part of it? I think when we did the sound booth and the materials came in and everybody got excited" "I remember working with you two and like testing the boxes, the sound boxes."
PowerPoint slide on community science, project beginning	Slide with information about the project in general, overview of data analysis	Dylan	Favorite thing was.."The presentation. Yeah it was pretty cool. Overall because it had all of what we did together, and when the presentation was going on, I kind of remembered every single thing we were doing. So that was definitely the part I most remember because it reminded me of everything."
PowerPoint slide on research questions	Introductory slide covering the group's research questions, presented in Town Hall	Katie	"We had a good presentation." "I liked being in the Town Hall…I had like three slides because Araceli wasn't here. And I had to say her parts." "I don't think it was a lot, but honestly I don't like talking very much, so it seemed like a lot. I think all the

			data was good, it was organized, like easy to say."
PowerPoint slide on sources of sound	Slide with top 3 loudest and quietest sounds and description, presented at Town Hall.	Rafael	"There's like different locations that we have recorded and that there's also traffic and parties and the decibels range from 27 to 108. We wanted the loudest sounds but we also wanted to record the quietest sounds to show that IV could be a quiet place, a peaceful place."
PowerPoint slide with graphs	Slide with graphs showing sound levels according to day of the week and time of day	Tomas	"We all participated and made us feel like we actually did something."
PowerPoint slide with map	Slide with information on the map, and demo of the map, presented at Town Hall.	Jatalia	"I know [I did a good job], oh my good it was shaking though."
Sound clips	Sound clips recorded on phone app, geotagged and with dB info	Tomas	Favorite was "just like going around and recording like in a group sound, like noise." "We definitely contributed by doing it in our own time and recorded sound files and you sent it."
		Araceli	"I remember the Sound Blast project. We just go around IV and just like use the app and also like..we just recorded with an app. Yah and see and collect all the data to see how much loud or quiet it is."
Sound wave print outs	Sound wave files showing amplitude over time, used to find the intercept and estimate time until decay for pre and post tests	Flora	"I learned how it worked and how it made a big difference in the room…like how it absorbed sound."; "I learned how to like, how to do the data, like how to average it and how to like arrange it." "You guys showed me how to make it as accurate as possible."
Wall acoustic panel	Plywood panels with individual acoustic panels attached	Flora	Didn't feel that analysis and building panels different because "they were like related to each other, so like not really that different." "I feel we did a very good job on it. I think we really succeeded on it. Because it actually did help. It helped, it helped get the study room quieter."
		Katie	"I'm not sure what the difference is with the acoustic panels. I mean, to me it seems the same they're like decoration on the wall. I guess it could work, if it is I'm not noticing it. The panels worked out good because like people did it." "What surprised me was that I actually did it, other than other projects that I liked being creative on the corkboard and acoustic panels. Well it surprises me how, for me, it makes no difference, but maybe it's me not really realizing it. But I just see it as some fabric and foam."
		Jatalia	"I didn't know about the sound thing what we have in the homework room. I didn't know that those things could help…Yah I thought that was pretty cool."

Appendix C: Paper 3 Data Displays

*In all charts, bold text emphasizes individual perspectives not shared by another participant.

Table 1
Participants' Perspectives on How People and Things Associated with their Worlds Support Them

Worlds	Malia	Zuleyma	Isabel	Sophia
Friends	• Finish work/projects • **Resolve problems at home**	• Finish work/projects • Resolve problems at school	• **Understand STEM concepts**	• Resolve problems at school • **Facilitate college acceptance**
Family	• Set high expectations • Support goals • Express pride/happiness • Encourage explore new opportunities	• Set high expectations • Support goals • Express pride/happiness • Resolve problems	• Serve as role models/trailblaze • Support goals • Resolve problems • Finish homework	• Set high expectations • Serve as role model/trailblaze • Finish homework • Encourage explore new opportunities
Teachers	• Set high expectations • Navigate school norms • Understand STEM concepts • **Finish work/projects**	• Set high expectations • Navigate school norms • Understand STEM concepts • Plan for future • **Advice, rec letters**	• Set high expectations • Navigate school norms • Understand STEM concepts • **Maintain grades**	• Set high expectations • Understand STEM concepts • Plan for future
Academy	• Facilitate college acceptance • Build skills • Make friends	• Facilitate college acceptance • Build skills	• Facilitate college acceptance • Build skills • Develop resilience, dedication	• Facilitate college acceptance • Maintain grades • Make friends • Develop resilience, dedication
Programs	• Tutor/homework • Provide support network • Navigate applications • **Understand STEM concepts** • **Build skills**	• Tutor/homework • Plan for future • Provide support network	• Tutor/homework • Plan for future • Navigate applications • **Make friends**	• Plan for future • Navigate applications • **Provide mentoring**

Self	• Stay on track for college, career • Maintain long-term motivation • **Be independent**	• Stay on track for college, career	• Finish homework	• Finish homework • Maintain long-term motivation

Table 2
Participants' Perspectives on How People and Things Associated with their Worlds Challenge Them

Worlds	Malia	Zuleyma	Isabel	Sophia
Friends	• Get off-track • **Issues/fights**			• Get off-track
Family	• Financial constraints • Lack space to work • Language barrier • **Issues/fights**	• Financial constraints • Language barrier • **Act as role model for siblings** • **Navigate system, ask others for help** • **High expectations, pressure to succeed**	• Language barrier	• **Chores, care for family dog**
Teachers	• High expectations, difficult grading	• High expectations, difficult grading	• High expectations, difficult grading	• High expectations, difficult grading • **Busywork not motivating** • **Understand STEM concepts**
Academy	• Demanding work, high pressure • Time constraints • Not accessible to family	• Demanding work, high pressure • Time constraints • Not accessible to family • Understand STEM concepts	• Demanding work, high pressure • Time constraints • Not accessible to family • Understand STEM concepts	• Demanding work, high pressure • Time constraints • Understand STEM concepts • **Monotonous schedule** • **Rejection from engineering academy**
Self	• High self-expectations, pressure	• High self-expectations, pressure	• Lack motivation/ procrastination • **Make friends, being shy**	• Lack motivation/ procrastination • **Navigate system, ask others for help**

Table 3
Comparison between Participants for Overall STEM Identity and Associated Dimensions

	Malia	Zuleyma	Isabel	Sophia
Overall STEM ID	• Known by others as science person • STEM as way to broaden opportunities and world view • **Latinx role models in STEM** • **STEM identity aligns with conventional/school science, notebooks and science vocabulary**	• STEM as way to broaden opportunities and world view • **Driven by breaking stereotype as Latinx** • **STEM career as way to be a role model for family, develop financial security**	• STEM as way to broaden opportunities and world view • **STEM subjects linked, importance of math abilities, art interests** • **STEM as hobby/skill building opportunity, not career**	• Known by others as science person • **Interest in computers, robots for engineering and human body exploration for medicine** • **Making as important hobby** • **Shift of world view from STEM important to her to STEM important to others**
Ideational STEM	• STEM in everything, useful • World view science and art complementary • **Science associated with STEM vocab (formulas and equations)** • Scientists create/build, invent	• STEM in everything, useful • **STEM as exploration** • **Engineering associated with programming, code, art, being “machine-y”**	• World view science and art complementary • Science person excels in school math, science • **Engineering associated with working hard, math, making**	• STEM in everything, useful, **but not personally relevant** • **Engineering associated with wire, technology, building** • **Science associated with take notes, memorize facts, fail** • Science person excels in school math, science • Scientists create/build, invent
Relational STEM	• Recognized by teachers and mentors • Parents proud • Parents struggle to	• Parents proud • Parents struggle to understand concepts/participation	• Parents proud • Parents struggle to understand concepts/participation	• Recognized by teachers and mentors • Strong women role models—family

	understand concepts/participation • **Strong women role models—Latinx engineers inspirational**	• **Latinx scientist means breaking stereotype for others**		• **Family encourages participation in medicine** • **Not swayed by others**
Material STEM	• Academy projects as representation of self, maker • **Physics notebook valuable** • **Light up artifacts as unique** • **Tech tools can build community**	• Machines, technology important for engineering • Academy projects as representation of self, maker	• Machines, technology important for engineering • Academy projects as representation of self, maker	• Machines, technology important for engineering • **Computers, robots at core of maker self** • **Scientists associated with lab and gear** • **Read/create how-to STEM guides**

Table 4

Comparison between Participants of Overall Academy Identity and Associated Dimensions

	Malia	Zuleyma	Isabel	Sophia
Overall Academy ID	• Initially unsure but aligned with college-bound goals • Relevance of Latinx identity • Enjoyed work • **Well-supported** • **Open to engineering as college major**	• Initially unsure but aligned with college-bound goals • Relevance of Latinx identity • Enjoyed wok • **Open to engineering-relevant careers**	• Initially unsure but aligned with college-bound goals • Enjoyed work • **Considering intersections of art and engineering**	• **Initially excited for engineering academy** • **Resentful after rejection** • **Initially excited for health academy, aligned with family's expectations** • **Disliked work, disillusioned with career options**
Ideational Academy	• Unique opportunity/cool factor • Applicable to real-world • Academically rigorous • At appropriate level, not discouraging	• Unique opportunity/cool factor • Academically rigorous • At appropriate level, not discouraging • Accommodation/flexibility on	• Unique opportunity/cool factor • Applicable to real-world • Academically rigorous • At appropriate level, not discouraging	• Academically rigorous • High standards within and out of health academy (GPA minimum) • Explore career ideas • **Time-**

	• Accommodation/flexibility on work • High standards • Project-based, direct/hands-on experience • Tests and homework rare • Achievable for anyone with hard work • Guided through work, but do on own • Teachers label as engineer	work • High standards • Project-based, direct/hands-on experience • Tests and homework rare • Achievable for anyone with hard work • Guided through work, but do on own • Explore career ideas	• Accommodation/flexibility on work • High standards • Project-based, direct/hands-on experience • Tests and homework rare • Teachers label as engineer	**consuming homework, regular tests** • **Busywork/not practical** • **Value science knowledge, memorizing**
Relational Academy	• Peers outside of academy think smart, inside feel normal • High expectations of teachers • Open communication with teachers • Family proud/pleased • New/different for family • Mixed feelings about Latinx rotation group • Work with partners, but individuals responsible • **Close bond with teachers**	• Peers outside of academy think smart, inside feel normal • High expectations of teachers • Family proud/pleased • New/different for family • Mixed feelings about Latinx rotation group • Hard to make friends • Work with partners, but individuals responsible • **Feel not as skilled/smart as academy peers** • **Others take experience for granted**	• Peers outside of academy think smart, inside feel normal • Same level as peers • High expectations of teachers • Open communication with teachers • Family proud/pleased • New/different for family • Positive feelings about Latinx rotation group • Hard to make friends • **Other peers with educated parents, parents as engineers**	• Peers outside of academy think smart, inside feel normal • Same level as peers • High expectations of teachers • Family proud/pleased • Neutral feelings about Latinx group • **Expected in family** • **Lack of bond with teacher** • **Friends as major supports**
Material Academy	• Projects displayed as examples for future students • Mobile as representation of self, maker • Surprise and pride in operate tools	• Projects displayed as examples for future students • Mobile as representation of self, maker • Surprise and pride in operate tools	• Mobile as representation of self, maker • Surprise and pride in operate tools • Tools as empowering	• **Lack of materials (organ activity only)** • **Off-site opportunities** • **Future internships**

• Tools as empowering • **Physics notebook, organization**	• Tools as empowering • **Complicated projects and materials**

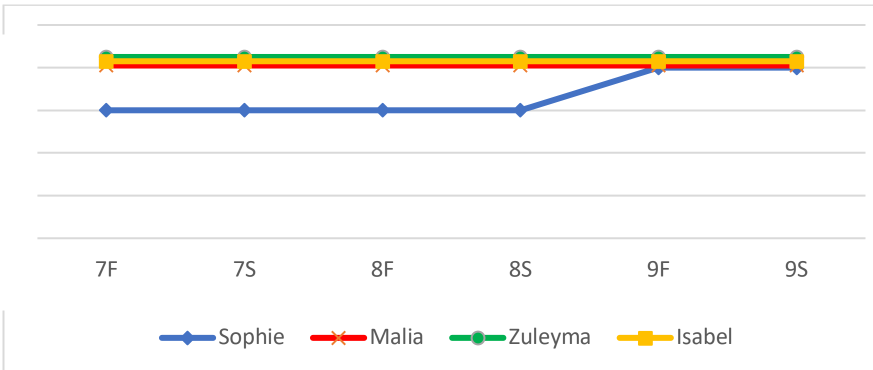

Figure 1. Self-reported math grades from Fall 7th grade through Spring 9th grade.

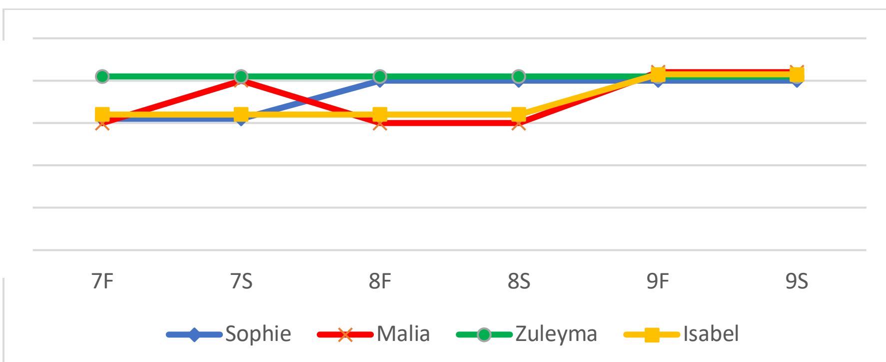

Figure 2. Self-reported science grades from Fall 7th grade through Spring 9th grade.

Appendix D: Interview Protocols

Transcription Template.

Transcriber:
Transcription Date:
Session Date:
Setting:

NOTES:

(word)	Use parentheses if guessing and uncertain, or hard to hear.
(???)	Use parentheses with question marks if cannot hear words.
--overlap	Use a dash to indicate when one speaker interjects into the speech of another, include the speech of the other at the beginning of the line, and then return to where the original speaker was interrupted if he or she continues.
((a loud noise))	Double parentheses contain transcriber's description rather than people's words.
wo::rd	Use colon to show lengthened/stretched word.
?	Use question mark to indicate rising pitch.
.	Use period mark to indicate falling pitch.
!	Use exclamation point to indicate animated speech tone.
,	Use comma to indicate continuing intonation, typically a falling-raising pitch.
word	Use underline to show word is stressed/emphasized, may involve pitch and volume.
((laughter))	Use to indicate when speaker is laughing.

** Not all interjections are transcribed. Only those that interrupted the speaker.
Other agreements such as "Yeah" of "UmHm" do not need to be transcribed.

ACTORS:

Name	*Facilitator*
Name	*Interviewee*

Timestamp	*Line #*
0:00	1
	2
	3
	4
	5
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	7
	8
	9
	10
	11
	12
	13
	14
	15

Paper 1 Interview Protocol.

Focal Activity and Purpose

Purpose of section: Understand the young person's participation in the Maker Tech Group at the St. George Family Youth Center, including how their involvement has changed over this past year.

1. Think about when you got started with the Maker group or Making in general at the Teen Center or elsewhere. Tell me about your first experiences with Making. What did it look like? What have you made? (ask for an example)
    - About how old were you when you started?
    - How did you get started? What was your motivation or reason for engaging in Making?
    - How did you feel about Making when you first started?
    - When you started doing Making, how would you describe your skill level? [Probe: What parts felt easy, like you were prepared to do? What parts did you need to learn how to do?]
2. Looking at this list of projects, can you list a few that were memorable? What stands out to you about that project(s)?
    - With that project in mind, what was the goal you were trying to accomplish?
    - How did the final artifact work [bean bag stand, interactive art, etc.]? If you needed to explain it to a stranger that approached your booth/art, what would you say?
    - Did you learn any new facts or skills, such as how to do something that you didn't know how to do before?
    - What was a challenge/obstacle, and how did you overcome whatever was in the way? Who if anyone helped you overcome the obstacle? How did they help?
    - What did you have to learn to complete the project?
    - Who was involved in the activity?
    - What was your role or contribution to X project? Did it change during the project?
    - How do you feel about the final product of X project?
    - What sort of impact do you think doing this project had on you? What changes do you see in yourself as a result of participating in these projects?
    - What projects would you want to do next?
3. What's similar about your experiences now to when you first started? What's different?
    - What was your experience like doing Teen Center Maker projects in collaboration with other groups and for different audiences (events with FLA, UCSB, LightWorks)
    - How did it feel presenting your work to a wider audience (UCSB Maker Day, Children's Day, Instructables, vlog) compared to sharing with other teens at the Center?
    - How did what you learned in X project influence or apply to Y projects [bean bag toss, I'm a Student Too, poetry map, Arduino hacking, LightWorks]?
    - Have you gained confidence in yourself as a Maker? What do you know that you didn't before you started? What's changed about how you participate? How do you know?

Maker Identity

Purpose of section: Understand the young person's stance toward Making.

4. How would you explain the term Maker?
    - What does it mean to be a Maker? What are five words you associate with Making?
    - What skills do you think are important to being a Maker in general? What skills or traits are helpful when working on projects like those created in the Maker group?
    - How are collaborative Maker projects different than making something on your own?

- Do you consider yourself a Maker?
- Do you think girls and guys are equally likely to make things (crafts, electronics, technology and art, robotics, etc.)
- Do you think girls approach Making differently than guys?

Science Value and Competence

Purpose of section: Understand the young person's interest in and value toward science, and compare school science to Maker group science.

5. How do you feel about your school science class? How does it compare to science in the Maker group?
    - How successful/capable do you feel in science class?
    - How successful/capable do you feel in the Maker group?
    - Do you feel you can take risks and not be afraid to fail in one or both settings?
    - What types of concepts are covered in each class?
    - How do you use technology at school compared to the Maker group?
6. Has anything you've learned in the Maker group applied to school science or anything you learned in school helped with Maker projects?
7. How would you rate yourself in:
    - Asking questions (for science) and defining problems (for engineering)
    - Developing and using models
    - Planning and carrying out investigations
    - Analyzing and interpreting data
    - Using mathematics and computational thinking
    - Constructing explanations (for science) and designing solutions (for engineering)
    - Engaging in argument from evidence
    - Obtaining, evaluating, and communicating information

Imagining possible futures

Purpose of section: To understand what ideas young people have gotten through participation in Teen Center Maker activities about who they could become or what they could do in the future.

As a result of engaging in the Teen Center Maker activities, have you gotten any new ideas about things you might want to do in the future? [hobby, for school, for work, or to make the world a better place.]

- What is one new idea you have gotten? How did you come up with that idea?
- (if no) - can you think of specific jobs [paid work] this might be preparing you (or other young people like you) for?
- (pick one job or activity) - Do you know anyone who is already doing [future activity]? Please tell me about it.

8. Imagine yourself five years into the future, and you are doing that [new idea]. What are some things you think you will need to learn or do, to be that person doing [new idea] in the future?
9. What have you already learned or done that prepares you to become that person doing [new idea]?
10. What kinds of things might get in the way of you accomplishing your future goal?

Paper 2 Interview Protocol.

Project Participation and Impact

- Tell me about your favorite experience from the joint leadership/maker project "I'm a student too."

- Overview
  - Looking at this list of activities (See List below), can you list a few that were memorable? What stands out about them?
  - What was the goal you were trying to accomplish with the project?
  - If you needed to explain the project to a stranger, what would you say?
  - How would you explain to someone the noise issue in [your town]? How would you explain noise pollution in general?

- Participation
  - What was your motivation or reason for joining or doing the project?
  - What was your role or contribution to the project? Did it change during the project?
  - Who else did you work with and how did you work together?
  - What was a challenge/obstacle, and how did you overcome whatever was in the way? Who if anyone helped you overcome the obstacle? How did they help?

- Skills and perspectives
  - Did you learn any new facts or skills, such as how to do something that you didn't know how to do before? (excel, PowerPoint, presenting, recording sound, talking about sound in community)
  - What did you have to learn to complete the project?
    - What did you learn about measuring sound? How do we measure sound?
    - What does 0db or 100db mean? At what level is sound too loud for human ears?
    - What does sound mean to you?
    - What sounds do you now associate with [your town]?
- Impact
  - How do you feel about the final product of the project (graphs, sound map)?
  - What sort of impact do you think doing this project had on you? What changes do you see in yourself as a result of participating in these projects?
  - What are your thoughts and feelings about presenting to the community at the Town Hall? How did it feel presenting your work to a wider audience?
  - What were some surprises that you experienced?
  - What is something you want to learn more about? What projects would you want to do next?

Maker or Community Scientist Identity

- How would you explain the term community science?
  - What do community scientists do? Who are community scientists?
  - Do you think of yourself as a community scientist? As a science person?
  - Who else, if anyone refers to you as a science person?

- The acoustic panel activity was one way we did Making here at the Teen Center. Tell me what Making/engineering design means to you.
  - Do you like Making? If yes, what do you like about Making?
  - What is easy about Making? What is hard?

- What does it mean to be a Maker? What are some words you associate with Making?
- What skills do you think are important to being a Maker in general? What skills or traits are helpful when working on projects like those created in the Maker group?
- How are collaborative Maker projects different than making something on your own?
- Do you consider yourself a Maker?

- How do you feel about your school science class? How does school science compare to science activities at the Teen Center?
    - Are maker activities different from the science you do at home or school? How so? Or if not, how are they similar?
    - How successful/capable do you feel in science class?
    - How successful/capable do you feel at the Teen Center?
    - Do you feel you can take risks and not be afraid to fail in one or both settings?
    - What types of concepts are covered in each class?
    - How do you use technology at school compared to the Maker group?
    - Has anything you've learned in the Maker/Community Science project applied to school science or anything you learned in school helped with Maker/Comm Science projects?

Activities for Sound Project

Figuring out project/set up

- Leadership discussions
- Creating guidelines for measuring sound
- Practicing taking sound measurements in Teen Center, getting quietest and loudest sounds
- Watching sound videos
- Coming up with research questions (which day the loudest?)

Data collection

- Collecting sound on own around town
- Sound blast group data collection

Data analysis

- Organizing and sorting data (most to least, etc.)
- Calculating max, min, averages
- Creating graphs (day of the week, time of day, etc.)
- Creating interactive sound map for PowerPoint

Results presentation

- Practicing presenting
- Presentation for Town Hall

Acoustic Panels

- Decorating with fabric on acoustic panels
- Pre and post-tests, experiments to compare sound levels in study room
    - Creating "mini room" comparisons with and without acoustic panels

Paper 3 Interview Protocols.

Pre-academy interview.

Project Experiences

- Tell me about your favorite experience from the joint leadership/maker project "I'm a student too."
    - What are the most important things that you have learned to do so far?
    - Tell me about something you liked doing.
    - What are some surprises that you experienced?
    - What is something that you want to learn more about?
    - What are your thoughts and feelings about presenting to the community at the Town Hall?
    - What are your thoughts and feelings about participating in the UCSB Maker Faire?

Interests and Perspectives on STEM

- Tell me what Making/engineering design means to you.
    - Do you like Making? If yes, what do you like about Making?
    - What is easy about Making? What is hard?
    - How important do you think STEM is?
- Tell me what it's like to do Maker projects here at the Teen Center.
    - Are the maker activities different from the science that you do at home or at school?
    - How so? Or if not, how are they similar?
- Tell me what it means to be a community scientist.
    - Do you know any scientists or engineers? (In person, or famous now/from history)
    - What are some things that you think scientists and engineers do? What do community scientists do? Who are community scientists?
    - Some people say that "all children are scientists." Do you agree or disagree with this sentence?
- Do you think of yourself as a science person? Do you think of yourself as a Maker?
    - Who else, if anyone, refers to you as a science person?
    - What do other people think you're good at, or going to do for a job?

Preparation for Engineering Academy

- How did you feel about the preparation process for applying for the engineering academy?
    - What part was the most helpful? (info packet, knowing months in advance, essay practice, group essay writing days, interview prep, mock interview)
    - What new skills, if any, did you learn throughout the application process?
    - How prepared do you feel to start the engineering academy?
- How do you think the engineering design classes will compare to the Maker activities you've done at the Teen Center?
    - How do you think engineering design classes will compare to traditional science classes?
    - How has the Maker group helped prepare you for high school or the engineering academy? (Skills, dispositions?)

Engineering Academy in Relation to Future

- What job do you see yourself doing in the future?
- How do you see participating in the engineering academy in relation to your future education or career?
- How do you think being a part of the engineering academy will affect your high school experience?
- What do you think about being the first group of students accepted from the Teen Center?

Social Dynamics of Engineering Academy

- Do you know anyone currently in the engineering academy? What type of students attend the engineering academy?
- Do you think the experience is different for girls than boys?

- Are you looking forward more to the individual projects or group work?
- What other electives or clubs do you hope to be a part of?

First year experiences.

<u>Overall Experiences in Engineering Academy</u>

- How would you describe the engineering academy to someone else?
    - What would you say to a student considering the program for next year?
    - What does a typical day look like?
    - What's your favorite rotation and why?
    - What's your least favorite and why?
    - What are the teachers like?
    - What parts are hard, what parts are easy? (classes, grades, concepts, students, teachers)
    - How do you the engineering design classes compare to traditional science classes? How do they compare to the Maker activities at the Teen Center?
- What have you been learning about? What have you made so far?
    - Tell me about your favorite project or session with the engineering academy.
    - What are the most important things that you have learned to do so far?
    - What is something you want to learn more about?
    - Tell me about your current project.
        - What did you like do for the project?
        - What was something challenging about the project?
        - What are some surprises that you experienced?

<u>Interests and Perspectives on STEM</u>

- Tell me what Making/engineering design means to you.
    - What do you like about Making or engineering?
    - What is hard about Making? What is easy?
    - How important do you think STEM is?
    - What are some things that you think scientists and engineers do?
- Do you think of yourself as a science person? Do you think of yourself as a Maker or engineer?
    - Who else, if anyone, refers to you as a science person?
    - What do other people think you're good at, or going to do for a job?

<u>Career Plans and Engineering Academy in Relation to Future</u>

- What job do you see yourself doing in the future? What are you planning to do after high school?
- What people or experiences have been major influences on your plans for the future? (teachers, family, friends, others, programs, either positive or negative)
- What do you see as challenges to reaching your goals? What are your resources?
- How do you see participating in the engineering academy in relation to your future education or career? (How do you see the engineering academy influencing your goals?)

<u>Dynamics of Engineering Academy</u>

- What type of students attend the engineering academy?
- What kind of person do teachers expect you to be in the engineering academy?
- How does being Latinx affect your experiences in the academy?
- How does being a girl affect your experiences?
- How do you think being a part of the engineering academy is affecting your high school experience?

Second year interview.

First Year Experiences

- Looking back on the first year in the engineering academy, how did it go?
  - What did you like about it? (Classes, teachers, peers, what learned)
  - What did you dislike about it?
  - What was something you felt proud of learning or doing?
  - What was the biggest struggle or challenge?
  - How would you describe engineering now?
  - Do you feel like an engineer-in-training? Do you feel like a Maker? Why or why not?
  - What do your friends outside the engineering academy think about you being in the engineering academy? What does your family think?

- How did your experience in the engineering academy compare to your other classes and experiences in high school?
  - How competent or prepared did you feel in your engineering classes? Other classes?
  - What were the teachers like in the engineering academy compared to at DP in general? What did they expect of you?
  - What were the other students in the engineering academy like compared to DP in general? Did you feel like you fit in at the Engineering Academy? Did you feel like you fit in at DP in general? Did you make new friends this year? (Were they in DPEA or at DP outside DPEA?)
  - How do you think being a part of the engineering academy is affecting your high school experience?

- Tell me about your mobile project.
  - What was your final design? How did you come up with this idea?
  - What parts were you proud of? What would you change?
  - What was challenging?
  - What were some of the most important skills or knowledge you gained from this project?

Second Year

- How are you feeling going into the second year? What do you expect next year to be like?
  - What are you excited about?
  - What are you nervous about? What challenges do you expect?
  - How are you feeling about balancing the engineering academy work with Teen Center leadership activities?

Appendix E: Paper 3 Diagrammatic Prompts

"Compass Points" Activity.
(Adapted from Harvard Project Zero, 2015)

- What excites you about the engineering academy?
  - What's the upside?
  - What good things do you expect? (new friends, learn more, cool projects, leadership experience, field trips)
  - What do you hope to learn or get from this experience?
  - What parts do you think will be easy or fun?
- What do you find worrisome about the engineering academy?
  - What makes you nervous?
  - What's the downside?
  - What challenges do you expect? (new place, classwork more/harder, social issues--youngest students, friends, others—teachers, parents' expectations, appearance, teasing).
  - What parts do you think will be hard (classes, grades, concepts, students, teachers)?
- What else do you need to know or find out about the engineering academy?
  - What additional information would help you evaluate things?
- What is your current stance or feeling towards the engineering academy?
  - What are some things you could do to confront challenges, or feel more prepared before starting?
  - What do you think you need to do to be successful in the engineering academy?

"What are Your Worlds?" Activity.

(Adapted from Cooper et al., 2011, Appendix 1, Bridging Multiple Worlds Toolkit)

- *What are your worlds?*
- *What do people expect of you in your main worlds (just Teen Center, school, STEM academy?)*
- *Who helps you and who causes difficulties related to:*
  - *planning your future*
  - *doing schoolwork*
  - *staying on track to get to college/career*
  - *dealing with problems*
  - *understanding STEM concepts, work*

What are your worlds?

Circle the worlds you participate in and write in important people you interact with in these worlds. You can add worlds. Write their relationship to you, such as mother, father, sibling, friend, coach, priest, counselor, or principal. These people can be positive influences in your life or may cause you difficulties.

Family

Myself

Neighborhood

Friends

Program

School

Church or Mosque

Music

Video games or Internet

Sports

What do people expect of you in your main worlds?

From the page above, think about the goals, expectations, and values that important people in your worlds have for you. Then from the list below, write inside each world you circled up to 6 expectations (you may write the numbers rather than the words).

Positive

1. Work hard
2. Stay in school
3. Do well in Math
4. Do well in English
5. Be a good student
6. Be confident
7. Go to college
8. Work right after high school
9. Be rich
10. Have a family in the future
11. Help others financially
12. Be successful
13. Be honest
14. Have respect for others
15. Be responsible for my own actions
16. Other:__________(write inside world)

Negative

17. Be lazy
18. Drop out of school
19. Do poorly in Math
20. Do poorly in English
21. Be a poor student
22. Be unsure of myself
23. Do not go to college
24. Be unemployed
25. Be poor
26. Have a family too soon
27. Not help others financially
28. Fail
29. Be dishonest
30. Be disrespectful
31. Be irresponsible
32. Other:_________(write inside world)

Math and Science Academic Pathways Activity.

(Adapted from Cooper et al., 2011, Appendix 1, Bridging Multiple Worlds Toolkit)

Example

Math grades (X)
Science grades (*)

	7F	7S	8F	8S	9F	9S
A		x	*	x		x
B	x*	*		*	x*	
C			x			*
D						
F						

Math grades (X)
Science grades (*)

	7F	7S	8F	8S	9F	9S
A						
B						
C						
D						
F						

“Career Pyramid” Activity.

(Adapted from Dominguez et al., 2011, It’s All About Choices)

I was hoping to talk a little about your future and where you see yourself in the next few years and for your career.

- Do you have any ideas of what you want to be? Write your end goal (what they just stated) at the top of the pyramid on the line Career Goals.

- Go to the bottom of the page, the Last Year or Previous Goals section and consider past goals or accomplishments in high school. (Looking back at this year, what were some accomplishments (in general, DPEA)? What were you proud of? What surprised you? Did your goals change from middle school to high school?)

- Now that they are in the second year of high school, what is their immediate goal? Write it down in This Year’s Goals. (What are you hoping to accomplish this year? What is something you’re excited about trying out or hoping to get done?)

- What are their goals for the next few years? (What do you hope to do by the time high school ends? What are some things you want to accomplish?)

- Finally, what are their long-term goals for Post High School? (Look into your crystal ball and think about after high school. Where do you see yourself? What are you doing? What type of school or work?)

- Ask students to read their goals, beginning from the bottom. (How does the engineering academy relate to your goals. How did you choose that career/what excites you about it?)

- Go to the side of the pyramid to CHALLENGES. Ask “What kinds of things or people might prevent you from reaching your end goal?” Tell them to write their challenges in the space provided to the left of the pyramid.

- Go to RESOURCES. “Now we’re going to look at what can help you reach your end goal. What kinds of things or people help you reach your goal(s)?

- Discuss challenges and resources they might encounter reach their goals (What helps you with these goals? What holds you back or is an obstacle? What do other people think of these goals? What do other people see you doing or encourage you to do?)

Career pyramid