STUDIO: Building capacity for STEM learning and identity for low-income and immigrant youth

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ABSTRACT
In this paper, we describe the STUDIO program as a platform to develop capacity for STEM learning for low income and immigrant youths through a partnership between the University of Washington and Neighborhood House in the High Point neighborhood of Seattle, WA (NH). In its first year of implementation, STUDIO has been a space to innovate on existing youth programs in a wrap-around service organization, as well as a space for undergraduates in a service-learning class at the University of Washington to form practice-linked identities as mentors and STEM practitioners. We discuss what we learned in Year 1 and possible steps ahead for the next year of implementation.

Categories and Subject Descriptors
J.4 SOCIAL AND BEHAVIORAL SCIENCES;

General Terms
Design, Human Factors

Keywords
Tinkering, Making, Mentoring, Identity, Youth Programs, Youth Leadership, STEM Education, Service-Learning

1. INTRODUCTION
In 2014, the University of Washington (UW) and Neighborhood House (NH), a multiservice community-based organization began a research-practice collaboration to provide low income and immigrant middle and high school youth with opportunities to develop interests, identities, and motivation to pursue further STEM learning in an out-of-school setting through tinkering and making activities. There were two distinct features of this collaboration. First, we explored situating a tinkering program at NH, a wrap-around service organization, by building upon existing youth development programs in the High Point neighborhood of West Seattle. Second, this collaboration involved developing mentoring relationships to support youths in STEM. We explore these two key features of the program in this paper.

Our program, STUDIO, joins with a growing network of informal STEM learning efforts that seek to support innovative making and tinkering communities for youths, including underrepresented minorities and girls and providing opportunities for them to engage in making in learning communities that support STEM interests and identities (Martin, 2015; Vossoughi & Bevan, 2014). Similar to Vossoughi & Bevan (2014), we understand tinkering and making from a sociocultural lens. We draw on Vygotsky's (1987) ideas about learning and development, where learning involves the creation, use, and sharing of cultural tools and artifacts and knowledge within rich social and cultural contexts. Thus, tinkering and making are part of everyday life. Making is fundamental to what it means to be human and has a long history that predates our current attention to design, engineering, and computer science. This intentionally broad definition of making inspires us to pay attention to a wider range of practices that youth and their communities bring to our program.

Our work is unique because it builds capacity for STEM learning within Neighborhood House, a backbone organization that provides a wide range of programming for residents of the High Point public housing community, including health and social services, early learning, youth programming, and adult ELL and job training classes. Youth participating in our programming have access to services that meet their varied needs and prepare them to benefit from additional STEM learning time. NH also provides opportunities for the community at large to become more knowledgeable about STEM careers and educational opportunities and more invested in supporting youth to take advantage of these opportunities.

Furthermore, this model is unique because it involves undergraduate mentors from UW from a variety of STEM majors. UW mentors are on-site at NH each week and develop sustained relationships to support the youth in STEM. Research suggests that mentoring and social support from adults can play a powerful role in youths success and identification with STEM (Cooper et al, 2005; Syed, Azmitia, & Cooper, 2011; Syed, Goza, Chemers, & Zurbriggen, 2012). In STUDIO, middle and high school youth work with UW undergraduate mentors from STEM fields to engage in making and tinkering activities in an after school setting on two separate days.

This paper explores how we have aligned best practices in STEM learning and youth development in a cultural context in order to address inequity in traditional STEM learning. Additionally, we will discuss how undergraduate mentors' cultural and STEM identities were developed over the course of the year through direct engagement with the practice of making, alongside a service-learning course and how non-traditional mentor roles have been crucial to the success of the STUDIO program.

2. DEVELOPING CULTURALLY GROUNDED INFORMAL STEM LEARNING WITHIN A YOUTH DEVELOPMENT FRAMEWORK

Neighborhood House is positioned as a local hub of educational and social services for various neighborhoods. The addition of a youth program focused on STEM embodies our sociocultural approach, which emphasizes learning as it takes place through practices in social and local cultural contexts (Herrenkohl & Mertl, 2010). It is a setting in which learning is broadly defined and where emphasis is placed not just on youth programming but on bringing the community together around shared experiences and expectations of success for youth development and college and career readiness (Anderson & Larson, 2009).

Over the course of the year, we have enrolled 22 middle school youth and 18 high school youth. A hundred percent of the youth are youth of color, 95% are immigrant youth, with 60% of them being female.

STUDIO built upon an existing NH youth development and leadership program called Youth Empowered with Leadership Strengths (YELS). Building on this existing foundation, the STUDIO work focused on marrying the ideals of both STEM learning and youth leadership development. We utilize nationally recognized best practices to develop and implement quality youth programs. In our first year of implementation, we emphasized launching a tinkering studio for youth to explore and develop STEM interests and identities. We also sought ways to expand youths' opportunities to learn about the role people of color have played in STEM in the past and present and imagine opportunities for their own participation in the future by providing information and role models for STEM in college and careers.

The STUDIO program utilizes a unique structure in order to better serve those youth and communities that have traditionally been underrepresented in STEM education and careers. Structural barriers such as registration fees, lack of transportation, and lack of pre-requisite STEM learning or interest limit the ability of low-income communities to participate in expanded STEM learning opportunities. Additionally, there are institutional barriers such as problems within the higher education system that keep students of color from completing degrees in STEM (Clewell & de Cohen, 2009, 2011). Students of color are particularly impacted by a lack of opportunities and poor STEM preparation before they apply for and enter college (Basu, Calabrese Barton & Tan, 2011; Moses & Cobb, 2001; NSF, 2010). Consequently, some youth of color neither receive support for careers in STEM, nor gain access to resources that will help them prepare for advanced training in STEM. Some youth may be actively discouraged from pursuing STEM training because STEM careers seem out-of-reach or are poorly understood. Moreover, there is evidence that schools have historically not met the needs of minority students in mathematics and the sciences (Moses & Cobb, 2001), thereby reducing opportunities for career development.

2.1 Aligning STEM Learning to a Local and Cultural Context

While school settings are essential learning environments, schools alone are often unable to address the challenges of access and barriers to opportunity faced by many youth like those served by the Studio program (AfterSchool Alliance, 2011). Parents, peers, and community members are highly influential and help shape the career choices that children from a young age entertain, whether they be in STEM or other areas (Basu & Barton, 2007) Housing the Studio program in a community hub such as Neighborhood House allows for the ability to connect youths' science interests with their family and cultural communities, thereby producing support within these communities for STEM learning and workforce development (Afterschool Alliance, 2011; Banks et al, 2007; Nasir et al, 2006). Additionally, offering these programs at no cost and within the community addresses many of the above stated structural barriers. Youth are able to walk to and from program, there are no registration fees, and there is a relationship with the entire family. Furthermore, youth are allowed to learn in a space that respects their cultural identities and their prior exposure, or lack thereof, to STEM learning. We have also been able to offer stipends for youth who enroll in the program to ensure that they can choose to attend STUDIO instead of work at an afterschool job.

Providing informal STEM learning opportunities outside of school also allows the youth to bring their own interests, ideas, and culture together with scientific tools and processes to making and tinkering (Kafai, 2006; Peppler & Kafai, 2007). Tinkering activities are open-ended and present clear, accessible, and interesting challenges. There is not "one right answer" but multiple pathways through an activity. Youth work at their own pace and control the expression of new ideas and artifacts (Basu et al. 2011; Elmesky, 2005). These features make tinkering especially empowering for people who think that they are not interested in or not able to succeed in STEM (Calabrese Barton & Tan, 2010; Basu & Barton 2007; Elmesky, 2005; Renninger, 2009).

2.2 STEM or Youth Development?

Since the conception of STUDIO, we have been asked if this is a STEM program or a youth development program. Our structure marries the two philosophies, utilizing best practices from both perspectives. It is our firm belief that to reach those youth that have been excluded from STEM learning, the program must also address the other socioemotional skills that are necessary for student success. In order to do this the STUDIO program aligns STEM learning with the David Weikart Center for Youth Program Quality's Youth Program Quality Initiative (YPQI). The YPQI establishes a framework for creating youth programs founded in evidence based best practices. In particular, the STUDIO program focuses on several main criterion including; Building Community and Youth Voice.

STUDIO is relationship based, meaning it is rooted in the intentional development of relationships among the staff, mentors, and participants. Each week staff lead the undergraduate mentors and participants in a community building activity. These activities build upon themselves throughout the semester. Initially, community builders focus on allowing the participants to learn about each other and create trust within the group. An example of this type of activity would be group bingo, where participants have a bingo card with facts about the other participants and they must walk around the room asking each other questions to mark off their bingo boxes. In this way, they are learning about each other while becoming more comfortable talking with one another. As time goes on the community builders become more complex. Participants were asked to join in discussions and reflections around multicultural identity in STEM and college readiness.

Youth voice is an extremely important component of any youth program. Youth must be allowed to have input in programmatic decisions in order to feel ownership over and connection to the program. Without a connection to the program, youth will not fully engage in the activities. The STUDIO program allows for youth voice in many different ways. On a basic level, youth are given choices within each activity. These choices might be content choices, such as what design to use in a wood burning project, or process choices, such as what media to use during final project development. On a more advanced level, youth voice is heard through a constant system of formal and informal feedback from the youth. Youth are asked to informally reflect on the activities as they are happening through written and spoken debrief exercises. An example of this would be asking participants to give a "thumbs up" or "thumbs down" on that day's lesson. Additionally, youth offer formal reflection on the program through various pre and post surveys throughout the year.

We sought to layer on this youth leadership development component to various tinkering activities that makers from The Exploratorium introduced to us at the beginning of the year, namely Marble Machines, Scribbling Machines, and Paper Circuits.

2.3 Moving Forward

With the completion of the pilot year of STUDIO, staff members are currently reflecting upon the successes and challenges we faced. Balancing activity structure with more open-ended activities is a current focus of our work. The NH and UW team is devising new strategies to allow for more independent youth guided work. This will include more youth-initiated project based work in the 2015/2016 school year.

3. DEVELOPING MENTOR STRATEGIES AND PRACTICE-LINKED IDENTITIES THROUGH TINKERING AND REFLECTION

In the academic year 2014–2015, we recruited and retained thirteen mentors from diverse racial and ethnic backgrounds (Asian American, Latino, Indigenous) and seven different STEM fields.

We used a hands-on, direct-mentoring approach with UW mentors and with NH middle and high school students to support all participants to develop interest and motivation in STEM. Mentors participate through a UW service-learning course that provides credit and distribution requirements for an undergraduate major and offers transportation to NH. This course consisted of program time with youth to cultivate strong and supportive relationships that increase NH youths' persistence, interest, and motivation in STEM and their understanding of and access to STEM educational pathways and careers. It also included an hour-long seminar to prepare and reflect work with youth at NH.

During seminars, mentors had the opportunity to reflect on their own cultural and STEM identities and use these as a basis from which to interact with the youth in the tinkering studio at High Point. This in turn also developed their cultural, STEM, and mentoring identities. The combination of the direct mentoring practice alongside a simultaneous seminar produced significant developments of mentor strategies and identities among the University of Washington undergraduates. The development of these strategies thus occurred through engaging in the practice of mentoring, alongside the opportunity to reflect on these practices and identities in the weekly seminars.

In order to better understand and track mentors identity development, we sought to collect and analyze several types of data. First, we collected mentors weekly reflections. Second, we documented discussions in seminars. Third, we collected mentor feedback at the end of the academic year via a paper and pencil survey that asked questions such as "What are the three most important things you've learning this year as a result of participating as a STUDIO mentor?" and "Rate the importance of seminar activities including reviewing weekly youth session plans, reflecting on mentors personal, cultural, and STEM identities in connection to youths, and discussing mentor strategies (i.e. Building relationships, facilitating activities, managing behavior.) We analyzed these data using qualitative and thematic approaches to create portraits to understand mentor experiences and improve our practice in the coming year.

3.1 Changing Mentor Roles in STUDIO

Undergraduate mentors went to Neighborhood House in High Point for two and a half hours each week, and through this time developed mentoring strategies as they interacted with the middle school and high school youth. In some sessions, mentors were assigned fixed groups of 2-4 youths to follow. In other weeks, mentors were randomly assigned to youth mentor groups. During the spring quarter, mentors, along with staff at Neighborhood House, assisted in guiding youth to complete six independent projects related to tinkering and making in health. Some projects included an interactive model of the body, a cooking storybook, a community garden, a health art installation, and a video on physical fitness.

3.2 Developing Strategies and Practice-Linked Identities as Mentors

At STUDIO, mentors developed "practice-linked identities" (Nasir & Hand, 2008), as they engaged in the role of mentoring at NH. Mentors were constantly seeking out strategies to navigate the difficult relationship between "friend" and "facilitator." As they acquired more strategies through the practice of being a mentor to both fixed groups and rotating groups, they developed their own identities as mentors. Furthermore, the undergraduate students used the service-learning seminar to reflect upon their problems of practice while in STUDIO as mentors. They participated in rotating groups that listened to each other's challenges as mentors and then offered specific suggestions and potential strategies that could be used to help develop their mentoring practice and relationship with particular mentees.

Developing mentoring strategies was a central focus of both the undergraduate's work in STUDIO as well as in the service-learning seminar. In a final reflection exercise with the undergraduate class, the majority of the mentors mentioned mentoring strategies as one of the top three things they learned throughout the year. These strategies ranged from the navigation of the mentor relationship with the youth to how to build relationships across cultures.

When the undergraduates were asked if it was "critical," "important," or "not important" to discuss mentoring strategies in class, more than half said it was "critical" and the rest indicated it was "important." As they were developing mentoring strategies in both the practice of being a mentor in STUDIO and discussing them in class, the undergraduates at UW also developed and thickened their identities as mentors (Holland & Lave, 2001).

3.3 Developing Mentor identities alongside Cultural and STEM Identities

In the end-of-year survey evaluation of the service-learning seminar, the second most important aspect of class was "Reflecting on our personal identities." During the seminar, two weeks focused on expressing and sharing the intersection of our cultural identities and STEM identities with each other in the group. Similar to the mentor identities that were being developed as undergraduates, Nasir and Hand's (2008) concept of "practice-linked identities" also extended to the undergraduate's STEM identities.

A mentoring strategy to build initial relationships with the youth, mentioned by several undergraduates was to first begin with our cultural "common ground" through mutual sharing of cultural identities as this student explains.

> *(One of the top three things I've learned is) To find common ground with them as soon as possible with students and staff, more about the demographics & cultures within High Point.*

Discussion and conversation about culture and language were often a point of connection between the UW students and the youth at High Point. This often intersected with the undergraduates' STEM identities as almost all the mentors were either women and/or culturally underrepresented STEM majors. Engaging in making and tinkering activities alongside mentees in an informal setting also served to thicken the undergraduate's STEM identities. Similar to the mentor identities that developed through engaging in its practice, the undergraduates' STEM identities were reinforced by practicing in tinkering activities in STUDIO and developing the STEM identities of their mentees through the mentoring relationship. STUDIO thus saw the intersection of mentor and STEM identities through engaging in both the practice of mentoring and tinkering. Furthermore, the seminar served as another space for the undergraduates to reflect on the development of their personal identities through the course of the year and use the formation of those identities to subsequently create a stance from which to act and interact with the middle and high school youth in STUDIO. One undergraduate explains this cyclical layering of identity in their end-of-year reflection.

> *I've learned: to see STEM in other ways, such as chemical reactions when cooking, to appreciate the support, faith and resources that have brought me thus far, to realize more deeply how essential it is to expose STEM to students at a younger age.*

As they explain, engaging in STUDIO as a STEM major and mentor helped them see STEM in other ways, and also how that made them "realize more deeply how essential it is to expose STEM to students at a younger age" and the implications for their role as a mentor to these youth.

3.4 Steps forwards and blurring the boundaries of Mentor and STEM identities at UW and STUDIO

At the end of spring quarter, two lead mentors developed one of the final projects related to tinkering and making in health, the interactive model of the body. These two undergraduates were biology majors and were able to use their understanding of biology to develop curriculum for the youth at High Point.

In the end-of-year evaluation of the mentor experience, every mentor mentioned the desire to use the undergraduate's background in the various majors (Math, Microbiology, Physics, Computer Science, Biochemistry) as funds of knowledge (Moll, Amanti, Neff & Gonzalez, 1992) that can be tapped on in STUDIO for the development of activities and programs. As we move into the second year of implementation, this is another space where the UW undergraduates' mentor and STEM identities could develop and intertwine in more complex ways in multiple spaces to blur the boundaries of these two learning environments.

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