Learning and Becoming in an After School Program: The Relationship as a Tool for Equity within the Practices of *Making and Tinkering*

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Abstract: El Pueblo Mágico is a social design experiment (Gutierrez & Vossoughi, 2010) in which youth and adults are developing deep and meaningful relationships which facilitate learning that is inclusive, participatory, and robust. This paper focuses on 'Making and Tinkering' practices to examine the relationship that develops as both adults and children engage in the joint activity of making, re-making, and designing artifacts such as 'Squishy Circuits'. Grounded in sociocultural theory, and situated within Nasir's (2012) work, this study draws on a corpus of data that includes weekly observations and interviews over one year, to examine how the M & T activities are socially organized to increase room for feedback, one of the four important aspects of expansive learning contexts (Nasir, 2012). Specifically, I analyze interactions to understand how relationships facilitated by the social organization of the practice of tinkering can be tools in the design of inclusive, equitable learning spaces.

Introduction

Re-Designing for Equity: The Potential of Making and Tinkering

Making & Tinkering (M & T) practices have shown to be a powerful means for engaging and exciting children around Science, Technology, Engineering, and Mathematics (STEM) learning (Resnick and Rosenbaum, 2013; New York Hall of Science, 2010). Because of the playful, imaginative nature of many M & T activities, the traditional notion that 'science is for scientists' begins to dismantle, as children discover that they too can engage in scientific pursuits. M & T environments have recently been lauded not only for their ability to engage children in STEM learning, such as figuring out what materials conduct electricity or how to create a circuit, but also for their reimagining of what learning can look like. M & T practices can open up new spaces for students to develop a sustained engagement with learning processes (Washor and Mojkowski, 2010; Resnick and Rosenbaum, 2013). However, though the idea of 'diverse learners' is invoked in recent M & T publications, the research around what potential M & T practices can have on environments and relationships aimed at creating equity remains lacking. Toward this end, I explore what role M & T can have in one learning context designed for a racially and economically diverse student body and their predominantly White, middle class teacher-figures.

The relationship between teachers and students in classrooms has historically been one of teacher-as-knower and student-as-receiver (Rogoff, 1990). Complicating this hierarchical relationship is the fact that most teachers in the United States are White, middle class women, many of whom have had few, if any, meaningful relationships with students of color before they enter the classroom (Matias, 2013). Alongside these realities is often a 'managerial-like' approach to classroom organization, where teachers see their teaching identities as being heavily intertwined with their ability to control the classroom and transfer their own content knowledge to their students. Considering the grave inequities that continue to pervade the US educational system in what many term as the 'opportunity gap', there is a continued imperative to reconsider this traditional teacher-student relationship and the participation structures of learning environments, especially in light of the changing demographics and the increasing disparity between them (Carter and Welner, 2013).

To address the need for more robust and equitable learning environments, it seems fruitful to re-imagine how classrooms could be organized differently and what design principles could alter the traditional teacher-student power dynamic. The ways in which a learning space is organized is known to have a relationship with one's ability to access and be a participant in that space (Rogoff, 1990). As such, a social practice designed to re-organize the space of learning in ways that encourage everyone to be a valued and active participant seems smart. M & T is an emergent framework for designing learning activity systems that attempts to do just that. Its design principles are governed by the idea that children should be the designers, rather than consumers, of the artifacts with which they interact. M & T practices encourage students to engage in an interest-driven collaborative process of (re)design, (re)production, reflection, and remixing. In the particular activity system for this study, undergraduate students and youth are brought together to engage in new media and tinkering practices that promote learning. The focus on children as designers, complimented by the immediate feedback nature of the activity of Squishy Circuits, is helping the undergrads to foster productive and

more symmetrical partnerships with the youth, often undercutting their initial ideas about how the relationship of adults and children in educational spaces is supposed to look.

Relationships as Tools for More Inclusive Practices of Teaching and Learning

While we know that relationships matter in overcoming normative stereotypes and discrimination (Nasir, 2012), I was curious as to if the 'partner-like' approach of M & T could have the ability to breakdown the power and authority which characterizes traditional teacher-student relations. I argue that the instantiation of M & T practices in educational environments has the potential to engender relationships and identities that are characterized less by the traditional teacher/student power dynamic to which we have become accustomed, and more akin to the valued partnerships known to be crucial to equity oriented social practice (Gutierrez and Vossoughi, 2010). Accordingly, I explore how the social organization of the M & T practice affords four tenets of learning (yet focus specifically on the first): consistent feedback, room for personal contribution, a sense of social belonging, and the availability of multiple roles; all of which combine to produce room for the development of meaningful, alternative relationships.

Theoretical and Methodological Approaches

Conceptualizing Learning and Relationship Processes through Analysis of the Social Organization of *Making and Tinkering* Practices

Recent interest in notions of connected learning (Ito, et al., 2013) have highlighted the importance of engaging youth in practices that are both interest-driven and expand youths' repertoires of practice across settings and institutions, particularly for youth from non-dominant communities. M & T activities provide a context for connecting youths' everyday interest and practices with new forms of activity and participation. Given the significant disconnect between youths' out-of-school and in-school practices, the design of such activities becomes more salient. Within this framework, I analyze how the social organization of M & T affords new forms of engagement and participation between youth and adults working in joint activity.

In M& T, students take ownership over their own learning processes, and the design of the activity facilitates immediate feedback, open exploration, and fluid experimentation (Resnick and Rosenbaum, 2013). M & T activities encourage people to embody the 'maker' spirit and identity during learning-centered activities and to develop a sense of ownership and sustained participation. Furthermore, the "maker movement nurtures communities of practice that bring adults and young people together around common interests" (Washor and Mojkowski, 2010: 1), invoking Nasir's (2012) notion that common interests aid in the development of meaningful joint activity and positive relationships between students and teachers.

Because M & T practices have been conceptualized as tools for fostering increased and sustained engagement among diverse types of youth (Washor and Majkowski, 2010), it seems fruitful to examine how its practices could engender and support greater equity in environments, such as schools, that are producing unequal outcomes. Because we know that teaching and learning are relational, and learning is a social practice that is organized in its context of development (Rogoff, 1990), it is important to investigate the relation between the organization of a learning environment and its effect on relationship building central to learning. To do this, I draw on insights and methods from Nasir (2012) as well as Gutierrez & Vossoughi (2010) to better understand how we can design for equity in learning environments.

Nasir (2012) analyzed how the social organization of the practice in alternative learning spaces such as dominoes and track and field afforded *four* key tenets that she identified as crucial to the creation of equity oriented learning environments: consistent feedback, availability of multiple roles, a sense of social belonging, and room for personal contribution. She found these fours tenets of a practice to be especially salient for children from non-dominant backgrounds in spaces dominated by Whiteness, such as in schools. For the purposes of this paper, I emphasis and explore the tenet of 'consistent feedback', as it reflects, albeit slightly differently, the M & T notion of how 'immediate feedback' from process and product in activity facilitates increased levels of inquiry and engagement in practice.

Taken together, Nasir argued that when spaces are organized in ways that engender these elements, students can develop social and academic identities that build on rather than oppose each other. In looking at the social organization of an activity, she found feedback to be a critical aspect of the practice. Consistent feedback speaks to the availability of critical and supportive feedback from adults in moment-to-moment activity, guidance/assistance when needed, opportunities for observation and modeling, and multiple chances to try again.

The activity of Squishy Circuits, in particular, merits further exploration as the central activity of analysis in this discussion. "Squishy Circuits, developed by AnnMarie Thomas, consist of two kinds of play-doh; one is conductive, the other not. By layering conductive and non-conductive play-doh in different configurations, simple, tangible, 'squishy' circuits can be made and hooked into simple electronics" (LeDuc-

Mills, et al., 2013:618). There are multiple elements of this specific medium of play-doh that lend itself to playful exploration and playful learning without needing certain levels of prerequisite knowledge, both important elements of learning from a sociocultural perspective. Johnson and Thomas note that "these compounds have extremely low entry barriers; anyone can learn from, and enjoy them. The procedures for implementing basic circuits are very simple as well…one can almost immediately start building circuits…This learning tool was especially effective [for improving knowledge about circuits and electricity] among students that, judging from the preliminary test, had almost no pre-existing knowledge of these subjects" (2010:4103). These qualities of the Squish Circuit allow both youth and adults to "jump into the practice", a central design principle of M & T at large and one especially helpful for facilitating co-learning by doing among intergenerational ensembles such as those at EPM.

Johnson and Thomas, in their discussion of Squishy Circuits and Science Education, also point to benefits of Squishy Circuits that are in line with Nasir's social conditions for learning, namely 'personal contribution' and 'social belonging'. "Playful learning and tangible mediums have been shown provide motivation to learn. Students are most involved in learning a topic when it intrigues their own *personal interests*. When students care about their work, they develop a profound understanding of their subject matter…Building circuits with the conductive and non-conductive dough, as well as various electronics components, gives students a *personal experience*, because they are designing their own implementations" (Johnson and Thomas, 2010: 4102-4103, *emphasis mine*). These localized learning experiences with the circuits should moreover be considered as tools to be taken up within the larger issue of lack of representation of diversity in STEM fields. "Research has shown a disconnect, between scientific direction presented in classrooms and students' pursuit of science on their own. By late elementary school many students do not see their efforts outside of the classroom as "science" at all. Playful learning through tangible mediums [e.g., Squishy Circuits] bridges this gap by combining what students learn, and what they do for fun…Using squishy circuits has the potential to bring playful learning methodologies to electronics education" (Johnson and Thomas, 2010: 4102). Johnson and Thomas illustrate the potential power that this particular M & T activity has for engaging students in a practice (and ultimately field) to which they may otherwise have not readily entered, through designing for play and leveraging student interests.

So how do Squishy Circuits serve to help dismantle inequities between traditionally hierarchical relationships in learning activity? My argument is that the social organization of the practice of M & T facilitates room for the transformation of participation structures and the building of meaningful intergenerational relationships in educational settings. From this perspective, instead of receiving knowledge from adults, the children jump right into the practice of creating and re-making, and in doing so, there is more collaboration and less stratification of power among participants (Washor and Mojkowski, 2011; Resnick and Rosenbaum, 2013). Because the child may find a way to light up his circuit before the adult, traditional roles of expert and novice may shift. These elements of the practice produce an alternative type of relationship between the adult and child, one in which all participants become doers and learners, alongside each other. This alternative relationship, I argue, may have the potential to re-mediate traditional teacher-student relations in practice, as well as re-mediate some of the deficit ideologies that teachers from dominant communities may bring to their classrooms of color (Gutierrez, et al., 2009).

Methods

There are many ways to organize learning environments that invite increased participation and positive relationships among teachers and students. However, in my research in this particular historically indexed, equity-oriented social design experiment, I noted particularly interesting practices and processes of relationship building that emerged from the Making and Tinkering activities. I began this research with an emergent interest in relationships and was oriented to the following types of research questions:

1. What are the affordances of the social organization of the activities of *Making and Tinkering* at El Pueblo Magico?

2. In what ways is relationship development between youth and adults shaped by the social organization of the *Making and Tinkering* activities?

These questions are aligned with my guiding curiosities about what power this practice could have on designing for equity. In dismantling the deficit frameworks that novice teachers often bring into the classroom, there seemed to be the potential to facilitate a more partnership-like relationship between adult and child.

Because my research questions are focused on the social practices around learning and becoming within an activity system, I situate my central constructs of learning and becoming within a sociocultural theory of learning that views learning and becoming processes as socially constituted and relationally based. I understand learning and becoming in practice as illustrated by instances of shifts in participation, often signaled

by discourse that reflects a sense of value and identity in the practice. For instance, when the children said things like "Look, I got it to light up, I'm a scientist!" I understood them to be engaging in some form of learning and becoming in practice. In order to get at how relationships are engendered in the M & T activities and environment, my unit of analysis was the social organization of the practice.

The research context for my project was a designed based intervention—an afterschool program *El Pueblo Mágico (EPM),* located in a predominantly Latino suburb of Denver, Colorado. EPM was conceptualized and directed by Professor Kris Gutiérrez, who designed *EPM* based on the principles of the Los Angeles 5th Dimension antecedent, *Las Redes*. *Las Redes*, like *EPM*, involves participants from both the elementary school and the University, to participate in a 'change laboratory' where transformative learning for both the student and the undergraduate is privileged (Gutierrez and Vossoughi, 2010). On each day, there were about thirty children from low income and Latino backgrounds who attended EPM. The CU undergraduates, as part of their Educational Psychology requirement, worked within ensembles of two to six children. The semester's target population of undergrads was primarily female and Caucasian.

I conducted a qualitative study drawing on principles of ethnography, to capture the social practices, specifically within the spaces of Making and Tinkering. I focused my eight field notes on the interactions and discourse among groups who demonstrated engagement over time with two primary M & T activities of 'Squishy Circuits', and in fewer cases, 'Scribbling Machines'. Scribbling Machines activity involves creating a moving drawing machine out of batteries and art materials, employing similar guiding tenets for design as those in Squishy Circuits. These activities served as ideal practices in which to study the affordances of "alternative learning spaces" (Nasir, 2012) supporting relationship development that involve processes of learning and becoming through doing, albeit disguised more informally as collaborative art/game design and play.

In order to investigate the affordances of the social organization of the practice, I focused my note taking on capturing the four tenets of Nasir's framework (social belonging, personal contribution, availability of roles, consistent feedback), as well as the discourse and social interactions among the participants and materials. To capture discourse around identity and relationship development *in situ*, I worked side by side in creating play dough within groups doing Squishy Circuits. After I analyzed and categorized the instances of affordances of social practices of M & T into the four categories, I began to understand the ways in which the M & T environment was lending itself to certain patterns of identity and relationship development. I added another layer of coding to my data based on the M & T design principles framework of Resnick and Rosenbaum (2013), such as 'easy to connect,' 'open exploration,' and 'fluid experimentation,' to examine their relation with Nasir's affordances of alternative learning spaces. I looked for disconfirming evidence as well, of which there were a few instances when the M & T practices engendered the traditional 'teacher as all knower' pedagogical practices and relationships. However, to a greater degree, the learning affordances between how Nasir (2012) conceptualized the practice of dominoes mirrored the learning affordances in Resnick and Rosenbaum's (2013) 'Scratch' Tinkering practice, overlapping in such a way as to confirm the reasoning behind deductively coding the second pass in this way. These analyses suggested that my constructs were appropriate and viable in addressing my topic of interest.

Major Findings, Conclusions, and Implications

Presentation of Findings

In my role as participant observer and interviewer, I documented the ways undergraduate participants discursively framed students. I noted a regularity in the use of phrases like "But this child is a problem, I don't know how else to describe it" or "It's hard for me to imagine what it must be like not to have support at home", or "Things went well today, all the children listened and did what they were supposed to." This seemingly deficit view of the children at *El Pueblo Mágico* was part of the everyday language I noted in this educational setting. As aspiring teachers, many of the undergrads initially talked about children, most of whom are predominantly low income children of color, in ways that positioned themselves as the sole source of knowledge, without an understanding of how children's repertoires of practices were essential to learning (Gutierrez & Rogoff, 2003). However, the organization of designed Squishy Circuits activities of which they were a part afforded new pedagogical and social relations in which undergraduates assumed 'partner-like' approach to teaching and mentorship.

The participation structures of the ecology of El Pueblo and M & T activity generated a range of ways for the undergraduates to mediate children's learning and participation. Specifically, I documented three primary forms of feedback: 1) verbal feedback from the undergraduates in activity; 2) the feedback from the construction and design of the SC; and 3) feedback arising from the joint activity and collaboration with peers. For example, when the children's attempt to make a circuit failed, the undergrads were able to provide feedback to the children in ways that were markedly different from their discourse outside the activity. Their feedback was supplemented by the consistent and immediate feedback nature of the actual Squishy Circuit. Ultimately, the forms of feedback helped to create an environment where the undergraduates could reframe their notions, in

ways that challenged pre-existing views of children from nondominant communities. As a result, new social relations between the undergraduates and the children developed into more collaborative and positive partnerships.

Drawing on Nasir's analytical framework of the four social conditions for learning, I coded the data deductively, seeking instances and examples of feedback, availability of multiple roles, social belonging, and personal contribution (Nasir, 2012). The results are shown below in Table 1. These analyses allowed me to see how the social organization of the practice of M & T was creating an environment in which the youth and adults, as co-learners, co-constructed relationships with the process, products, and participants that led to increased and sustained participation in the learning activities.

Table 1. Instances of the 4 social conditions for learning (Nasir, 2012) in m & t practices across 8 observations and 6 interviews

Feedback	Availability of Multiple Roles	Social Belonging	Personal Contribution
- 22 instances of 'consistent feedback' - 13 instances of 'see the result' - 19 instances of 'see the process'	-35 instances	-33 instances	- 22 instances

However, as the table reveals, the emergence of consistent and immediate feedback (invoking both Nasir and Resnick and Rosenbaum's notion of the potential of feedback) seemed to be especially important to the particular practices of Squishy Circuits (and Scribbling Machines, despite their less prevalent use). To that end, I focused my analysis for this paper on the role that feedback played in helping to transform participation structures in this social design context.

I use the following representative example to illustrate the shift from discourse to practice. Undergraduate Miley described Ericka, a Latina 2nd grader as a really "sweet, obedient girl" (Interview 3, 3.20.13). When asked about what role race and socioeconomic status played in education, she said "they dictate the type of relationship you have with education…because like if your parents didn't go to college you may not be as inclined to go." At one level, Miley's words were reflective of a deficit framework commonly used to talk about allow income non-dominant students. Her discourse also suggests that she may not have viewed Ericka as a likely candidate for college, on the basis of her parents' education. Interestingly, I had specifically sought out Miley for an interview towards the end of the semester because her relationship and practice with Ericka during M & T activities stood out as an exemplary of the affordances of the practice, and highlighted the relationship between activity and mediation. When working together to make Squishy Circuits, as we see below, Miley continually asked Ericka (the child) for guidance in creating the perfect conducting dough, as well as questioned her about how to say things in Spanish.

> Field Note 5, 3.5.13: I positioned myself close to Miley, a blonde undergraduate, and her two Latino youth: Jennifer and Ericka, who were seated on the floor together making insulating play dough. Miley asked: "What do you want to be when you grow up?" to which Ericka says "a princess." Miley tells her that she had also wanted to be a princess. They continue to talk about the princess life, and Miley asks Ericka for help in adding the right amount of water to her dough as hers is too dry. The group next to them is talking about Spanish words for animals. I then hear Miley say, "What Spanish words can you teach me", and Ericka says "P-e-r-r-o"…

It was particularly noteworthy that Miley's discourse shifted significantly in the M & T practices. The collaborative activity of making a Squishy Circuit requires all participants to sit together on the floor, coordinating their activity in ways that positioned them physically at the same level with each other. These practices also invite participants to work in close proximity, distributing their expertise and shared ideas in ways that were more intimate and reflective of a partnership. Moreover, Squishy Circuits is an activity that appeared to foster conversation-in-process in which the participants were able to move from task-based conversation to personal conversation in a fluid and integrated way, allowing for increased potential for relationship building. Lastly, the use of play dough afforded different ways of designing the artifact, providing opportunities to continually repair both discourse and practices. I argue that these elements of the activity helped to created an

environment in which Miley could be expert and novice—a space in which she felt comfortable to ask questions and seek assistance from her youth.

Specifically, the consistent and immediate feedback provided throughout the development of the artifact allow for the learners to engage in "fluid experimentation" (Resnick and Rosenbaum, 2013). This fluid experimentation has been identified as important for youth learning and becoming in practice. Even in the case of a student who had struggled with behavior at EPM (Jose), we see how participation in the M & T activity engendered immediate feedback practices that helped transform one's identity in the practice, and thus one's identity as learner. The below excerpt is illustrative of how children's ability to 'succeed', even briefly, is important for their sense of becoming in the practice.

> Field Note 1, 1.29.13: Jose, a Latino boy who I had worked with last semester, stands close to Lisa as she explains Making and Tinkering activities. He seems uninterested and reticent, as evidenced by the fact that he says "I'd rather be playing video games" while Lisa was giving the two minute introduction speech. After about thirty minutes playing with the Squishy Circuits, however, he says "I'm a genius" when he was able to conduct electricity through a new manipulation of his pepperoni pizza play dough. Many others in his group seem excited and engaged based on their continual touching of the materials and talking with each other and the undergraduates, and their laughing, smiling, and saying things like "See, I'm a genius!"

This example demonstrates a shifting participation in practice (Rogoff, 1990). From a sociocultural theoretical perspective, one's connection and identity in a learning environment are central to one's ability to engage in expansive learning. Jose, I argue, shifts his understanding and engagement in the activity after recognizing his ability to be a valued participant in the practice; aided by the immediate, iterative, and localized feedback nature of the Squishy Circuit. Jose, similar to Jacqueline in the example below, seemed to display a sense of ownership in the activity, thereby increasing his/her proclivity to continue to engage in the learning process (Nasir, 2012).

> From field note 8, 4.5.13: I sit close to Jacqueline, who is creating a butterfly out of the dough. She says that she hopes to light up its eyes. When I get up to see what she is doing and she can't make it light up, she tries various ways to plug in the wires and the batteries. She then says "I'll call you back when it's ready." Jacqueline's undergraduate says to her: "How do you think you made it work the first time?" Paige and Devon, two other kids who are working to light their designs up next to Jacqueline, are also struggling initially either because of battery, LED, or wire issues. A few minutes pass of them talking about previous successful or failed attempts, and then Paige (youth) says "Devon it's so cool-it's so bright because I'm touching it!" Jacqueline then chimes in: "Wait I got it- It's working! It's working, and it's so bright!"

Instead of asking for help, Jacqueline chose to continue to re-make her circuit through repeated instances of trial of error. This room for repair is a necessary social condition for learning (Nasir, 2012), and in this case not only does Jacqueline have the time and space to repair, but she seemed to value this feature of the activity, as she wanted to take charge of this process. When she is finally able to make it light up, she took pride in her success so much so that she called the attention of others to her learning accomplishment.

The opportunity for consistent feedback from peers and mentors, as well as the availability of multiple roles, increased participants' connections to the learning activity. The interaction with Rossdy below highlights how both the actual activity as well as the environment in which it was embedded allowed Rossdy room to negotiate her understanding of the science reasoning behind the functioning of the 'Scribbling Machine'.

> Field Note 4, 2.27.13: When I asked Rossdy what she was thinking about when she was designing her scribbling machine, she said "I was thinking about what was going to work." When she tries out her machine on paper, the propeller spins vigorously but the cup doesn't move on the paper like it is supposed to. She and Jordan talk about why this could be the case, such as because the propeller is too heavy or the pen is bad. I signal to Andrew, a boy seated nearby at the computers with more experience in making Scribbling Machines, to come over and help. He says that we need to change pens before going back to his station. I offer to go get thicker pens and bring them back to Rossdy. The scribbling machine now scribbles around the page in a circular fashion. When I ask Rossdy if she knew that the machine would go in circles when she was making it, she said no. A few moments later, she says, "Maybe it's because it is a circular cup." Another pause… "Or because the propeller spins in a circle".

Without being asked to do, Rossdy proffers a number of possible explanations to why her machine was working better or worse during our exchange. The social organization of the practice was such that she was able

not only have the ready assistance and 'repair' opportunities (Stone and Gutierrez, 2007) of her undergraduate, Jordan, but she was also able to talk through her thinking with Andrew and me, both more 'experienced Tinkerers'. This immediate and localized feedback and room for repair is important for the development her own identity as a learner, in that she had the time and space to learn from others through modeling and to situate herself as competent within the practice. If the experiment had ended with Rossdy's first attempt at making her Scribbling Machine draw, her understanding of motion and battery propelled energy (or simply her enthusiasm for exploration) may have been left wanting.

Because different designs produce different results in the activity of Squishy Circuits, it is difficult for there to be an expert in the practice. There are often unpredictable results, again dismantling the more traditional, recipe-like instruction so common in classrooms. The activity operated in a way that allowed for participants to play different roles at different times. This meant that undergraduates and youth became co-learners in this activity, as they both needed to try out different designs in order to create the brightest or biggest circuits. As the below excerpt from my interview with Miley demonstrates, she herself acknowledges how she did not know the science behind the functioning of the activity.

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Interview with Miley, 3.20.13:

Me: What do you believe to be the affordances/constraints or benefits/obstacles within Tinkering?

Miley: Um, to get them to actually do the projects instead of just making the dough and playing with the dough, cause I think that the appeal of it is that it feels cool on their hands and stuff like that and they like making it because it's like cooking with their families. Ericka has started to like doing that lighting it up even though it was hard, but like when she figured it out and stuff, she liked it.

Me: And what would be like the benefits within that exercise, or the activity?

Miley: Um, if you can get them to give you responses to why the light bulb is lighting up, and understanding the insulating dough and everything like that. I mean remember you asked me yesterday why our circuit was lighting up a certain way, and I was like I don't even know the answer to that!

Miley's responses in regard to the affordances of M & T reflected Nasir's tenets of learning: "to get them to actually do the project" invoked Nasir's 'room for personal contribution', "they like making it because it's like cooking with their families" mirrored Nasir's 'sense of social belong', and "like doing that lighting it up...when she figured it out" demonstrated its ability to provide consistent feedback. These aspects of the Squishy Circuit practice facilitated an environment which had the necessary social conditions for learning (Nasir, 2012). Moreover, the fact that Miley herself is actually unable to position herself as an expert, despite her status as an adult and mentor in the learning activity, highlights the potential power this M & T practice has in transforming participation and engagement structures in classroom-like settings.

Conclusions and Implications

Through Nasir's conceptualization of how the social organization of alternative learning spaces helped to provide necessary social conditions for learning, I found the Squishy Circuits activity to similarly afford four crucial elements for inclusive, participatory learning: consistent feedback and room for repair, the availability of multiple roles, the valuing of personal contribution, and a sense of social belonging among the students. Students' connection to the M & T practice was further facilitated by the expanded opportunities for learning and becoming in practice, and this affected their sustained engagement in the learning activities. Specifically, I argue that the availability of consistent and immediate feedback engendered space for the development of alternative and meaningful connections between the dominant undergraduates and their non-dominant students of color.

The undergraduate's relations with students during M & T activities more closely resembled partnerships, rather than the typical power dynamics often seen in educational environments. In their discourse, the undergraduates demonstrated a managerial, one-sided approach to teaching. Yet during M & T activities, their practice looked very different: they often positioned themselves as novices, engaged in question-asking teaching practices, and easily enacted a mentor/partner-like role with the children. I argue that these different types of relationships were facilitated by the social made available by the instantiation of M & T.

These findings of new learning practices merit further investigation. I argue that alternative relationships are important not only for practices of good teaching and learning, but for designing for learning spaces that embody an equity-oriented lens and the abandonment of racialized identities and deficit pedagogies. Historically marginalized communities may benefit even more from the instantiation of M & T practices, as students from these communities are typically not given access equal amounts of access to higher order material, relational, and ideational resources (Nasir, 2012). The need for more opportunity to engage in meaningful practices should direct us to continue to focus on how to design robust and equitable spaces. The present study

suggests that M & T practices have the potential to foster alternative and positive relationships in educational spaces, with the opportunity to engender new types of participation structures where students and teachers can learn and become in practice, together.

References

Brown, J., Collins, A. and Duguid, P. (2012). Situated cognition and the culture of learning. *Educational Researcher*, *18* (1), 32-42.

Carter, P.L. and Welner, K. G. (Eds.) (2013). *Closing the opportunity gap: What America must do to give every child an even chance.* Oxford.: Oxford University Press.

Cole, M. and Engestrom, Y. (1993). A cultural-historical approach to situated cognition. In G. Salomon (Ed.), *Distributed Cognitions: Ecological and Educational Considerations* (pp. 1-46). New York: Cambridge University Press.

Cooper, C. (2011). *Bridging multiple worlds: Cultures, identities, and pathways to college*. New York: Oxford University Press,

Engestrom, Y. (2004). From design experiments to formal interventions. University of Helsinki, Finland, 1-29.

Gutierrez, K. and Vossoughi, S. (2010). Lifting off the ground to return anew: Mediated praxis, transformative learning, and social design experiments." *Journal on Teacher Education, 61* (102), 110-117.

Gutierrez, K. Morales, P. and Martinez, D. (2009). Re-mediating literacy: Culture, difference, and learning for students from nondominant communities. *Review of Research in Education*, *33* (1), 212-245.

Gutierrez, K. and Rogoff, Barbara (2003). Cultural ways of learning: Individual traits or repertoires of practice. *Educational Researcher,* 32 (5), 19-25.

Ito, M. et al. Hanging Out, Messing Around, and Geeking Out. Cambridge: The MIT Press, 2010.

Johnson, S. and Thomas, A. Squishy circuits: A tangible medium for electronics education. CHI 2010, Work-in-progress. Atlanta, GA, 4099-4104.

LeDuc-Mills, B., Dec, J., and Schimmel, J. (2013). Evaluating accessibility in fabrication tools for children. Proceedings of the 12th International Conference on Interaction Design and Children - IDC '13, New York.

Matias, Cheryl. Keynote Speech at Teachers of Colors and Allies Summit, CU Boulder, October 22, 2013.

Nasir, N. (2012). *Racialized identities: Race and achievement among African American youth*. Stanford: Stanford University Press,

New York Hall of Science. (2010). Proceedings from the "Innovation, Education, and the Maker Movement" Workshop. Accessed through http://www.nysci.org/media/file/MakerFaireReportFinal122310.pdf

Resnick, M. and Rosenbaum, E. (2013). Designing for tinkerability. In Honey, M., & Kanter, D. (eds.), *Design, Make, Play: Growing the Next Generation of STEM Innovators*, pp. 163-181. Routledge.

Rogoff, B. (1990). *Apprenticeship in Thinking: Cognitive Development in Social Context*. Oxford: Oxford University Press, 1990.

Stone, L. and Gutierrez, K. (2007). Problem articulation and the processes of assistance: An activity theoretic view of mediation in game play. *International Journal of Educational Research*, *46* (1-2), 43-56.

Washor, E. and Mojkowski, C. Making their way: Creating a new generation of "Thinkerers". Accessed through http://www.handoc.com/documents/makersymposium.pdf