Challenging STEM Education for All: Making and Tinkering in a Women's Prison
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Abstract: STEM-for-All narratives permeate discourse in education and policy without recognizing the challenges to implementing STEM programming equitably and truly for *all.* This paper examines how theories of *critical making*, *expansive learning*, and *trauma informed pedagogy* coupled with social design experiment methodology can be leveraged to support intergenerational STEM learning for incarcerated women and their children. Drawing on the author's experience attending educative programming in prison, emergent themes on working with hyper-vulnerable populations are discussed and in what ways these themes potentially transfer to other learning spaces.

Introduction

Policymakers and educators often use the rhetoric "STEM for All" and propose initiatives to meet this objective without deeply considering what "for all" entails. For example, recent efforts to support "computer science for all" had former President Obama calling for a "Nation of Makers" to meet the growing workforce demand for STEM workers (State of the Union Address, 2013; Fried & Wetstone, 2014; Smith, 2016). This led to an increase in research and development into making and tinkering practices and maker-spaces, but research is showing that uncritical approaches to making result in makerspaces suffering from a serious lack in age, race, income, and education level (Blikstein, 2013; Dubrov, 2015). While more programming and research is attending to "critical" and "equity-oriented" making (e.g., DiGiacomo & Gutierrez, 2016; Schwartz & Gutiérrez, 2015; Vossoughi, Escudé, Kong, & Hooper, 2013), this paper argues that more work needs to be done to understand how making and tinkering can support STEM learning for hyper-vulnerable populations, if we truly believe in STEM learning for *all.*

In this paper, I describe the initial efforts being made to develop and research making and tinkering activities in a minimum-security women's federal correctional facility. First, I describe the background of the Saint Louis University Prison Program and their efforts to develop rich and meaningful educational opportunities for incarcerated men and women. Then, I provide the theoretical reasoning for *making* as a STEM pedagogical tool and why expanding its capacity to serve hyper-vulnerable populations through trauma-informed pedagogical practices broadens the reach of STEM-for-all. Next, I discuss our methods for engaging in this research through *Social Design Experimentation* (SDE) and how SDE, making practices, and trauma-informed pedagogy align. Given the nascent status of the research, much of the research has yet to occur. However, I present initial findings from ethnographic work conducted with prison program that is informing our future activity and discuss how these findings inform other spaces of STEM learning.

Background

The Saint Louis University (SLU) Prison Program began in 2008 as part of the university's mission to serve their local community and greater humanity by extending the university offerings to state and federal prisons in Missouri and Illinois. The Prison Program offers a variety of programming including an associate's degree for both incarcerated individuals and correctional center staff, college preparatory programming, and the "prison arts and education" program which offers intellectually stimulating educational experiences for incarcerated people, prison staff and community members that foster human connection, and resources for positive self-expression and personal growth. This program has been primarily arts and humanities focused, but both SLU Prison Program and incarcerated men and women have asked to create more robust STEM offerings through the "Inside Out Speaker Series."

The "Inside Out Speaker series" are informal lectures and workshops that last 90 to 120 minutes and are open to all people at the facilities, both inmates and the staff. The work presented here focuses on programming offered to the Federal Correctional Institution in Greenville, Illinois. The facility hosts a medium-security men's prison and a minimum-security women's prison. Guest speakers are invited to present at both facilities. STEM Ecologies of Learning for Families is partnering with the SLU Prison Program to bring STEM-based lectures to the speaker series (for both the men and women) and then conduct a series of making and tinkering workshops with the women only. During these workshops, currently incarcerated women will co-design and co-research making activities and supports to use during a visitation day for a family making event.

The Promise of Making for STEM Learning for Hyper-Vulnerable Populations

Making has a general appeal in learning because of its interest-driven nature and STEM educators in particular have embraced it as promising tool to support STEM learning and creativity (Martin, 2015; Bevan, 2017), develop STEM identities and dispositions (Moore, et al., 2013; Bathgate, Schunn, & Correnti, 2014), and create pathways towards STEM careers (Crowley, et al., 2015). Some even see the reach and potential of making to support broader community change and democratize access to invention and production (Blikstein, 2013; Hatch, 2014; Doughtery, 2016). The ability of making to empower all learners is not without its critics, particularly when maker spaces reproduce the dominant cultural practices of the Silicon Valley technology culture it seeks to emulate (Martin, 2015; Vossoughi, Hooper, & Escude, 2016; Calabrese Barton & Tan, 2017). In response, critical or "equity-oriented" making practices are emerging to recognize how making is present in all communities including those communities historically marginalized from STEM practices (Vossoughi, Hooper, & Escude, 2016) and making activities are being designed to support not only new artifacts but new equitable ways of being for communities (DiGiacomo & Gutierrez, 2016). Thus, educators can build on funds of knowledge (Gonzales, Moll, & Amanti, 2006) to support participants' co-construction of STEM knowledge and expertise (Calabrese Barton & Tan, 2018).

Designers of informal making activities are increasingly leveraging the relationships within families to support learning in theses spaces (e.g., Roque, 2016; Brahms & Crowley, 2016). Learning within families and intergenerational learning has been a routine topic of research in informal STEM learning from environmental education and biology (e.g, Ballantyne, Fien, & Packer, 2001; Zimmerman, 2016) to computing and technology (e.g., DiSalvo, Ried, &

Roshan, 2014; Simpkins, Davis-Kean, & Eccles, 2005) just to name a few examples. Learning theorists recognize the importance of family relations in learning across time and settings (NRC, 2009). Although more research in making and maker spaces is attending to the needs of families from historically marginalized communities (e.g., Peppler & Bender, 2013; Vossoughi, Hooper, & Escude, 2016), and how we can expand social networks for youth and adults through co-making (Calabrese Barton & Tan, 2017), little is known about how best to support learning for hyper-vulnerable populations in these spaces and activities. This research is filling this gap.

Engaging the Hyper-Vulnerable and Broadening STEM-for-All to Recognize Trauma

Decades of research has refuted deficit-oriented framing of youth from non-dominant communities as being "underprepared" or lacking in their ability to be knowledgeable and successful in formal learning contexts (e.g. Calabrese Barton & Tan, 2009; González, Andrade, Civil, & Moll, 2001). Instead, taking an asset-based approach requires recognizing that all learners develop valued repertoires of practice through participation in their communities (Gutiérrez & Rogoff, 2003). This perspective looks for ways to incorporate the often-unrecognized community knowledge, skills, and abilities of marginalized groups into organized learning opportunities (Yosso, 2005), with the goal of bridging these valued everyday practices with traditional disciplinary practices. Research into science learning shows the potential of "hybrid spaces" to integrate students' everyday knowledge into both formal and informal learning environments and position students as doers of science capable and empowered to be problem solvers of their daily lives (Calabrese Barton & Tan, 2009; Rahm, 2008).

This works extends anti-deficit thinking to hyper-vulnerable students and families. Although children with an incarcerated parent have significant risk factors for their health and well-being, for example they have an increased likelihood of living in poverty and experiencing household instability (Philliphs, et al, 2006), they are often thought of from deficit and demeaning perspectives. For example, they are misperceived with no evidence as being more likely to engage in criminal activity than their peers (Raimon, Lee, & Genty 2009). Research into the stigmatization of children with incarcerated parents suggests that processes of stigmatization contribute to adverse outcomes for these children, and that risk factors are complicated and need comprehensive treatment; in any case these children do not need to be "fixed" but rather need greater opportunities for success and leadership (Phillips & Gates, 2011). A similar view is shared by proponents of trauma-informed pedagogy in that all children have strengths and competencies to be built on, and should not be defined by their past trauma (Cole et al., 2009).

The number of Americans affected by incarceration is large, and an even greater number are affected by trauma. More than 2.7 million children in the United States have an incarcerated parent, and approximately 10 million children have experienced parental incarceration at some point in their lives (The Pew Charitable Trusts, 2010; Mauer, Nellis, & Shirmir, 2009). The number of incarcerated people serving long-term prison sentences quintupled between 1980 and 2008 (Siegel, 2011) and the number of women in prison increased by 587% during this time with more than 60% having a child younger than 18 (The Sentencing Project, 2012). Parental incarceration is recognized as an "Adverse Childhood Experience" (ACE), it is distinguished from the other ACEs (e.g, physical abuse, household mental illness, household substance abuse, etc.) in that children experience a unique combination of trauma, shame, and stigma (Hairston,

2007). Thus, we characterize children of incarcerated parents as hyper-vulnerable. By incorporating concepts from trauma-informed pedagogy, this work as an even further reach. Estimates suggest that 1 in 3 children have had an ACE that leads to trauma (Rossen & Hull, 2013) and a Kaiser study found that 2/3 of their respondents reported at least one ACE and over one-fifth of respondents reported three or more (Felitti, 1998).

Principles of trauma informed pedagogy align well with current research in equity oriented making, including recognizing individual's cultural and historical practices, supporting voice and choice, and collaboration (Bath, 2008; Cole, et al., 2013). We plan to incorporate other trauma informed pedagogy principles such as Bath's principle of connection and recognizing the need for participants to feel safe, not only physically and emotionally, but as part of the groups in which they engage (Cole, et al., 2013). Drawing on theories of trauma-informed pedagogy, we recognize the need to incorporate the following principles in our work: physical, emotional, and social safety; trustworthiness and transparency; support and connection; inclusiveness and shared purpose; collaboration; empowerment and voice; intersections of cultural, historical, racial, and gendered identities.

Methodology

This project has two ecological frameworks that reflexively support one another. First, this project is focused on creating a STEM ecology that recognizes both horizontal and vertical movement within STEM activity. Horizontal movement refers to the ways in which everyday practices can be leveraged toward more expansive forms of learning (Engeström, 1987; Gutiérrez & Vossoughi, 2014). Thus, we will examine how incarcerated women can connect their and their children's everyday practices to STEM practices, widening the possibilities for what can be seen as STEM. At the same time, we are interested in how opening the possibility for a range of STEM practices, allows families to take interest in particular STEM activities and support their movement into more focused and deeper learning in particular practices, or the vertical dimension of learning (Engeström, 2003). Second, our project represents an ecology of research. As researchers, we are aware that dominant forms of research often reproduce power-laden relationships between the researcher and "the researched" that need to be interrogated for whom – and with what consequences – the knowledge gained from research is generated (Gutiérrez & Penuel, 2014; Esmonde & Booker, 2016). Therefore, we draw on principles from participatory design research (Bang & Vossoughi, 2016) to acknowledge the expertise of our participants including incarcerated women, STEM professionals, and the researchers. Our ecology of research is a partnership with all involved to "extend the notion of the so called 'expert' to encompass a wider range of stakeholders" (Dimitriadis, 2008). In addition to co-designing the making activities, our participants are also helping to construct and analyze the research data.

We believe the most appropriate way to research how hyper-vulnerable populations are learning is to embrace an anti-deficit approach to research. Building on principles of design-based research (Cobb, et al, 2008; Design-Based Research Collective, 2003), we are engaging in *Social Design Experimentation* (SDE). SDE expands on the collaborative approaches to research found in traditional design-based research to recognize how participants are "designers of their own futures" (Gutierrez & Jurow, 2016, p. 2). SDE is humanist and equity oriented (Gutierrez &

Vossoughi, 2010) in which researchers are designing *with* rather than for. This calls for building relationships that value human agency over intervention (Engestrom, 2011). Particularly for vulnerable populations, we believe the relationships should be built on care and dignity, and are consciousness raising for both researchers and participants (Paris & Winn, 2014). Enlisting incarcerated women as co-researchers is not new (e.g. Fine et al., 2003); however, leveraging the expertise of incarcerated women as makers and mothers is. We will use social design experimentation (SDE) as our primary method because it recognizes the learning happens in complex ecologies and also enables democratizing forms of inquiry (Gutiérrez & Jurow, 2016). An intended outcome is that participants are empowered to organize new futures for themselves and their communities - or in this case families (Gutiérrez & Vossoughi, 2010).

A Vignette from one Speaker Series Event

The following is an attempt by the author to capture the experience of witnessing a Speaker Series event at the correctional facilities. In the spring of 2018, the Greenville Correctional Facility took part in the National Endowment of the Arts Great American Read Program in which the read Haitian-American author Edwige Danticat's memoir *Brother, I'm Dying.* This book chronicles Danticat's father and uncle's emmigration to the United States and her developing sense of self becoming a parent. She participated in SLU's prison speaker series. The author accompanied her to both the men and women's lecture, as well as informally interviewed her about her experience. Several faculty from the SLU Prison Program were also in attendance.

> *The Greenville Federal Correction's Facility is about an hour east of St. Louis in the barren plains of western Illinois. You can see the Facility from the interstate and it is striking in its mundanity. While the men's prison sits behind barbed wire fencing with a guard tower watching from above, the adjacent women's facility is called the "camp" and has the look and feel of a community college. It is an unassuming structure with a bland exterior and colored roof. Once inside, passing through the metal detector feels no different than entering any government building; it is less invasive than your standard TSA screening at the airport. Donald Trump's portrait hangs in the entryway adding to the surrealness of the event.*
>
> *We pass from the main building through a grassy, green courtyard, where women are training service dogs. I inquire about the program and the guard escorting me tells me the prison-service-dog program has been a great success as "many of the women in the program have never known responsibility." We head to the multi-purpose recreation facility. The building has a full-size basketball court; one side has sporting equipment next to elliptical machines and free-weights. The other side has the bleachers extended with a podium, microphone, and speakers. The facility is dated but functional. Edwige Danticat begins giving her lecture over the hum of the fans brought in to circulate the air. I sit in the bleachers beside incarcerated women and take in their appearances. It's hard not for me to compare their jumpsuits to the images I had from the contemporary show "Orange is the New Black." I peccantly wanted to know if they have similar personalities to the characters I had become familiar with, but when they greeted me with a polite but short, "hello, ma'am" I knew they wished to not engage with me.*

Ms. Danticat talks about her experience as a mother and what stories of her family she would like to pass on to her daughter. After Ms. Danticat's evocative talk about her experience as the daughter of Haitian immigrants, the women ask her poignant questions about her past as well as practical questions such as how to become a published author. The women are attentive and engaged; Ms. Danticat is more than obliging.

We travel next door to the men's side of the facility. The lecture is in a medium size room that also served as the chapel for the men. The podium where Ms. Danticat is to speak serves a dual purpose as a lectern. The chairs are in rows in front of Ms. Danticat, a guard sits next to her. Behind the chairs, long rectangular work tables are positioned to separate us from the men; this time those of us who came to listen to the talk are not allowed to sit with inmates. One of the inmates cheerily shakes the hand of the SLU Prison Program Faculty. They clearly know each other intimately (most liking having known each other for some time) but have to be restrained in their interaction.

As men file in, the guards direct them where to sit. I notice when an African-American man is tapped on the shoulder to remove his stocking cap, while sitting right next to him, a man wearing a Muslim kufi made of the same material is ignored. Ms. Danticat shares a different part from her memoir. This time she focuses more on her father and uncle who were political refugees from Haiti. While her father was successful in his pursuit to come to the United States, her uncle died in US immigration custody chained to a hospital bed. It is difficult for me not to think about the current US administration's hard stance on immigration.

When her talk is over, she fields questions by the men. A stocky man, with a shaved head and ominous tattoos raised his hand. He begins by saying, "Thank you for sharing your story of your uncle, I too know what it is like to be chained to your bed in a hospital. I wanted to comment on your father's unwavering faith and I can't wait to meet him in heaven." Upon hearing this, Ms. Danticat's eyes tear, she thanks the man, agrees with his sentiment that her father was a man of faith, and confesses that her tears are because her own faith wavered.

On the ride back to SLU from the prison, I ask the faculty member about the man who shook her hand. She tells me his name, and then says, "he's a lifer." I ask Ms. Danticat why she agreed to give this talk and participate in the program. She tells me that she used to participate in similar programs in Florida. The Florida prisons she worked were deep in the Everglades and an inmate once told her, "here we are the ones behind fences, with the animals looking in on us; how do we not turn into animals ourselves."

Discussion of Themes

The main reason for attending Ms. Danticat's lectures was to determine the feasibility for implementing STEM programming in prison. After witnessing some of the most profound educative moments between the inmates and Ms. Danticat, I realized the only limitations to developing STEM programming are our own minds. Do we believe that incarcerated men and

women “deserve” educational opportunities? I happen to think yes. In order to implement STEM learning opportunities for these populations, the following three themes ought to be addressed: the inherent humanity of all people; building relationships of trust; and recognizing intersectionality.

The Inherent Humanity of All People

For a decade, the SLU Prison Program has believed in providing educative opportunities to incarcerated men and women. Despite any societal transgression, incarcerated individual should not be stripped of their humanity. This has been an easier ask for proponents of humanities-based instruction and the arts. I believe it should be extended to STEM programming as well. The question of “who deserves education” is confronted when you meet a “lifer” who has no chance of parole, but setting this question aside, the women in the minimum-security facility are not in there for more than a few years, if that, on average. These women will return to society and more importantly 80% of them are mothers. Despite any punitive reasons one might have for offering educative opportunities, their children have every right to their full potential.

Building Relationships of Trust

I was struck by multiple things during my experience in the prison. For one, I am rarely if ever referred to as “ma’am.” To me this signaled a deference that would inhibit building a relationship in ways I am used to with other students. More importantly, I was struck by my own attitudes towards others. One might call it *schadenfreude* in that I was curious as to why did these men and women end up here. What made them so different. I asked several of the Prison Program faculty if this was a normal reaction. They told me that it was and that it dissipates over time. As you begin to build relationships through the learning experience, the reasons for being there are inconsequential. One instructor told me, “you would never begin an on-campus class – or any class for that matter – by asking your students to tell you their most embarrassing or shameful life moment. Why would these students be any different?”

Recognizing Intersectionality

Although I do not know for sure, I suspect that the man who asked Ms. Danticat the first question would be classified as a “white supremacist” as he had the markings for it. It was a remarkable exchange to witness his humble confession and her response. Similarly seeing the guard ask one man to remove his hat but not the other, put into focus that these events are experienced very differently depending on your identity markers. Although I am an outsider making these judgments, the guards and other staff are reinforcing how “they” are not like “us.” There is little doubt in my mind that the women training the service guide dogs did in fact know responsibility in their lives, it just may not have looked like that to some of “us.” If we are going to break down the barriers to work with these populations, we will have to account for all the myriad ways of being in the world.

Conclusion

Mass incarceration is a growing problem in the United States and under our current presidential administration it is likely to grow. Current rhetoric of "us" versus "them" is dominating our cultural landscape as we build tent cities to hold migrant families whose actions are misdemeanors and do not warrant such treatment. It is my belief that we need to combat this by engaging in projects that challenge this rhetoric. The theoretical and methodological framing presented in this paper, is our attempt at this. This framing extends to all spaces where dominant ideas regarding disciplinary learning, cognitive agency, and the researcher as epistemic expert are present. If we are interested and committed to designing for learning in a truly equitable manner, as many of the STEM-for-all initiatives claim, then our theories and methods must encompass the possibility for change and empowerment locally as well as distally. In our work, we are attempting to create an equitable design of learning locally for incarcerated women and their children that will extend to other communities more broadly (Gutiérrez & Penuel, 2014). Understanding the foundations for how this is accomplished supports other equity through learning endeavors.

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