Technology as a cultural broker across learning environments

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"The design of any technology must be understood not simply as the construction of a physical artifact to meet a functional specification, but as a process in which relations among people are realized." (Bruce, 1993)

"*It is misleading to divide human actions into "art," "science," or "technology," for the artist has something of the scientist in him, and the engineer of both, and the very meaning of these terms varies with time so that analysis can degenerate into semantics."* (Smith, 1970)

"In similar ways to the Black Panther Party and Black Liberation Radio, resistance has been a motivating factor for musicians in the reconception of technological artifacts, practices, and knowledge. One example of this can be seen with DJs and the act of scratching." (Fouché, 2006)

Introduction

In this paper we report on the first phase of a research project focused on the development of a sound-engineering strand within a larger STEM summer program (Grades 7-12) at University of Washington Tacoma (UWT), the Math Science Leadership program (MSL). What makes this project unique is that we are situating the idea of brokerage in the context of a piece of technology (a portable synthesizer). Making this attribution to a piece of technology inadvertently links us to several schools of thought, e.g., Bourdieu's (1986) notion of cultural capital in an *objectified state*, Rogoff's (2003) concept of cultural tools as well as sociological approaches to the study of technology (e.g., Callon, 2012, Warschauer, 2003). Leveraging the cultural capital of an electronic instrument, the intended goal of the sound-engineering program is to broker existing local social and cultural capital across organizations serving specifically non-dominant youth; hence, the design process for one STEM program in one learning context involves parallel attention to its interconnectivity across multiple community programs, their histories, individuals, cultures and physical spaces. Given the challenges around technology integration nationwide, we believe that informal settings specifically focused on non-dominant youth with their critical attention on sociocultural capital, brokering, families, community contexts and equity, are the places where the most pertinent and deepest integration takes place. Consequently, work in those environments, including the one introduced here, has the potential to inform not only other informal learning environments (i.e., out-of-school settings), but also formal settings in regard to understanding, designing and integrating technologies socially and culturally. Our paper represents a small contribution to scholarship on informal learning and brokerage with the focus on technology integration as a grassroots, sociocultural process connected not only to individual identities and communities, but also to cultural and social capital historically associated with non-dominant groups.

Brokering and the MSL program

The Math Science Leadership Program is a 3-week long summer Science, Technology, Engineering and Math (STEM) program at UWT focused on introducing STEM practices and on building self-efficacy for youth (grades 7-12) traditionally underrepresented in the STEM fields. Over the 13 years since its foundation, the program has been funded through grants, crowdsourcing, and donations. Each grade level is associated with a STEM theme that represents a project that students complete on their own and in collaboration with others (Table 1).

Table 1

Current MSL Program Themes by Grade

GRADE	THEME
7	Explore metrics of health for water, air and soil in Tacoma
8	Work in teams to program robots to solve challenges
9	Design and create video games with Microsoft's Kodu program
10	Use cutting edge forensic science to protect local wildlife
11	Use technology to protect our cyberspace
12	Apply advanced chemistry and build community partnerships to protect local waterways

In addition to the projects they create, students present projects and posters to a panel of experts consisting of UW Tacoma faculty and local content experts in the field (e.g., Kodu's lead developer) as well as to family and community members. Brokering occurs not only in the context of the 3-week long summer program but also through monthly events on the UW Tacoma campus organized by the office of transitional services and attended by former MSL students, family members and guest visits from faculty and community brokers. Besides several school districts and community partners such as the YMCA, Boys & Girls Clubs, the MSL program is connected to the university's office of admissions, career development, and several academic programs such as the Institute of Technology, Interdisciplinary Arts and Sciences and the Education program. Each collaborating entity is a broker in their own right. They provide but are not limited to:

- students (that participate with MSL)
- potential instructor candidates (current UWT students or recent graduates) seeking to work with MSL
- transportation for participants (Boys & Girls Club Members)
- curriculum (provided by or collaborated with faculty/experts)
- chaperones for field trips (big field trips and small)
- professional mentoring and/or expertise (expert panel)
- building access and resources

While we are beginning to understand and evaluate brokerage in terms of human practices (e.g., Barron, Takeuchi & Fithian, 2009; Ching, Santo, Hoadley & Peppler, 2015), as curriculum designers and youth project developers we also see a need for thinking about and identifying technologies that broker. Based on what we learned so far in examining the relationship between technology and community, this appears to be a two-part approach: examining technology (1) in terms of sociocultural capital and history relative to a group of interest (in our case, youth of color) and (2) the design of a particular technology (i.e., its aesthetic qualities as a material object, ease of function, its capacity as an identity resource, cultural and social tool). We hypothesize that though both can exist independent of each other, i.e., we can have technologies that are culturally relevant but have weak design or technologies with a strong design and superficial cultural capital, it is when the two components are strong together that they have the biggest impact in terms of brokerage.

Material, conceptual and identity resources

Despite its prominence as a symbol of modernism and progress (Misa, 2003), after brief scrutiny, one realizes that the term, technology, is multilayered, complex, ideological (e.g., Mahvunga, 2014), and thus ought to be viewed with caution. We approach our project with the assumption that technology is neither autonomous nor its design value free or acultural, but that technology (i.e., its design, use and manipulation) is both social and historical (Rogoff, 2003, p.276), sociality and history existing on small and large scales, from local communities and local history to larger social movements and national history. Therefore, technology use and integration exist simultaneously at the individual, community and cultural level as well as more specifically within a historical and political context. Much of technology's brokering capital rests on the strength of its connections across all levels.

The synthesizer project has its origins in early discussions between several programs that work with youth who are historically underrepresented in STEM fields. These roundtable exchanges focused on sharing criteria for deciding on a project, in particular what tools/technology could be used, connections to STEM practices and how to assess the impact of a project. It became clear that tools/technology for organizations and for the youth they serve play a fundamental role for these programs in that they are viewed as central to representing STEM practices and programs. Given the myriad of options, the group as a whole agreed that there is a need for defining criteria to guide choices in finding quality tools to create a high quality curriculum, again placing technology as a central component for the programs.

Over the last few years since those meetings, our research drew us closer to defining criteria and tools that both reflect (1) designed aesthetic attention (e.g., the perceived affordances of a technology such as how well it is constructed, how well it sounds or how it feels to the touch, Norman, 1993) and (2) serve as cultural and *material identity resources* for youth (Cote & Levine, 2002; DeNora, 1994; Nasir & Cooks, 2009) and their communities. Thus, we understand technology as situated in a larger sociocultural context and as such arriving with social and cultural capital and particular affordances for individuals and groups as well as the potential for marginalization (Mahvunga, 2014). The sociocultural capital and affordances can be viewed as *natural and intentional* (Tomasello, 1999) components of a technology, *intentional* referring to the culturally and historically transmitted understanding of cultural artifacts, *natural* to the affordances an artifact may have, e.g., an object's portability. Both are viewed as important in this context contributing to a technology's brokerage. Together, the perceived affordance (Norman, 1993) of the material design and the cultural capital of a technology such as a musical instrument, contribute to brokering as cultural artifacts in their dual "ideal (conceptual) and material" manifestation (Cole, 1996).

Connections between music technology, brokering potential and non-dominant youth

The definition of the term, technology, and by association engineering, is often problematic and divisive (Marx, 2010; Schatzberg, 2006), frequently impacting marginalized, non-dominant groups and their practices. We aim to broaden the term to include cultural practices and tools such as breakdancing, sampling, turntable scratching, graffiti, and DJing, practices that play an important role for non-dominant youth. As indicated above, we are learning to identify technologies based on their cultural/social capital and design, in our case, a portable synthesizer with specific current and historical roots connected to diverse communities, many of which are non-dominant, e.g., sound engineering, electronica, DJ, turntablist, musician, artist and designer communities. We view these roots are a fundamental component of a technology's brokering potential. Specifically, what helped us guide our project design was not only our understanding of learning as a social process, but also the seamless interconnection between the cultural and the material (i.e., technological and social artifacts, Cole, 1996, p.121; Rogoff, 2003, p.274), their specific embodied values, culture, interests and politics (Tiles & Oberdiek, 1995). It is the understanding of technology as situated in complex idiosyncratic sociocultural, historical, political and economical contexts, all of which impact non-dominant youth, families and communities. In the context of music and technology, Taylor (2001) traces the interconnections this way,

> Whatever music technology is, it is not one thing alone. It is not separate from the social groups that use it; it is not separate from the individuals who use it; it is not separate from the social groups and individuals who invented it, tested it, marketed it, distributed it, sold it, repaired it, listened to it, bought it, or revived it. (p.7)

Viewing technology integration as connected to design, cultural capital and history, we understand that historically non-dominant and marginalized groups are linked to the creation of electronic music as a form of communication, activism, personal and cultural expression—more accurately through highly inventive, counterhegemonic approaches to technology (Fouché, 2003)—and one of its most successful instruments, the synthesizer (Pinch & Bijsterveld, 2003). Throughout this paper, we are suggesting that the strength of these conceptual, sociocultural and material links (i.e., their alignment with a community) determines the brokering potential of a technology. The technology we selected serves not only as a vehicle for learning STEM practices but equally as a tool to affirm agency and identity to broker relationships between people and the knowledge underlying the history of the technology. Moreover, we are learning that the commonly made distinctions between engineering and artistic practices lead to particular choices of technologies and the continued marginalization of those groups that are at the fringes of these categories or simply do not fit a Western, dominant views of science, engineering and technology (Mahvunga, 2014; Medin & Bang, 2014). Breaking them apart means in the best-case scenario losing existing connections, in the worst, privileging one over the other. Examining the relationship between African American cultural practices and technology, Rose (1994) writes that, "…rap music is a technological form that relies on the reformulation of recorded sound in conjunction with rhymed lyrics to create its distinctive sound. Rappers bring black cultural priorities to bear on advanced technology. Rappers also bring black oral practices into the technological mix" (p. 85). She concludes, " Rap technicians employ digital technology as instruments, revising black musical styles and priorities through the manipulation of technology." (p. 96).

Because of the sociocultural capital of specific music instruments, their capacity as a material identity resource (Nasir & Cooks, 2009) and resulting connectivity, our initial conclusions lead us to think that especially technologies connected to cultural capital—in particular those with a history of empowerment and resistance—can be seen as brokers for non-dominant youth. As argued here, we believe that technology design plays an essential role in promoting or hindering its brokering capacity.

Designing and brokering

"Indeed, in my eyes indifference towards people and the lives they lead is the only sin a designer can commit. Design that does justice to the intended function comes about from the intensive, comprehensive, patient and thoughtful examination of life, the needs, wishes and feelings of people." (Klemp, 2012)

The main ideas addressed in this paper center around the design of a technology and a program that represents and extends the notion of STEM practices beyond its own physical and conceptual boundaries, organizational structure and environment (the university setting), i.e., with the capacity to connect and adapt to other organizational structures in the community (i.e., out-of-university settings) that serve underserved youth. Furthermore, we described technology as connected to sociocultural and historical aspects of human life, its design possibilities marginalizing but also empowering non-dominant groups. We suggested throughout that the design of a technology being a social and cultural endeavor matters to its function as a brokering tool. Just like high quality brokering is associated with specific practices and qualities of social agents (e.g, Ching, Santo, Hoadley & Peppler, 2015), technology that brokers, i.e., cultural capital in an *objectified state* (Bourdieu, 1986) requires a set of criteria to be considered a high quality broker.

Thus, we return to the importance of design, i.e., the "good design" we are seeking to define, which influenced our initial choice in selecting the synthesizer as a brokering instrument. The preceding statement raises immediately three questions: (1) What is design, (2) how do we qualify good design and (3) what is its impact on technologies that broker? We define design as a plan for a project (or an intervention) but also in the case of the synthesizer, the end product comprising the synthesis of multiple elements such as form, color, material and construction. Design is a term that refers to the interaction between conceptual, aesthetic and material elements. The process that leads to good design is one of problem solving, functionality being at the center of good design (Rams, 1976). A set of theses on design that in part shape our thinking around qualifying technology for functionality and aesthetics is the one offered by Rams (1987). By aesthetics, we mean the appearance of an object and how it complements its functionality but also the aesthetic pleasure we might get from viewing or using an object. For instance, the perceived affordance of the synthesizer to turn a crank is simultaneously pleasurable to a musician for its visual, haptic and auditory feedback designed into the synthesizer.

Dieter Rams is considered one of the most influential living industrial designers. His work spans the last 60 years and continues to influence new generations of designers as well as the look and feel of mobile technology today (Klemp, 2012). Rams developed a set of design theses (*Thesen* is commonly translated from German as "principles". We prefer theses as they capture their non-dogmatic quality that Rams wanted to communicate) over a period of almost two decades (Table 2). In part, this list informs our thinking around what makes good design, a view that is mainly aligned with functionalist ideals of design, i.e., with a design aesthetic of objects that is on the surface simple, unadorned, and clear.

Table 2

Dieter Rams' Ten Theses of Good Design

01. Good design is innovative
02. Good design makes a product useful
03. Good design is aesthetic
04. Good design makes a product understandable
05. Good design is unobtrusive
06. Good design is honest
07. Good design is long-lasting
08. Good design is thorough down to the last detail
09. Good design is environmentally-friendly
10. Good design is as little design as possible

While these theses have been created in the context of product design, they are not direct guidelines for what a product (e.g., technology) will or should look like. Rather they comprise an ethical framework of how to approach design. At the same time what is missing is the sociocultural context, i.e., attention to specificity and intentionality of which we as curriculum designers have to be aware, especially those who work to support non-dominant youth. Cultural capital and brokerage of the technology as stated across the paper resides in a larger social network connected to it, such as in this technology's reputation (and status) amongst professional musicians and its specific cultural links with marginalized groups (e.g., its ability to sample directly from a built-in radio, Katz, 2010). We suggest that its social capital is not only due to its powerful functionality—it is a combination of tools in one small piece of technology, i.e., a synthesizer, a sampler, sequencer, 4-track, beat-machine— and its reputation, but also due to its aesthetic design that echoes Rams' theses and design work. For Rams, aesthetic design and usefulness are integral. Moreover, evaluating the aesthetic quality (thesis # 03), according to Rams, requires visual expertise:

> However it has always been difficult to talk about anything visual since words have a different meaning for different people. Secondly, aesthetic quality deals with details, subtle shades, harmony and the equilibrium of a whole variety of visual elements. A good eye is required, schooled by years and years of experience, in order to be able to draw the right conclusions. (Rams, 1995, p.6)

Undoubtedly, the design and functionality of the synthesizer is also inherently linked to its cultural function. Its innovation lies in its size and combination of tools made available in one small artifact. The size and design of the instruments hide its status and power as a professional music instrument, making it an unobtrusive, accessible, and a reliable broker (the equivalent of a trustworthy human broker). The synthesizer allows for individual expression as well as collaboration (connecting synthesizers to one another) or sharing of sound samples (patches) to be used by others. Thus, social brokering also means thinking about mobility and connectivity related to technological tools, brokering being supported by easy transport to move tools across contexts, environments and between individuals.

Conclusion

Historically, instruments and musicians straddle the fuzzy lines between art, science and technology (Pinch & Bijsterveld, 2004; Smith, 1970). We suggest that individuals who engage with electronic music and electronic instruments de facto engage directly in STEM, physics and engineering, without having to frame it in the context of STEAM, i.e., STEM + art/design. Importantly, we do not consider brokering technology as described in this article simply a tool for learning engineering concepts or for learning physics of sound, a STEM tool in a STEM program. Our interest and work is with non-dominant youth, marginalization and social equity. Brokering is an essential aspect of our work. It is multifaceted and complicated. What we tried to demonstrate in this article is that brokering might require different agents including cultural tools linked to cultural practices of non-dominant populations. In our context, this also means recognizing science and engineering in historically non-dominant settings and practices. Katz (2010) provides an example of the persistence, development and expression of cultural tools in a historically marginalized culture. Analyzing the interactions between technology and music, he describes the practice of sampling as the continuation of "the predigital, prephonographic practice of signifying that arose in the African American community" (p. 164). In this paper, we tried to draw attention to the identification of such unique technologies and their sociocultural capital, i.e., technologies that can take on the role of a broker. Defining that role for a piece of technology requires individuals who work with traditionally disenfranchised youth to be aware of a technology's sociocultural and historical capital as well as the quality of material design that aides in brokering its capital.

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