Urban Education
48(5) 705–733
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DOI: 10.1177/0042085913490555
uex.sagepub.com
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Repatriating Indigenous Technologies in an Urban Indian Community

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Abstract

Indigenous people are significantly underrepresented in the fields of science, technology, engineering and math (STEM). The solution to this problem requires a more robust lens than representation or access alone. Specifically, it will require careful consideration of the ecological contexts of Indigenous school age youth, of which more than 70% live in urban communities (National Urban Indian Family Coalition, 2008). This article reports emergent design principles derived from a community-based design research project. These emergent principles focus on the conceptualization and uses of technology in science learning environments designed for urban Indigenous youth. In order to strengthen learning environments for urban Indigenous youth, it is necessary, we argue, that scholars and educators take seriously the ways in which culture mediates relationships with, conceptions of, and innovations in technology and technologically related disciplines. Recognizing these relationships will inform the subsequent implications for learning environments.

Keywords

Indigenous youth, urban Indians, design research, technology

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The role of technologies in learning and learning environments is increasingly a focus toward and a hope for more equitable and transformative learning, particularly for students from nondominant communities whose use and skill with new medias has rapidly increased. However, scholars have argued that learning technologies designed for underrepresented communities have yet to create effective ways for learners to be more than technological consumers and transition into becoming makers of technology (Warschauer & Matuchniak, 2010). Further, the demands of informed citizenship, the workforce, and navigation of technologically saturated communities increasingly requires competent use of and understanding of technologies. While there is an overall paucity of research on these issues with Indigenous youth and communities, the work that does exist has similarly suggested that it is necessary for Indigenous communities to be engaged not only as the users but also the architects of technologies (e.g., Prins, 2002).

In this article we explore the intersections of culture, technology, and learning in the context of an after-school learning environment in an urban Indigenous community developed through design based research methods. In this after-school program, youth and adults created new technologies and learned complex scientific subject matter through culturally based programming. We present findings from a retrospective analysis of the design of this program and argue that learning environments must build from sociocultural contexts and expansive views of technology and learning (Engeström, 1999) that mobilize community-based knowledges with the goal of effectively and sustainably engaging Indigenous youth and communities.

Much of the research to date concerning technology and Indigenous peoples' has focused on issues of access and dissemination of technologies (e.g., Chakraborty & Bosman, 2002; Ortiz & HeavyRunner, 2003), issues of sovereignty and intellectual property rights in relation to digital information (Nayyer, 2002; Biolosi, 2008), and underrepresentation in technologically related fields (Bissell, 2004; Davis & Trebian, 2001; NSF, 2011; O'Donnell et al., 2003; Varma, 2009a, 2009b). While this work is important, research needs to reach beyond discourses of access, dissemination, and standard achievement toward expansive views of technologies and learning to enable deeper consideration of the ways in which culture and sociohistorical context mediates relationships with knowledge, the roles of technology in knowledge construction, and the use of technologies in learning.

Furthermore, in order to create teaching and learning environments that successfully improve learning for Indigenous students and contribute to the well-being of Indigenous communities, scholars must attend to the multiple geographies and lived realities of contemporary Indigenous peoples. Achievement research and discourse about Indigenous learners, of which

learning and technology are a part of, explicitly or implicitly assumes that these learners are rural and reservation based, when in actuality more than 70% of Indigenous school age youth live in urban communities (NUIFC, 2008). Understanding these lived realities requires rigorous engagement with the sociohistorical contexts that are embedded in and shape Indigenous learners and communities contemporary relationships with technology.

Historically, Western modern forms of science and technology have been used to colonize and dominate Indigenous communities in North America (e.g., Deloria, 1999; Tsosie, 2012). The legacies and artifacts of colonial technologies continue to be present in Indian country in various forms. Some scholars have suggested that technology-based efforts in Indigenous communities can continue to implicitly or explicitly serve hegemonic functions (Salazar, 2007). For example, scholars have explored the ways in which Indigenous peoples are perceived and constructed as being antitechnological often in the service of legitimizing imposed development and use of new technologies (e.g., Deloria, 1999; Varma, 2009b). Other research has reported that tribal representatives have expressed both a desire to increase youths access to the latest technologies as well as a need to protect youth from technology that reflects intrinsic cultural biases and may facilitate movement of Indigenous youth away from their culture and communities (Gordon, Gordon, & Dorr, 2003; Matthewson, 1994; Robbins, 2007; Thaman, 1997; Va'a, 1997; Wah, 1997). In addition, some scholars have suggested that digital media is just a form of capitalism (digital capitalism) and is recreating and further entrenching some of the same social disparities created by other material resources (Becker & Delgado, 1998; Delgado, 2003; Forte, 2002; Hernandez & Calcagno, 2003; Monasterios, 2003; Pilco, 2000; Salazar, 2007). These findings, we suggest, serve as evidence that Indigenous communities are grappling with historically determined narratives and paradigms in which technology is defined by Western societies.

However, this history and perspective is not complete. Considering issues of technology in Indigenous communities from an expansive lens—one which views technologies as tools—makes visible the ways in which communities have been developing and using technologies from time immemorial and have historically been skilled at adopting and incorporating useful technologies developed outside of their particular nations (Cajete, 1999; Deloria, 1999; James, 2006; Kawagley, 1995). Despite the ways that some technologies have served to recreate historical marginalization in new forms, a number of Indigenous communities are reclaiming and repurposing digital technologies and other forms of technology toward meaningful community-driven goals (Hermes et. al, 2012; Salazar, 2007).These innovations have ranged from remediating public representations of Indigenous peoples, to

new forms of social services, innovations in energy production,and more recently, toward cultural and linguistic revitalization. For example, in the context of museums in which representations of Indigenous peoples have long been problematic, information and communication technologies (ICT) have enabled self-authoring and significantly transformed these public representations (e.g., Srinivasan, 2005, 2006a). In addition, several studies have suggested that Indigenous peoples are utilizing ICT to focus on the development of online communities and interfaces to tell stories and construct representations of self (i.e., Iseke-Barnes & Danard, 2007; Levy & Storeng, 2007; McLoughlin, 1999). Further, communities have been developing innovative uses of wireless access for intercultural dialogue, political mobilization, and action related to civil and human rights issues (e.g., Minana, 2007). In short, tribal communities are increasingly asserting their right to self-determination and are innovating with technologies to assert this right (e.g., Ginsburg, 2002; Srinivasan, 2006b).

The increasing utilization of technologies for meaningful community driven goals reflects an important shift from use of technologies singularly for representation and communication toward new innovations of technologies as authoring tools. For example, communities are developing green energy technologies and practices (Carrasco & Acker, 2002), remote health care services and telemedicine (e.g. Becker et al., 2004; DeCourtney et al., 2003; Kokesh et al., 2011; Sequist et al., 2005), and new educational materials focused on simulations and traditional practices (Eglash, 2007; Inglebret, Banks, Pavel, Friedlander, & Stone, 2007; Neal et al., 2007; Robins, 2007). Language revitalization efforts[1] serve as a particularly robust context in which new technologies and new medias are being used toward critical community goals (Auld, 2007b; Bernard, 1992; Bowers, 1998; Hermes et al., 2012; Holton et al., 2007; Keegan, 2007; McKenny, Hughes, & Arposia, 2007; Warschauer, 1998, 1999, 2000). These bodies of research demonstrate that when technology, culture, and sociohistoric context are appropriately intertwined, movements toward transformative praxis and the development of new knowledges emerge.

In this article, we argue that in order to develop similarly dynamic learning environments with Indigenous learners, we must engage with expansive views of technology and learning based in cultural and sociohistoric contexts. While many Indigenous youth are no doubt savvy technology users, we argue that this shift is critical in order to increase Indigenous students' creative innovation with technologies. In doing so, technologies are dislodged from colonial legacies that implicitly or explicitly position technologies as having only Western-European ontologies. This shift ensures learning environments no longer position Indigenous learners to be challenged border crossers

(Aikenhead, 1996) or create issues with ethnic and academic identities (Nasir & Saxe, 2003) for learners.

Theoretical Framework: Theories of Culture in Learning

Central to this work are the ways in which core understandings of culture are constructed. Increasingly scholars are conceptualizing culture as the routine practices in which individuals and communities engage, rather than "box models" of culture defined by categorical membership and tendencies to essentialize behaviors and beliefs of individuals assigned to such categories (Gutiérrez & Rogoff, 2003; Lee, Spencer, & Harpalani, 2003; Moll & Gonzalez, 2004; Nasir et al., 2006). This understanding of culture implies that there is no cultureless or "neutral" perspective any more than a photograph or painting could be without perspective. Sometimes these perspectives are explicit, but they are often implicit in practices, goals, and representations. In this sense, everything is cultured (Rogoff, 2003), including the ways in which schools are organized and education is implemented (Lipka, 1998; Warren et al., 2001), the layout of museums (Bitgood, 1993; Duensing, 2006), scientific practices and the practices associated with teaching science in school (Warren & Rosebery, 2004), and the constructions and uses of technology (Salazar, 2007).

This framework of culture is increasingly being articulated in relation to technologies specifically. Salazar (2007) encourages us to "consider indigenous media as a socio-technical system of relations where technology becomes a cultural construction appropriated according to relevant cultural codes and social relations" (p. 3, digital books). Increasingly we will need to understand how technologies come into being—that is how they are both a process and a product of culture with their own logic (Salazar, 2007). In short, scholars need to examine the complex relationship between Western and Indigenous knowledge systems in the creation of digital technologies (i.e., Hennesey & Moore, 2007; Rodríguez & Eli Gazi, 2007; Salazar, 2007). We agree, and suggest, that parallel processes can and need to unfold in a variety of technologically related domains not just in digital ICT mediums. Eglash (2002) points out that the role of Indigenous code and computation in the Americas (e.g., Code Talkers in WWII) has remained relatively underexamined, at least in relation to education and technology and that further work is necessary to make sense of the variety of relationships between computational thinking in Western knowledge systems and Indigenous knowledge systems.

As we increasingly grapple with issues of learning and technology, we will need to understand the inherent cultural and epistemological underpinnings of

what counts as "information" and knowledge in STEM fields and Indigenous knowledge systems (for ICT specifically see Christen, 2006; Leclair & Warren, 2007; Srinivasan, 2006b). As Yazzie-Burkhart (2004) asserts, "in Indigenous paradigms the idea that because something can be known does not mean it should be known stands counter to western knowledge traditions" (p.18). "Information" in Indigenous communities is not facts to be known; information or knowledge is the experiences of communities, and thus along with knowing comes responsibilities shaped by complex systems of kinship, age, and gender, among other social dimensions (Srinivasan, 2006a). From this perspective "technophobic" and access explanations (or lack there of) minimize the epistemic complexities of information and knowledge in ways that may enable technological hegemony (Srinivasan et al., 2010). Constructing effective learning environments will require that Indigenous technologies and knowledge systems be engaged, valued, and nurtured, rather than submerged by dominant paradigms that fail to see cultural variability in origins and architecture of technologies and of knowledge systems (Cajete, 1999; Deloria, 1999; Dyson, Hendricks, & Grant, 2007; Ingold, 2000, 2010; Kawagley, 1995; Salazar, 2007; Srinivasan et al., 2010).

Our project did not set out to be centrally focused on technology and learning, but our design methodologies enabled retrospective analysis about the ways in which designers, teachers, and youth developed new relationships and forms of engagement with technologies beyond digital mediums; we call these developments *processes of repatriation*. Repatriation generically means the bringing or calling back of someone or something to its origins. Within Indigenous communities repatriating cultural objects and human remains have been the focus of significant legal and anthropological efforts.[2] To understand how the repatriation of technologies was achieved in the context of our design research project, we explored the dimensions and dynamics that emerged and restored conceptions of technology to Indigenous paradigms. Central to this process was the engagement with what we call "original technologies"—or those technologies which community members saw and knew as deeply situated within Indigenous communities and tended to be placed in the contexts of origin stories and narratives of tribal communities (see Cajete, 1999; Kawagley, 1995 for further review).

We present findings that suggest engaging with original technologies opened the conceptual space for technologies to be seen from long views of sociohistorical contexts. This sociohistorical repositioning enabled innovative teaching and learning with Indigenous knowledge systems and supported project participants to reconceptualize or repatriate technology into becoming makers of technology rather than just consumers. In other words, project participants shifted their views of technology and technology-related domains

as being derived, developed, and adopted from non-Indigenous communities to conceptions of technology as rooted in both contemporary and historic Indigenous practices and tools for knowledge-making practices toward meaningful goals. We report the processes of repatriation to Indigenous perspectives in the context of this project and suggest some design principles for future learning environments with Indigenous youth.

Methods: Design Research as a Tool in Decolonization

Our larger research project aimed to engage in decolonizing methodologies (Tuhiwai Smith, 1999) using various methodological tools and making adaptations when necessary. One such tool and adaptation was with *design research*. "Design research" is an interactive process driven by goals of progressive refinement of both theory and practice (Brown, 1992; Collins et al., 2004; Design Based Research Collaborative, 2003). This methodology enables researchers to contextualize theoretical questions about learning within people's everyday lives (Collins, Joseph, & Bielaczyc, 2004) and is the cornerstone methodology of the learning sciences. Design research is in many ways a mixed-methods approach to studying learning and teaching and was developed in recognition of the complexity of creating robust, effective learning environments (Bell, 2004; Brown, 1992). Further, in many complex interventions while we have good measures of impact, precise understandings of why, how, or when interventions have impacts are impossible to discern from many methodologies (Design Based Research Collective, 2003; Shavelson et al, 2003). Design research enables robust inquiry into a variety of factors affecting the intervention—from the development of the intervention to the completion of its implementation.

According to Edelson (2002), "[d]esign is a sequence of decisions made to balance goals and constraints . . . These are decisions about (a) how the design process will proceed, (b) what needs and opportunities the design will address, and (c) what form the resulting design will take" (p. 108). However, Confrey (2005) argues that decision makers are not typically drawn from students' communities and the learning sciences have had little to say about issues of power and equity in design processes. Heading this call, we have worked to make explicit the position and power of decision makers as well as potential opportunities to reconfigure aspects of design toward equity. As an initial step in retooling design research, we engaged a broad range of community members as the key decisions makers in the design of learning environments and their enactment. We refer to this process as *community-based design research* (CBDR; See Bang et al., 2010 for more details). CBDR

draws on design research methodologies as well as community-based participatory action research (Hermes, 1999; Tuck, 2012). The intent of using CBDR as a tool is to support community members in reclaiming the classroom level of teaching and learning for Indigenous children (Tuhiwai Smith, 1999).

Indigenous scholars have suggested that moving toward self-determination[3] requires the reclaiming, uncovering, and reinventing of our theoretical understandings and pedagogical best practices (e.g., Bang, 2009; Battiste, 2002; Smith et al., 2002; Tippeconnic III, 1999). Design work, from our view, affords community the autonomy to work through the intergenerational trauma (Duran, Duran, & Yellow Horse Brave Heart, 1998) that has defined our experiences with formal education and helps us to better understand the "complexity, contradiction and the self-determination of lived lives" (Tuck, 2009, p. 416). We further suggest that the design of learning environments that involve technologies engages community members from stances of being architects or engineers. Architecting technologies opens the necessary space for Indigenous approaches to the development of technologies broadly (Prins, 2002; Srinivasan, 2006b) and we suggest developing culturally based learning technologies and environments in which technology is embedded in routine engagement from places of equity and empowerment.

Study Context

This study occurred in the context of a community-based science learning environment serving middle school students in the Chicago American Indian community developed using community-based design research methodologies (see Bang et al., 2010). The project was part of larger community efforts to ensure the vitality and health of urban Indigenous youth and their families. Chicago is among the largest and oldest urban Indian communities in the United States, with approximately 40,000 Native Americans living in Cook County. The Native community in Chicago is tribally diverse and the American Indian Center of Chicago (AIC) is one of the primary cultural resources for Native people residing in Illinois. The AIC is located in a residential neighborhood on the north side of Chicago. Surrounding the building is a 3,000 square foot garden of naturalized savanna habitat that includes plants traditionally used for medicinal, culinary, artisanal, and functional purposes. All of the authors of this article have lived, worked, and/or participated in community activities at the AIC and the Chicago community for many years. Further, our authorship reflects one of the primary investigators of the project, two of the teachers involved in design and implementation, and a lead research assistant.

A primary goal of our project was to find ways to improve science learning and school achievement for Native American middle school students in ways that served to both strengthen community and strategically prepare young people to be critical actors in the world. A core strategy to do this was to support students' navigation between Indigenous knowledge systems and Western scientific knowledge systems. During the first 2 years of the project, the majority of work was completed in bimonthly community designer meetings in which the learning goals and the architecture of the program were constructed. A range of community members including elders, parents, teachers, community content experts, degreed experts, other interested adults, and youth participated in design activities and served as the critical decisions makers.

The foundations of the learning environment stressed relationships to place, people, and the natural world (see Bang et al., 2010, Bang et al., in press). Youth learned about invasive species, hydrology, and land management issues, with an emphasis on prairie and wetland restoration. Units were enacted over the summer in a 2-week pilot study. Teachers engaged in two additional iterations of design and program implementation for two subsequent summer sessions. In the fourth round of design, the program was integrated into the after-school program at the AIC and teachers delivered lessons on weeknights during the school year, daily in the summer, as well as conducting Saturday family days on a biweekly basis at a local forest preserve. Remarkably, as project youth and teachers engaged in prairie restoration work in this urban environment, they developed novel technologies to replicate Indigenous historic and contemporary burn practices, as well as new innovative land management and restoration techniques.

While more general findings focused on student learning and outcomes from the learning environment of focus in this paper have been reported elsewhere (Bang & Medin, 2010) we will briefly mention that students demonstrated shifts in their epistemological orientations, engagement with science, and identification with science as a result of our programs. As mentioned, our larger study was not originally constructed to focus on technology. However, as the continual cycles of design and implementation progressed, we began to notice a shift in view of technology as legitimate and worthwhile to use in the learning environments both by the community designers and teachers. Eventually teachers and youth started experimenting with the development of new technologies. The current study is informed by two research questions:

1. How did the use and conceptions of technology change over the course of the project?
2. What design principles can we gleam from this project's uses and conceptions of technology?

To answer these questions we examined data drawn from designer and teacher meetings as well as implementation video over the course of 4 years. The data set consists of 23 design meetings in which 7 to 18 community members participated and 25 teacher planning meetings in which four to six teachers participated regularly. Meetings typically lasted between 1 and 4 hours. All data were video recorded, logged, and transcribed by project research assistants. All of our research assistants were members of the community. Pseudonyms have been used throughout the data. Transcribed data was coded in Nvivo. All transcripts were coded at each individual's "turn" level. The design meetings and teacher meetings were coded in their entirety. Codes were developed through an iterative process, as well as from a bottom-up and top-down approaches. Following community-based design principles, we held analysis meetings with project participants, including community members, teachers, and research assistants to shape and refine our coding schemes and to maintain ecological validity (Cole, Hood, & McDermott, 1997). At these meetings, codes were refined and implications of the analysis were developed after coding was completed.

Given our theoretical framework, we wanted to capture the range of practices and approaches to knowledge making that were reflected over the course of the project. Through an iterative process, three major categories of codes emerged capturing conceptions of knowledge-making practices in the data. These codes consisted of dimensions that shaped designers and teachers design decisions in constructing the learning environments. The major categories included: tools and sources for construction knowledge, the role of place in knowledge construction, and forms of engagement for knowledge construction. Each of these categories contained a range of subcodes that refined each category. The analysis we present focuses on the tools category, which consisted of the following subcodes: books, maps, media, technology, and tests or experiments. In what follows, we report findings from this analysis and then, informed by our qualitative analysis, we present design principles that have emerged from this work.

Designing Learning Environments: Toward Repatriating and Innovating Indigenous Technologies

As mentioned our project was not apriori focused on technology; however, as the project unfolded, it became increasingly clear that there was something happening in relation to technologies. This was intuitively evident in the design choices that were made about implementation of

programming. For example, community designers and teachers decided to introduce programs like Alice and NetLogo to students, to use GPS technologies to engage in bio-mapping and to use fire technologies. Tensions about how to productively use technology are evident in transcripts from design meetings and we highlight these tensions later in the article. However we think, the move to use original technologies elevated Indigenous epistemologies and moved design conversations to more productive spaces.

To test this intuition, we conducted a trend analysis of designer and teacher utterances that were coded for technology as a tool in knowledge-making practices in meeting. The number of design meetings held was not evenly distributed over the course of the project and because each meeting varied in length, we chose to group data by project year and to calculate averages for each year. Each year marked a cycle of design, implementation, analysis, and redesign. We found there to be a significant increasing trend ($r^2 = .675$) in teachers and designers utterances that reflected conceptions of technology as a tool in legitimate knowledge making practices. We are not suggesting that this in itself a robust finding. However, this finding provides evidence there was a trend developing in the context of this project in which teachers and designers were increasingly talking about and making decisions to involve technology in our learning environments. To more precisely understand the nature of this increased engagement, we conducted qualitative analysis of the utterances in this trend analysis and derived design principles for future learning environments.

Our analysis focused on understanding the meanings of technology reflected in the coded data. We developed principles for each year of design and implementation to capture the expansive shifts in conceptions of technology over the course of the project. The program developed several units focused broadly on land management and restoration—in urban environments and on tribal lands. Three major forms of technology emerged: fire technologies, agriculture technologies, and natural resource mapping. It is worth noting that these thematic areas are rigorous domains of inquiry among experts broadly in ecological sciences and more specifically in restoration sciences, however, none of these fields were being referenced in this way during the design process, rather they were being dicussed as Indigenous practices.

In presenting our design principles, we will focus on the development of fire technologies. While all three are interesting—especially because digital technologies emerged as useful tools in natural resource mapping—in this article, we focus on fire technologies. We focus on fire technologies because it was not a digital technology and because fire is an "original technology" of many Indigenous peoples. As previously mentioned, "original technologies"

are intended to reference technologies that Indigenous people have used from time immemorial and are embedded in our stories, traditions, and histories. Further, fire technologies were the first technology that community designers engaged with during the design process and, in our view, gave rise to engagement with other forms of technology. Further, fire technologies were also the domain in which innovation and new authoring occurred.

Teachers, designers, and youth developed contemporary fire technologies in the garden at the American Indian Center (AIC). This space is typical, if not small, compared to nearby homes and organizations. Over the course of the project teachers, youth, and community members developed "spot burning" practices in restoration efforts across Chicago but started these burns in the garden at the AIC. "Burning" is a common technique used to remove invasive species in restoration efforts, stimulate plant growth, and impact soil composition. Typically, contemporary burns are orchestrated in large rural environments. After learning about the benefits of fire ecology, the project teachers and students began conducting small experiments with innovative tools, specifically small propane torches instead of the commonly used drip torch. Teachers and students found that propane torches burned hotter and incinerated the brush quicker, producing little smoke. The burns became a neghborhood attraction and space where residents—both Native and non-Native, could learn and become familiar with fire ecology practices and technologies, or as we came to find out, remind people of past generations and ancient practices. Some community elders made remarks such as, "This is what autumn is supposed to smell like" or "This reminds me of back home when we burned in the forests." The stimulation of elders' memories is remarkable in multiple ways, but these unprompted comments served as strong, positive reinforcements for the youth and project participants that the innovations were culturally appropriate.

From our analysis describing the designer and teachers' conceptions of technologies and knowledge making over the course of the program, four crucial design principles emerged for significant reengagement with and effective learning with technology to occur. We present one principle that emerged in each year of our design and implementation work. We think the progression of these principles may matter for the future design of programs involving Indigenous youth and communities and are worth further exploration.

Design Principle 1: Engage Original and Everyday Technologies

The first principle that is evident from our project is that learning environments must engage Indigenous students with "original technologies"

thereby shifting the ontological assumptions that technologies are Western, assumptions that are typically embedded in learning environments. Importantly, this must be done in ways that do not reify narratives in which Indigenous technologies are positioned as less sophisticated and Western technologies as advanced. In our project, fire became a central focus for original technologies. In this section, we share two pieces of exemplary data from design meetings. The presented discourse takes place across two different meetings that occurred in 2006. In the first piece, one of the designers, Tina, then a graduate student in Ethnopharmacology, suggests that the group engage in understanding the many uses of plants. She ends her turn by introducing plants as a fuel source. Another designer, Sandra, who helped to build the community garden, builds on Tina's point by explaining how plant fibers can be used to make fire.

Tina: . . . Maybe teach them about how plants are important in our daily lives as far as fueling the heat and if you have a wood heater, or something like that in the home that you live in and the cotton, the clothes that you wear, things like that would also be . . .

Sandra: Those things actually hands on things that we'd be doing to plant fibers thinking—actually making fire without matches if you make the bow drill and the base on the wood that we find and we make the straight and the bow drill out of fibers that we pick and then it turns in the fire right before your face. It's very awesome.

While these designers have not yet explicitly named these as parts of "original technologies" in this data, short discussions like these that situate fire within everyday use can be found throughout our data corpus in the 1st year. In fact, teachers and designers continually returned to ideas about fire technology and agricultural technology, both as they related to historical or traditional practices and how they can be used in today's context.

Importantly however these discussions frequently led to a focus on the use of fire in teaching moments and original technologies. As this meeting continued, Jen and Sandra, two community elders, expressed hopes of having a fire outside the community center. Leonard, another design and practicing scientist, questions where such a fire would take place and how they would start the fire. Dorothy, another community designer, links the discussion back to community stories about relationships to fire.

Jen: And hopefully they'll be able to have a fire.

Sandra: Yeah, we're going to work on that, having a fire-fire outdoors.

Leonard: Fire outside the Center?

Sandra: You can get it approved and you can get . . . I'm going to check all this out, like a freestanding fireplace that's on wheels . . . It's another element that's important that the kids could access . . .
Leonard: Teaching them how to make fire without matches?
Jen: Yeah, that would be awesome.
Dorothy: And the stories about fire; what's the relationship with different . . . Different people have different relationships with fire.

Across these two pieces, designers considered original technologies (e.g., fire), their uses and meanings (e.g., making fire and stories about fire), and the potential for engaging youth with these technologies in this particular urban Indian context (e.g., fuel and outside in a residential area).

It is important to note that for these designers, fire technology is not associated with historicized images and narratives of Indians. Rather, these designers view fire technology as a lived, heterogeneous technological practice infused with cultural origins and meaning. This is clearly seen in Dorothy's turn. Dorothy's use of "the" before stories ("and the stories about fire") implies that stories have a continuous temporal quality. At the same time Dorothy marks the heterogeneous nature of this community when she says, "Different people have different relationships with fire." The focus on fire as an original technology opened space for designers and teachers to engage in deeper meanings of technologies and simultaneously reposition technology from Indigenous ontologies.

Design Principle 2: Explore the Nature and Uses of Technologies

In the early stages of our design process many community designers conceptualized science and technology as something from western cultures and believed that Indigenous peoples did not use technologies. However, there were important nuances to this thinking that were taken up in our project and that enabled new relationships to emerge. For example, in an early design meeting, community members were discussing how students might think about plants and think about the health of the soil in the garden surrounding the center. They discussed what they thought would typically be done in science learning environments and how they would do it differently (see Brayboy & Maughan, 2009 for a similar dynamic). An elder made the following comment:

Sarah: In science they use all those different test tubes and chemicals and all of that to identify and all of that quantify—all of that. So, here we

> are, we're using our natural senses to do that. It is native science and we could say that, we can demonstrate that. You don't have a test tube here but what would you do. We could pose a question to them like that. We don't have something to separate, quantify, and qualify but just by looking at the color of this or just looking at the [texture].

We could argue that she has set up a dichotomy that echoes the idea that Indigenous communities are antitechnological (Verna, 2006) by suggesting that Indigenous people use "natural senses" to identify and quantify as opposed to how science uses tools ("test tubes and chemicals and all of that"). However, we believe there are two dimensions in this utterance that are important and are examples of two of our design principles. In this utterance Sarah has put forth the idea that there are different methods—or "techniques" and "tools" for accomplishing a desired goal. For the moment, we will focus on techniques and tools.

We draw on the work of Tim Ingold (2000) to shape this design principle. Ingold traces the development of the philosophy of technology from a Western lens and works to explain how the central features of and differences between Western and non-Western philosophies of technology center on the ways in which they either embed or remove people and relations to place. Ingold (2000) distinguishes between "technique and technology in terms of whether human perception and action are either immanent in, or detached from, the process by which things get made and used (p. 315)." He distinguishes further between technology and tools and suggests that tools are objects that extend the capacity of an "agent" in a local context. From the perspective that both the agent or person and the local context matter, it almost necessitates that various cultural communities would engage with technologies differently. From a cultural historical activity theory (CHAT) perspective, the mediational roles of technology from one cultural historical activity system are being imposed onto another, rather than embedded in or taken up in culturally appropriate ways. This is precisely how technological hegemony can unfold.

In this instance specifically, we are suggesting that Sarah's meaning of "natural senses" is aligned with Ingold's definition of technique and her meanings of test tubes and chemicals are akin to Ingold's definition of technology—something in which people are not embedded. What is crucially important here is that Sarah's stance reflects a meaning of tools and technology in which they are a part of knowledge-making practices and not containing the knowledge itself. She is suggesting that the tool one uses ("natural senses" vs. "test tubes") shapes engagement ("just by looking" vs. "something to separate, quantify, and qualify") with knowledge making and inquiry

("It is native science and we could say that, we can demonstrate that"). These types of distinctions became a central conceptual heuristic in design meetings and we believe functions as an important counter-hegemonic stance because it resists notions of technological determinism and reflects agency.

Importantly, this specific utterance was made in the context of thinking about plants and soil quality. In this meeting, observing plants to infer soil quality was the major focus of conversation. Overtime the group increasingly focused on the health of the garden and prairie plants in general. It is important to note the context of Illinois—"The Prairie State" in which only 1% of the state's original prairie survives (there are currently several large restoration efforts underway throughout the state). Design meetings began to focus and shape the garden as a microrestoration site. Prairie burns became a central focus of conversation but the spot burns had not yet evolved in the dialogues. However, they quickly did when the broader context and use of burns were explored.

Design Principle 3: Situate Technologies in Cultural and Sociohistoric Contexts

Learning and technologies are often shaped by views and discourses focused on "new" technology (e.g., new media, new literacies). From Indigenous perspectives, we think this framing has the potential to reify colonial forms of looking for "new territories" and is another dimension of the abstraction of people from technologies (at least those that are not part of the development of new technologies) that Ingold suggests. While this design principle is a straightforward suggestion, we nonetheless think that situating technologies in cultural and sociohistorical contexts has far reaching implications for learning technologies. As cultural historical activity theory (e.g., Cole & Engeström 2007) has already put forth, and we reiterate here as it emerged explicitly in our process, learning environments need to reflect the idea that technologies have always been part of human societies and social relations. The silencing and erasing of this reality in learning environments perpetuates colonial-dominated worldviews. During our design process, community members increasingly narrated the histories of contemporary technologies and practices and named technologies as something Indigenous people have been developing for millennia and can authentically do again. As an example, in a teacher meeting postimplementation, teachers were reflecting on a day in which Indigenous youth participated in a burn. Greg, an elder teacher who is involved both in his urban and reservation community, said:

Greg: Through that whole process those kids learned, you know, the ecosystem of the prairie and what buffalo did from a historical context, to

> how that land changed. Well not really saw the land change but the fact that here we've got a restored Big Blue Stem prairie . . . what their process was in terms of their environment . . . and those kinds of things that weren't managed in the way that it was in the past. And looking at fire in terms of a management practice by Native people which is something that we did and also the amount of natural fires that go on and that's something that today everybody gets all upset because wherever it is like Colorado and there's beautiful homes or in California, they're always trying to stop these fires but fire is a natural part of that cycle. Lord knows we're affecting that natural cycle by putting those fires out to save those homes but I mean so all those things went on historically with those landscapes that we don't have today.

As evidenced in his comment, Greg not only historicizes burn practices, but he also connects how this technology impacted their overall content learning (ecology of the prairie). In addition, Greg extends his focus to contemporary understandings of fires in relation to what he sees as dominant Western values and knowledge. Thus, the placing of technologies in sociohistoric contexts not only opens views of more than just histories of technology across cultural communities, but also opens the space for community-based knowledges to be used as lenses on contemporary technologies in meaningful ways.

Design Principle 4: Technological Innovation and Learning: Engage in Community-Driven Goals and Use Technology as a Tool Toward Those Goals

By the 4th year of our project, spot burning and efforts toward prairie restoration had become a central practice in our program. We began to receive city-wide recognition of the garden around the center and eventually acquired additional lands to restore and manage in the Chicago area. The loss of Indigenous homelands is a defining issue in Indigenous communities. Though we did not acquire formal ownership of these lands in Chicago, the symbolic reacquisition of land and the rights to manage these lands was particularly motivating. Imagining what we might do with these lands opened up many exploratory conversations. In addition to building our relationships to this land by knowing its history and how it came to be in its current condition, we wanted to assess the health of the land. We decided a critical step was to inventory the plants in our restoration sites and used GIS technologies to complete the task. Eventually teachers and youth engaged with a range of digital technologies including: GIS technologies, Google Earth, digital video and photography to document, and engage in restoration practices. How did

this explosion of technology use occur? We are suggesting that the previous three design principles, combined with a motivating community-driven goal, in this case the management of reacquired lands, created the conditions under which transformative praxis and innovation could emerge.

In the final year of our project, we saw new pedagogical stances and teacher reasoning began to reflect the above three principles as they designed and implemented their lessons. We present an overview of an exchange that occurred after a day of implementation in which students engaged in "spot burning." Teachers were discussing both their goals for youth and the affordances and constraints of engaging with fire technology. They located understanding relationships with plant communities and human communities as central to developing an understanding of the technology itself. Thus for these teachers, technology was intertwined in knowledge creation and content understanding—not a standalone artifact. Ed begins reflecting on what students learned.

> **Ed:** . . . What I noticed with [the students] was that when they saw [static] burn but then the leaves would still be untouched. You know some of the plants didn't burn but the ones that aren't used to fire just shriveled up and burned, so I thought that was good . . . that was something good to see understanding how fire operates and why it's important.

Importantly, teachers delved deeper into making sense of "how fire operates" They explored the impacts on burns during seasonal time. This reflected their conversations and class activities in which they discussed the significance of fire use for local tribes (Miami nation) in seasonally (fall, spring, etc.) specific ways. The teachers in this interaction pushed deeper into the impacts on plant life from the burns:

> **Leonard:** Are there any- I don't want to say ramifications- but are there any- What differences are there doing burns at different intervals? They're not on the same clock so to speak . . . this is interesting because normally burn sites are big giant, you know all at once . . .

As we mentioned in the beginning of this article, restoration and burn efforts are not typically seen as possible in urban areas. In this utterance, Leonard was wondering if there is an impact on the plants within one site that has different burn intervals[4] specifically because they are spot burns in urban environments. The teachers go on to discuss this a bit and Greg returns to Leonard's comment.

Greg: . . . To go back to what Leonard was saying, I think there's a difference between like a prairie open burn kind of thing and then the sort of the covered woodland burning that went on because that was probably more like what we sort of did where you get the sort of woodland forest cover plants because what that succeeded in doing was getting those smaller sapling trees burning those up and leaving space there for big orchards.

It is important to note that Greg's reference to the burning that went on is a reference to historical burns in Indigenous communities and practices. The teachers go on to discuss the relationship between historic burns, what they did, what the impacts on the plants and land were and finally what they are trying to teach to their students. Importantly for these teachers, technology use is related to complex disciplinary knowledge. These teachers and designers are drawing on their knowledge of plant communities, seasons, and human communities as they discuss the feasibility of conducting burns and the potential learning opportunities arising with fire technology. Ultimately burning activities with youth became spaces where students learned about traditional uses of fire, contemporary methods, meteorology, soil chemistry, hydrology, and fire science. The hands on approach allowed youth to put methods into practice and innovate with these methods based on local soil and climatic conditions. It also helped reestablish a sense of seasonality among youth participants and other community members, and the burning of the AIC garden became a marker of autumn and spring within the community and surrounding neighborhood. The cyclical, seasonal, and interrelated ways of knowing and constructing knowledge are reflective of defining features of Indigenous knowledge systems (e.g., Cajete, 1999). In short, the program successfully began implementing and engaging technologies based in Indigenous knowledge systems in contemporary ways leading to innovation and robust learning.

Discussion

Addressing issues of achievement and equity with technology requires a reconceptualization of our foundational notions about what technology is and the origins of technology. Across our project, we saw teachers and designers both articulating technological goals and situating technology within cultural and sociohistoric contexts that opened the possibility to repatriate relationships

with technology and learn from old (and now new) configurations. Expanding Indigenous students' and communities' use of and engagement with contemporary technologies requires a critical lens of the historical narratives implied in learning environments. The need for new technologies and new discoveries echoes "new world" forms of Western domination in relation to Indigenous communities; in short, we believe it will be critical for learning environments to reposition narratives of technology so they are not the "new" forms of Western settler colonialism (see Bang et al., in press). The emergent conceptions of technology evident in our project acknowledged that all societies have had different forms of technologies. Further, designers and teachers came to recognize that technologies have embedded in them particular epistemologies, values, and are created and implemented in goal-directed and place-based activities. They historicized technology and technological domains in ways that uncovered colonialism and domination and enabled new relationships with technology and learning. In this case, technology and tools were no longer seen as objects with authority derived from outside of Indigenous communities, rather, students and teachers became makers of technologies for use in the construction their own knowledge. While this shift may seem subtle, in our work the change in epistemic positioning in this learning environment opened the space for deep inquiry, creative engagement and innovative problem solving.

Implications for Urban Learning Environments

At the beginning of this article we suggested that scholars should attend to the multiple geographies of Indigenous peoples and the lived realities of contemporary communities. While we have not made significant distinctions or qualifications about urban verses rural contexts in relation to the central argument in our article, we have drawn attention to the ways in which this kind of work is typically assumed to be next to impossible in urban communities. A crucial challenge in successfully engaging Indigenous children in culturally responsive education or any other education is critically examining the historical frame of reference. Typically, classrooms—especially urban classrooms, are developed from colonial timeframes and not Indigenous timeframes of place. For example, scholars have examined the ways in which narrow foci on Indigenous people during October and November, or minimal engagement of Indigenous histories precontact are rigorously engaged with in schools, and serve to perpetuate and legitimate settler colonialism (e.g., see forthcoming special issue of Environmental Education Research for extensive review). This tendency functions as a perpetual microaggression in which Indigenous children living in urban environments endure throughout

their schooling environments (Walters et al., 2009). Further, urban environments are often positioned synonymously with Western domination and technological saturation. Urbanization and globalization are in many ways positioned as the demonstrations of Western forms of technologies and development. The coupling of these assumptions with the identity narratives of urban Indigenous people asassimilated, Westernized, and displaced creates a host of identity issues for children. From this view technology becomes another way in which these narratives play out and position urban Indigenous children as deficient.

Implications for Culturally Responsive Learning Technologies

As another step toward educational self-determination, we are suggesting that it will be necessary for Indigenous communities to expand our engagement with technologies beyond information and communication technologies (ICT) especially in learning environments in order to more carefully consider the roles of tools in knowing and coming to know. This is not intended to minimize ICT. As scholars are increasingly reflecting, ICT can and has been serving important communities needs, "From cultural recuperation, revival, and political mobilization, to questions of cultural autonomy and Indigenous rights to artistic and intellectual property" (Salazar, 2007). Salazar (2007) suggests that ICT in fact has proven a useful tool in constructing alternative spheres of representation and debate. We are not contesting this. Tools, techniques, and technologies are a part of all communities—their positioning and focus on importance in relation to thinking and learning is a crucial dimension of difference across cultural communities (see Richardson, 2011). As revitalization and regeneration in Indigenous communities continue, it will become increasingly necessary to repatriate technologies that are for new knowledge building as well as for knowledge dissemination and sharing. These issues are, at their core, epistemological and more work is needed in understanding their role in processes of teaching and learning. This will require that the design of learning environments and the development of technologies must centrally involve Indigenous communities as decision makers. Further, the space and time to work through the layers of sociohistoric context will be necessary for any shared meanings and goals to be developed. This poses important challenges but also potential opportunities for teachers not from Indigenous communities to engage students' families and members of Indigenous communities in their classrooms and curricula.

Acknowledgments

We are grateful to all of the community members, teachers, designers and research assistants who participated in this work. Specifically we would like to thank Lawrence Curley, Sally Wagoner, Julia Brownwolf, George Strack, Cynthia Soto, and Douglas Medin. Thank you Jasmine Alfonso who not only helped with the project but also lent extra support in preparing our manuscript.

Declaration of Conflicting Interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The authors disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: This material is based upon work supported by the National Science Foundation REC # 1205758, 1208209.

Notes

1. Indigenous languages are severely threatened in North America and their maintenance and revitalization are the efforts of communities, scholars, and governmental agencies, both tribal and federal.
2. For example there has been laws passed like the Native American Graves Protection and Repatriation Act that gave legal basis for tribal communities to bring back both their cultural artifacts and human remains.
3. Self-determination refers to the legal, political, social, and culture beliefs in which tribes in the United States exercise self-governance and decisions making on issues that affect our own people. Generally, the current era of history and policy making is considered to be in the new era of self-determination and marks a significant shift in U.S.–Indian relations.
4. Burn intervals are the sequencing of burns in a given environment shaped by issues of the local habitats, seasons, and weather.

References

Auld, G. (2007a). Talking books for children. *Australasian Journal of Educational Technology*, *23*(1), 20.

Auld, G. (2007b). Case studyXV- Talking books: A technological transformation. In L. E. Dyson, M. Hendriks, & S. Grant (Eds.), *Information technology and indigenous people* (pp. 197-199). Hershey, PA: Information Science Publishing.

Bang, M. E. (2009). Understanding students' epistemologies: Examining practice and meaning in community contexts. Ann Arbor, MI: ProQuest.

Bang, M., Curley, L., Kessel, A., Marin, A., & Suzokovich, E. (in press). Muskrat theories, tobacco in the streets, and living Chicago as Indigenous lands. *Environmental Education Research*.

Bang, M., & Medin, D. (2010). Cultural processes in science education: Supporting the navigation of multiple epistemologies. *Science Education*, *94*(6), 1008-1026.

Bang, M., Medin, D., Washinawatok, K., & Chapman, S. (2010). Innovations in culturally-based science education through partnerships and community. In M. S. Khine & I. Saleh (Eds.), *New science of learning: cognition, computers and collaboration in education* (pp. 569-592). New York, NY: Springer.

Battiste, M. (2002). *Indigenous knowledge and pedagogy in First Nations education: A literature review with recommendations*. Ottawa, ON: Apamuwek Institute.

Becker, S. A., Sugumaran, R., & Pannu, K. (2004). The use of mobile technology for proactive healthcare in tribal communities. In *Proceedings of the 2004 annual national conference on Digital Government Research* (p. 1-2). Seattle, WA. Retrieved from http://dl.acm.org/citation.cfm?id=1124323

Becker, M., & Delgado, G. (1998). Latin America: The Internet and indigenous texts. *Cultural Survival Quarterly 21*(4). Retrieved from http://209.200.101.189/publications/csq/csq-article.cfm?id=1455

Bernard, H. R. (1992). Preserving language diversity. *Human organization*, *51*(1), 82-89.

Bissell, T. (2004). Digital divide dilemma: Preserving Native American culture while increasing access to information technology on reservations. *Journal of Law, Technology & Policy*, *1*, 129-150.

Bitgood, S. (1993). Social influences on the visitor museum experience. *Visitor Behavior*, *8*(3), 4-5.

Bowers, C. (1998). The paradox of technology: What's gained and lost? *Thought and Action*, *14*(1), 49-57.

Jones Brayboy, B. M., & Maughan, E. (2009). Indigenous knowledges and the story of the bean. *Harvard Educational Review*, *79*(1), 1-21.

Brown, A. L. (1992). Design experiments: Theoretical and methodological challenges in creating complex interventions in classroom settings. *Journal of the Learning Sciences*, *2*(2), 141-178.

Burkhart, B. Y. (2004). What Coyote and Thales can teach us: An outline of American Indian epistemology. In A. Waters (Ed.), *American Indian thought: Philosophical Essays* (pp. 15-26). Malden, MA: Blackwell.

Cajete, G. (1999). *Native science: Natural laws of interdependence*. Santa Fe, New Mexico: Clear Light Publishers.

Carrasco, A., & Acker, D. (2002). *The role of extension education and the cuban agricultural knowledge and information system*. Ames: Iowa State University. Retrieved from http://www.aiaee.org/attachments/article/1395/pa10.pdf

Chakraborty, J., & Bosman, M. M. (2002). Race, income, and home PC ownership: A regional analysis of the digital divide. *Race and Society*, *5*(2), 163-177.

Christen, K. (2006). Ara Irititja: Protecting the past, accessing the future—Indigenous memories in a digital age. A digital archive project of the Pitjantjatjara Council. *Museum Anthropology*, *29*(1), 56-60.

Cole, M., Hood, L., & McDermott, R. P. (1997). Concepts of ecological validity: Their differing implications for comparative cognitive research. In M. Cole,

Y. Engestrom, & O. Vasquez (Eds.), *Mind, culture, and activity: Seminal papers from the Laboratory of Comparative Human Cognition* (pp. 49-56). New York, NY: Cambridge University Press.

Cole, M., & Engeström, Y. (2007). Cultural-historical approaches to designing for development. In J. Valsiner & A. Rosa (Eds.), *The Cambridge handbook of socio-cultural psychology* (pp. 484-507). New York, NY: Cambridge University Press

Collective, T. D.-B.R. (2003). Design-based research: An emerging paradigm for educational inquiry. *Educational Researcher*, *32*, 5-8.

Collins, A., Joseph, D., & Bielaczyc, K. (2004). Design research: Theoretical and methodological issues. *Journal of the Learning Sciences*,*13*(1), 15-42.

Confrey, J. (2005). The evolution of design studies as methodology. In R. K. Sawyer (Ed.), *The Cambridge handbook of the learning sciences* (pp. 135-151). Cambridge, MA: CUP.

Davis, T., & Trebian, M. (2001). Ending the digital divide. *Educause Review*, *36*(1), 38-46.

DeCourtney, C. A., Jones, K., Merriman, M. P., Heavener, N., & Branch, P. K. (2003). Establishing a culturally sensitive palliative care program in rural Alaska Native American communities. *Journal of Palliative Medicine*, *6*, 501-510.

Deloria, V., Deloria, B., Foehner, K., & Scinta, S. (1999). *Spirit & reason: The Vine Deloria, Jr., Reader*. Golden, CO: Fulcrum Publishing.

Delgado, G. (2003). Solidarity in cyberspace: Indigenous peoples online: Have new electronic technologies fulfilled the promise they once seemed to hold for indigenous peoples? The answers are yes, and no. In NACLA, *Report on the Americas*, *35*(5), 49-53.

Deloria, V., Deloria, B., Foehner, K., & Scinta, S. (1999). *Spirit & reason: The vine Deloria, Jr., reader*. Golden, CO: Fulcrum Publishing.

Duensing, S. (2006). Culture matters: Informal science centers and cultural contexts. In Z. Beckerman, N. Burbules, & D. Silberman-Keller (Eds.), *Learning in places: The informal education reader* (pp. 183-202). New York, NY: Peter Lang Publishing.

Duran, B., Duran, E., & Yellow Horse Brave Heart, M. (1998). Native Americans and the trauma of history. In R. Thornton (Ed.), *Studying native America: Problems and prospects* (pp. 60-76). Madison: University of Wisconsin Press.

Dyson, L. E., Hendriks, M. A. N., & Grant, S. (2007). *Information technology and indigenous people*. Hershey, PA: Information Science Publishing.

Edelson, D. C. (2002). Design research: What we learn when we engage in design. *Journal of the Learning Sciences*, *11*(1), 105-121.

Eglash, R. (2002). Computation, complexity and coding in Native American knowledge systems. In J. Hankes & G. Fast (Eds.), *Changing the faces of mathematics: Perspectives on indigenous people of North America* (pp. 251-262). Reston, VA: National Council of Teachers of Mathematics

Eglash, R. (2007). Ethnocomputing with Native American Design. In L. E. Dyson, M. Hendriks, & S. Grant (Eds.), *Information technology and indigenous people* (pp. 210-219). Hershey, PA: Information Science Publishing.

Engeström, Y. (1999). Activity theory and individual and social transformation. In Y. Engeström, R. Miettinen, & R.-L. Punamäki (Eds.), *Perspectives on activity theory* (19-38). Cambridge, UK: Cambridge University Press.

Forte, M. C. (2002). We are not extinct": The revival of Carib and Taino identities, the Internet, and the transformation of offline indigenes into online'N-digenes'. *Sincronia*, *1*(2), 32-37.

Ginsburg, F. (2002). Mediating culture: Indigenous media. In K. Askew & R. Wilk (Eds.), *The anthropology of media: A reader* no. 2 (pp. 210-236). Malden, MA: Blackwell.

Gordon, A. C., Gordon, M., & Dorr, J. (2003). Native American technology access: the Gates Foundation in four corners. *The Electronic Library*, *21*, 428-434.

Gutiérrez, K. D., & Rogoff, B. (2003). Cultural ways of learning: Individual traits or repertoires of practice. *Educational Researcher*, *32*(5), 19-25.

Hennessy, K., & Moore, P. J. (2007). Case study XIII- Language, identity, and community control: The tagish first voices project. In L. E. Dyson, M. Hendriks, & S. Grant (Eds.), *Information technology and indigenous people* (pp. 189-191). Hershey, PA: Information Science Publishing.

Hermes, M. (1999). Research methods as a situated response: Toward a First Nations' methodology. In L. Parker, D. Deyhle, & S. Villenas (Eds.), *Race is . . . race isn't: Critical race theory and qualitative studies in education* (pp. 83-100). Boulder, CO: Westview Press.

Hermes, M., Bang, M., & Marin, A. (2012).Ojibwemodaa! technology and design for indigenous language revitalization. *Harvard Educational Review*, *82*, 381-402.

Holton, G., & Berez, A. (2007). Case study XVII- Building the Dena'ina language archive. In L. E. Dyson, M. Hendriks, & S. Grant (Eds.), *Information technology and indigenous people* (pp. 205-209). Hershey, PA: Information Science Publishing.

Holton, G., Berez, A., & Williams, S. (2007). Building the Dena'ina language Alaska archive. In L. E. Dyson, M. Hendriks, & S. Grant (Eds.), *Information technology and indigenous people* (pp. 205-209). Hershey, PA: Information Science Publishing.

Inglebret, E., Banks, S. R., Pavel, D. M., Friedlander, R., & Stone, M. L. (2007). Case study VII- Multimedia curriculum development based on the oval tradition. In L. E. Dyson, M. Hendriks, & S. Grant (Eds.), *Information technology and indigenous people* (pp. 123-125). Hershey, PA: Information Science Publishing.

Ingold, T. (2000). Making culture and weaving the world. In P. M. Graves-Brown (Ed.), *Matter, materiality, and modern culture* (pp. 50-71). New York, NY: Routledge.

Ingold, T. (2010). The textility of making. *Cambridge Journal of Economics*, *34*(1), 91-102.

Iseke-Barnes, J., & Danard, D. (2007). Indigenous knowledges and world view: Representations and the Internet. In L. E. Dyson, M. Hendriks, & S. Grant (Eds.), *Information technology and indigenous people* (pp. 27-29). Hershey, PA: Information Science Publishing.

James, K. (2006). Identity, cultural values, and American Indians' perceptions of science and technology. *American Indian Culture and Research Journal*, *30*(3), 45-58.

Kawagley, A. O. (1995). *A Yupiaq worldview: A pathway to ecology and spirit*. Prospect Heights, IL: Waveland Press.

Keegan, T. T. A. G. (2007). *Indigenous language usage in a digital library: He hautoa kia ora tonu ai* (Doctoral dissertation). Hamilton, New Zealand: The University of Waikato. Retrieved from http://researchcommons.waikato.ac.nz/handle/10289/3997

Kokesh, J., Ferguson, A. S., & Patricoski, C. (2011). The Alaska experience using store-and- forward telemedicine for ENT care in Alaska. *Otolaryngologic Clinics of North America*, *44*, 1359.

Leclair, C., & Warren, S. (2007). Portals and Potlach. In L. E. Dyson, M. Hendriks, & S. Grant (Eds.), *Information technology and indigenous people* (pp. 1-13). Hershey, PA: Information Science Publishing.

Lee, C. D., Spencer, M. B., & Harpalani, V. (2003). "Every shut eye ain't sleep": Studying how people live culturally. *Educational Researcher*, *32*(5), 6-13.

Levy, J. M., & Storeng, K. T. (2007). Living positively: narrative strategies of women living with HIV in Cape Town, South Africa. *Anthropology & Medicine*, *14*(1), 55-68.

Lipka, J. (1998). Expanding curricular and pedagogical possibilities: Yup'ik-based mathematics, science, and literacy. In J. Lipka, G. V. Mohatt, & the Ciulistet Group (Eds.), *Transforming the culture of schools: Yup'ik eskimo examples* (pp. 139-181). Hillsdale, NJ: Lawrence Erlbaum.

Matthewson, C. (1994). *Distance beyond measure: A view from and of the Pacific. Journal of Educational Studies 31*, *16*(2), 29-35.

McKenny, D., Hughes, B., & Arposio, A. (2007). Towards an Indigenous language knowledge base: Tools and techniques from the Arwarbukarl community. In L. E. Dyson, M. Hendriks, & S. Grant (Eds.), *Information technology and indigenous people* (pp. 192-196). Hershey, PA: Information Science Publishing.

McLoughlin, C. (1999). Culturally inclusive learning on the Web. In K. Martin, N. Stanley, & N. Davison (Eds.), *Proceedings of the teaching learning forum 1999* (pp. 272-277). Crawley, Australia: The University of Western Australia. Retrieved from http://lsn.curtin.edu.au/tlf/tlf1999/mcloughlin.html

Minana, V. G. (2007). Case Study I - ICTs for intercultural dialogue (ICT4ID). In L. E. Dyson, M. Hendriks, & S. Grant (Eds.), *Information technology and indigenous people* (pp. 52-54). Hershey, PA: Information Science Publishing.

Moll, L. C., & Gonzalez, N. (2004). Engaging life: A funds-of-knowledge approach to multicultural education. *Handbook of Research on Multicultural Education*, *2*, 699-715.

Nasir, N., Rosebery, A., Warren, B., & Lee, C. (2006). Learning as a cultural process: Achieving equity through diversity. In R. K. Sawyer (Ed.), *The Cambridge handbook of the learning sciences* (pp. 489-504). New York, NY: Cambridge University Press.

National Science Foundation. (2011). *Women, minorities, and persons with disabilities in science and engineering: 2007* (NSF Publication No. 07–315). NSF 41. Division of Science Resources Statistics, Arlington, VA.

National Urban Indian Family Coalition. (2008). *Urban Indian America: The status of American Indian and Alaska Native children and families today*. Baltimore, MD: Annie E. Casey Foundation.

O'Donnell, M., Mitchell, M., Anderson, A., Lambert, L., Burland, D., & Barber, K. (2003). Information technology and tribal colleges and universities: Moving into the 21st century. In M. Benham & W. Stein (Eds.), *The renaissance of American Indian higher education: Capturing the dream* (pp. 257-273). New York, NY: Routledge.

Ortiz, A. M., & HeavyRunner, I. (2003). Student access, retention, and success: Models of inclusion and support. In M. Benham & W. Stein (Eds.), *The renaissance of American Indian higher education: Capturing the dream* (pp. 215-240). New York, NY: Routledge.

Prins, H. E. L. (2002). Visual media and the primitivist perplex: Colonial fantasies, indigenous imagination, and advocacy in North America. In F. D. Ginsburg, L. Abu-Lughod, & B. Larkin (Eds.), *Media worlds: Anthropology on new terrain* (pp. 58-74). Berkeley: University of California Press.

Richardson, T. (2011). Navigating the problem of inclusion as enclosure in native culture-based education: Theorizing shadow curriculum. *Curriculum Inquiry*, *41*, 332-349.

Robbins, C. (2007). Developing culturally inclusive educational multimedia in the South Pacific. In L. E. Dyson, M. Hendriks, & S. Grant (Eds.), *Information technology and indigenous people* (pp. 65-79). Hershey, PA: Information Science Publishing.

Rodríguez, C., & El Gazi, J. (2007). The poetics of indigenous radio in Colombia. *Media, Culture & Society*, *29*, 449.

Rogoff, B. (2003). *The cultural nature of human development*. New York, NY: Oxford University Press.

Salazar, J. F. (2007). Indigenous peoples and the cultural constructions of information and communication technology (LCT) in Latin America. In L. E. Dyson, M. Hendriks, & S. Grant (Eds.), *Information technology and indigenous people* (pp. 14-26). Hershey, PA: Information Science Publishing.

Sánchez, P., & Salazar, M. (2012). Transnational computer use in urban Latino immigrant communities. *Urban Education*, *47*(1), 90-116.

Sequist, T. D., Cullen, T., & Ayanian, J. Z. (2005). Information technology as a tool to improve the quality of American Indian health care. *American journal of public health*, *95*, 2173.

Smith, L. T., Smith, G. H., Boler, M., Kempton, M., Ormond, A., Chueh, H. C., & Waetford, R. (2002). "Do you guys hate Aucklanders too?" Youth: voicing difference from the rural heartland. *Journal of Rural Studies*, *18*(2), 169-178.

Srinivasan, R. (2005). *Weaving spatial, digital and ethnographic processes in community-driven media design* (Unpublished doctoral dissertation). Harvard University, Cambridge, MA.

Srinivasan, R. (2006a). Where information society and community voice intersect. *The Information Society*, *22*, 355-365.

Srinivasan, R. (2006b). Indigenous, ethnic and cultural articulations of new media. *International Journal of Cultural Studies*, *9*, 497.

Srinivasan, R., Becvar, K. M., Boast, R., & Enote, J. (2010). Diverse knowledges and contact zones within the digital museum. *Science, Technology & Human Values*, *35*, 735.

Srinivasan, R., Enote, J., Becvar, K. M., & Boast, R. (2009). Critical and reflective uses of new media technologies in tribal museums. *Museum Management and Curatorship*, *24*(2), 161-181.

Thaman, K. H. (1997). Reclaiming a place: Towards a pacific concept of education for cultural development. *Journal of the Polynesian Society*, *106*(2), 119-130.

Tippeconnic III, J. W (1999). Tribal control of American Indian education: Observations since the 1960s with implications for the future. In K. Swisher & J. Tippeconic (Eds.), *Next steps: Research and practice to advance Indian education* (pp. 33-52).Washington, DC: Office of Educational Research and Improvement.

Tsosie, R. (2012). Indigenous peoples and epistemic injustice: Science, ethics, and human rights. *Washington Legal Review*, *87*, 1133-1295.

Tuck, E. (2009). Suspending damage: A letter to communities. *Harvard Educational Review*, *79*, 409-428.

Tuck, E. (2012). Repatriating the GED: Urban youth and the alternative to a high school diploma. *The High School Journal*, *95*(4), 40-18.

Tuhiwai Smith, L. (1999). *Decolonizing methodologies: Research and indigenous peoples*. New York, NY: Zed Books.

Va'a, R. (1997). Cultural accountability in the USP science courses at a distance. In L. Rowan, L. Bartlett, & T. Evans (Eds.), *Shifting borders: Globalisation, localisation and open and distance education* (pp. 83-97). Victoria, Australia: Deakin University Press.

Varma, R. (2009a). Attracting Native Americans to computing. *Communications of the Association for Computing Machinery*, *52*(8), 137-140.

Varma, R. (2009b). Bridging the digital divide: Computing in tribal colleges and universities. *Journal of Women and Minorities in Science and Engineering*, *15*(1), 39-52.

Wah, R. (1997). Distance education in the South Pacific: Issues and contradictions. In L. Rowan, L. Bartlett, & T. Evans (Eds.), *Shifting borders: Globalisation, localisation and open and distance education* (pp. 69-82). Victoria, Australia: Deakin University Press.

Warren, B., Ballenger, C., Ogonowski, M., Rosebery, A. S., & Hudicourt-Barnes, J. (2001). Rethinking diversity in learning science: The logic of everyday sensemaking. *Journal Of Research in Science Teaching*, *38*, 529-552.

Warren, B., & Rosebery, A. S. (2004). *What do you think Keenan means?: Exploring possible meanings of explicitness in the science classroom*. Speaker Series: *Center for the Scholarship of Teaching*.:College of Education, Michigan State University.

Warschauer, M. (1998). Technology and indigenous language revitalization: Analyzing the experience of Hawai'i. *Canadian Modern Language Review/La Revue canadienne des languesvivantes*, *55*(1), 139-159.

Warschauer, M. (1999). *Electronic literacies: Language, culture, and power in online education*. Hillsdale, NJ: Lawrence Erlbaum.

Warschauer, M. (2000). *Network-based language teaching: Concepts and practice*. Cambridge, MA: Cambridge University Press.

Warschauer, M., & Matuchniak, T. (2010). New technology and digital worlds: Analyzing evidence of equity in access, use, and outcomes. *Review of Research in Education*, *34*(1), 179.

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