# Culturally Responsive Making with American Indian Girls: Bridging the Identity Gap in Crafting and Computing with Electronic Textiles


Kristin A. Searle
Graduate School of Education
University of Pennsylvania
3700 Walnut St.
Philadelphia, PA 19104
searle@gse.upenn.edu

Yasmin B. Kafai
Graduate School of Education
University of Pennsylvania
3700 Walnut St.
Philadelphia, PA 19104
kafai@upenn.edu



## ABSTRACT

The Maker Movement has been successful in refocusing attention on the value of hand work, but heritage craft practices remain noticeably absent. We argue that combining heritage craft practices, like those found in many American Indian communities throughout the United States, with maker practices presents an opportunity to examine a rich, if contentious space, where different cultural systems come together. Further, we argue that the combination of heritage crafts, maker practices, and computing provides an opportunity to address the "identity gap" experienced by many girls and individuals from non-dominant communities, who struggle with taking on the identity of a "scientist." In this paper, we focus on the experiences of twenty-six American Indian girls (12-14 years-old) who participated in a three week, culturally responsive e-textiles unit as part of their Native Studies class at a tribally-controlled charter school located just outside of Phoenix, Arizona. In order to understand if the combination of a tangible design element with computing and cultural knowledge would be a promising activity for attracting American Indian girls to computing, our analysis focused on students' initial engagement with e-textiles materials and activities, their agency in designing and making e-textiles artifacts, and the ways in which e-textile artifacts fostered connections across home and school spaces.



## Categories and Subject Descriptors
K.3.0 **[Computers and Education]:** General

## Keywords
Electronic textiles, education, Indigenous Communities, K-12


## 1. INTRODUCTION

The Maker Movement promotes cross-disciplinary, interest-driven engagement with a wide variety of hands-on activities like building robots, designing game controllers, developing programmable locks, and creating musical instruments [19]. New technologies like laser cutters, 3D printers, and open source micro controllers provide opportunities to integrate the physical and the digital. Yet to date, most maker activities have focused on male-oriented activities. An analysis of *Make* magazine, arguably the most public face of the Maker Movement, revealed that men have dominated the magazine's covers since its inception and that the projects featured were primarily robotics or electronics projects whose primary audience was male [3]. It is clear that while maker activities have been successful in refocusing attention on the value of hand work, noticeably absent from all these developments have been heritage craft practices, especially those that could attract students of all genders and Indigenous backgrounds.

Crafts are an integral part of any maker activity but traditional practices like sewing, stitching, knitting and heritage craft practices like regalia beading, basket weaving, and pottery making prominent in many Indigenous communities throughout the United States have received less attention than their digital counterparts [9, 18]. All of these practices not only produce aesthetically pleasing objects of artistic value, but they also produce objects that serve utilitarian (a basket for storing grain, for instance) and ceremonial (a dress worn by a girl for her coming-of-age ceremony, for instance) purposes that are deeply embedded in larger cultural contexts. While craft practices like beading and basket weaving have been passed down through generations of (mostly) American Indian women, today many skills (weaving a particular basket pattern, for instance) are being lost and, with them, the stories and cultural meanings embedded in not only the artifacts themselves but also in the processes of making.

In connecting traditional and heritage craft practices to maker practices we can examine a contentious but rich space that brings together different cultural systems. Construction kits like the LilyPad Arduino kit for making electronic textiles combine traditional aspects of fabric crafts using needles, thread, and cloth with a microcontroller that is both sewable and programmable, various actuators such as LEDs or speakers, and novel materials such as conductive fabrics, paint, and even tinfoil [6]. In a study of LilyPad Arduino hobbyist users, Buechley and Hill [4] found that significantly more women use the LilyPad Arduino than the functionally equivalent Arduino. These findings suggest that maker activities can successfully combine traditionally feminine practices of crafting and sewing with the more masculine



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activities of engineering and computing. Given the success that making activities with electronic textiles had in attracting female students to hands-on, project-based learning that integrated physical and digital components, we wondered how the element of craft in e-textiles might be leveraged to attract students from non-dominant cultural backgrounds.

In this paper, we bring together hands-on, project-based learning with craft practices and Indigenous Knowledge Systems [2] in the context of an elective Native Studies class for junior high youth at a tribally controlled charter school located outside of Phoenix, Arizona. We focus on the experiences of twenty-six American Indian girls (12-14 years-old) who participated in a three week, culturally responsive e-textiles unit as part of their Native Studies class. In order to understand if the combination of a tangible design element with computing and cultural knowledge would be a promising activity for attracting American Indian girls to computing, we analyzed girls' completed artifacts as documented in photographs and code screenshots, their design practices as documented in daily field notes, and their perspectives from reflective interviews guided by the following research questions: (1) What initially attracted girls to working with e-textiles materials? (2) How did girls engage in design agency through the process of making? (3) How did girls' e-textile artifacts serve as boundary objects that fostered connections across home and school spaces? Drawing upon three case studies from the larger data set, our findings highlight the importance of craft practices as an initial point of connection, the importance of allowing space for design agency in engaging students in making activities, and the ways in which the tangible aspect of e-textiles artifacts facilitated connections across multiple dimensions of students' lives. These findings contribute to larger conversations about how maker activities can appeal to a broad range of students, especially girls and students from non-dominant backgrounds.

## 2. BACKGROUND

Our focus on computing and crafting with American Indian girls contributes to efforts to increase overall representation of women and minorities in science and engineering. While the percentage has increased slightly [31], women still remain underrepresented and disparities are especially marked in computer science and engineering, where women comprise 25% and 13% of the workforce respectively. When gender and race intersect, the situation is even more dismal. Latina, African American, and American Indian/Alaska Native women comprise fewer than one in ten employed scientists and engineers [31]. These statistics suggest that ongoing efforts to address the participation gap by "unlocking the clubhouse" [27] have been only mildly successful and that we need to look elsewhere to identify the reasons behind the persistently low numbers of women, particularly women of color, entering into science and engineering related fields.

However, even more significant than the "participation gap" is an "identity gap," where females and minorities may be unable to see themselves taking on the identity of a scientist [34]. As STEM moves to the forefront of the national educational agenda, it is especially important that we understand what kinds of activities and environments can inspire female and minority students to see themselves as scientists. In computing education most efforts to address the identity gap have focused on creating more appealing programming activities like storytelling and game design [8, 20, 23] and new spaces for doing computing [4, 11, 25] that incorporate the cultural values of distinct social groups. The approach of culturally responsive computing has shown particular promise for engaging students from diverse class and cultural backgrounds [14]. In culturally responsive computing, mathematical and computational concepts and practices found in particular communities are drawn upon to design relevant tools and environments for learning computing. One well-known example is the Virtual Bead Loom by Eglash and his colleagues [12] that allows students to virtually create beaded designs following algorithms present in Shoshone-Bannock bead work using principles of recursion and iteration.

In extending culturally responsive computing to culturally responsive making, we wanted to provide a context for situating computation (i.e., to make it relevant to existing cultural practices) as well as for challenging beliefs about computation (i.e., what is computing) and participation (i.e., who can become involved in computing). Culturally responsive making involves using pedagogical strategies that "make sense" to learners from a particular cultural background [24]. Furthermore, it involves engaging with learners' interests along a spectrum of cultural practices ranging from heritage cultural practices, like the indigenous craft practices we emphasize here, to vernacular cultural practices, like skateboarding or graffiti, and engaging in both cultural affirmation and critique [15]. In general, indigenous practices connect to identities–the ways of being, knowing, and valuing—that are, in part, embedded in and learned through processes of making in indigenous communities [2].

In the context of culturally responsive making, crafts have a particularly interesting but also complicated connection to the identities of American Indian girls. For many decades, crafts were being taught to American Indian girls in schools, beginning with craft lessons taught in federal Indian boarding schools in the early 1900s [26]. These craft lessons provided a crucial link to girls' identities as indigenous peoples that was often missing from other school activities and content. These missing links remain today, with school learning often disconnected from students' identities and lives outside of school, especially in STEM fields [35]. Working with e-textiles can integrate indigenous technologies of crafting and sewing with electronic technologies and computer programming and thus provide a context for examining identity connections and disconnects. Prior research demonstrated that youth learning with e-textiles expanded not only their repertoires of computing and engineering practices, but also their perspectives on the gendered nature of these fields [21, 32].

In the current project, we wanted to build on these findings and connect to prior efforts in integrating e-textiles with indigenous practices [22] by focusing on girls' interests, participation and perspectives. We believe that three elements of culturally responsive making with e-textiles materials are especially salient for helping girls to navigate multiple identities. First, the opportunity for girls to connect with STEM in ways that are comfortable for them is crucial. Girls from non-dominant communities are faced with many competing narratives about who they should be and these often lead to conflicts between ethnic and academic identities [30]. Yet, we know that creating spaces for doing science that engage other aspects of girls' identities, such as doing social justice work on behalf of their communities, can be crucial in supporting girls' identities in STEM [34]. Second, the relatively open-ended nature of e-textiles design activities provides an opportunity for girls to engage in what Eglash & Bennett [13] have called design agency, the negotiations that take place between design tools, their environment, and students' agency. By further limiting students' design options in a culturally-connected way, we suggest that we may be able to help students find spaces where all of their multiple identities—as girls, as Indigenous peoples, as scientists, and beyond—may co-exist. Finally, the ability of e-textiles materials and artifacts to act as boundary crossing objects [1, 33] whose meanings are simultaneously adaptable based on context (school or home, for instance) and constant enough to maintain a shared identity across spaces, may help to lessen the "identity gap" for American Indian girls engaged in computing.

# 3. METHODS

## 3.1 Participants

The participants in our study were 26 seventh grade American Indian girls ( 12-14 years) who attended a charter school on tribal lands located just outside of Phoenix, Arizona. They participated in a three-week e-textiles unit as the culminating project in an elective, gender segregated Native Studies class. The students reflected the demographic of the school, which was almost entirely American Indian (99%), with slightly less than half of students (46%) eligible for free or reduced lunch. Although there were spaces within school where the participants could engage in interest-driven, hands-on learning, such as an elective robotics class, girls tended to frequent these spaces less than their male peers and often complained about how "boring" or "tedious" their other classes were. Prior exposure to computing was limited to general technology use. Most of the participants had cell phones or tablets and played video games for entertainment, but they had little sense of what computing entailed and who could or could not do it. While in many contexts youth have strong (albeit not necessarily positive) ideas about what a computer scientist looks like [10], this was not the case amongst our participants: they had little to no sense of girls being excluded from computing but rather saw it as a profession outside the realm of possibility for all Indigenous youth.

## 3.2 E-Textile Design

The e-textile design activity described here focused on making "human sensor" sweatshirts [21] using the LilyPad Arduino construction kit [5]. This kit enables novice makers to embed electronic components into textiles and consists of a sewable, programmable microcontroller and a variety of sewable sensors (e.g., temperature sensor, accelerometer) and actuators (e.g., LED lights, sound buzzers). Sensors and actuators are sewn to ports (holes that can be sewn through) on the LilyPad using conductive thread, which acts like the wire in more traditional electronics projects, and is knotted to secure a particular connection (see Figure 1). When these components are sewn together using conductive thread and then programmed, they become a small, wearable, student-built computer. In order to program the LilyPad Arduino, either the Arduino or Modkit [29] development environments were used.

The activity drew on cultural content by having students make e-textile designs connected to plants that were of significance to local Indigenous communities. One goal was that making a light up, wearable version of a traditional food source would reinforce what students had already learned about the significance of traditional food sources and perhaps spark larger community-level conversations when students took goal was that students would learn something about computation and its connections to culture

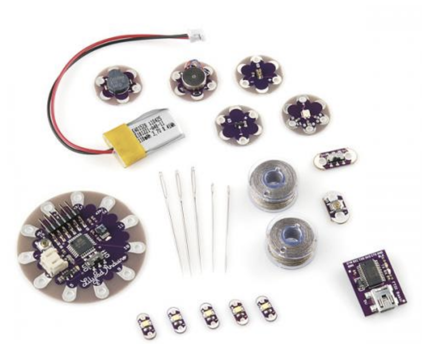

**Figure 1: LilyPad Arduino kit**

through the process of designing and making e-textiles. Students were asked to design and make e- their projects home. Another textile patches comprised of a culturally-relevant aesthetic design, a LilyPad Arduino, at least three LED lights, and two metal snaps attached to the negative ground and an analog port respectively. These snaps connected to snaps on hooded sweatshirts that were pre-"wired" with conductive fabric patches on the cuffs that connected to metal snaps on the front of the sweatshirt. When a student's e-textile patch was connected to the snaps on the sweatshirt, it created a "human sensor" e-textile project (see Figure 2). In a "human sensor" project, the two conductive fabric patches on the cuffs of the sweatshirt function as a sensor to measure resistance from the human body when touched simultaneously. This adds a dimension of computational complexity to students' e-textile projects. In a longer workshop, students would have "wired" the hoodies themselves but, given the time constraints, the conductive fabric patches and conductive fabric "wiring" that connected the cuffs to the snaps and, by extension, to the LilyPad Arduino were pre-ironed.

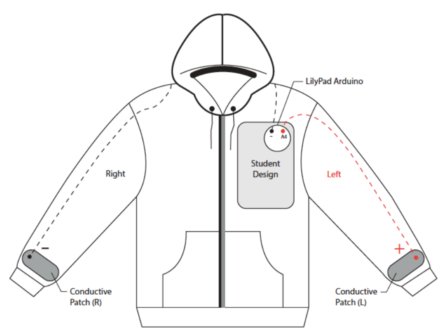


**Figure 2: Human Sensor Hoodie**

## 3.3 Native Studies E-Textile Unit

In addition to daily classroom sessions during the three-week unit, course instructors also held lunchtime sessions where students could bring their lunch and work on their projects. These sessions were not mandatory but provided an important space for students to engage in making without some of the physical and behavioral constraints of the classroom, opening up spaces for peer-to-peer mentoring and relationship building. The first week provided students with the necessary background knowledge in crafting, circuits and coding to enable them to design and make their own "human sensing" hoodies. Sample projects were shown to help students conceptualize their own e-textiles projects. In the second week, each student created her own design or chose a design from one of seven plant design templates based on previous classroom discussions of "Southwest Desert Foods" including the Saguaro cactus, the fruit of the Saguaro cactus, the Agave plant, Manzanita berries, Prickly Pear cactus leaves, acorns from the Emory Oak tree, and Mesquite pods. Students then drew a circuitry blueprint to determine where to place the LilyPad, how to orient the LED lights, and how to create the circuitry in such a way as to minimize potential short circuits created by crossing wires and then moved on to crafting their design out of felt and then affixing the electronic components. Because many of the students had prior sewing experience, instructors provided instruction on an as-needed basis and focused primarily on the ways in which sewing with conductive thread differs from sewing with regular, non-conductive thread. In the third week, students turned to coding their e-textiles projects. Due to limited computer access and project completion, students learned to setup up their boards and write simple code in Modkit while working with one of the course instructors on an individual basis or in small groups of two to three students.

**Table 1. Overview of Native Studies E-Textile Unit**

| Week | Activity | Description |
|---|---|---|
| 1 | Introductory PowerPoint Presentation & Fashion Show<br>How Circuits Work<br>LilyPad Circuitry Worksheet & Circuitry Jeopardy | Students are introduced to e-textiles & potential sources of connection to Pima and Maricopa cultures. Students briefly learn about how electricity and how circuits work by making their own simple circuits using alligator clips, a switch, a battery, and an LED light. Students are then introduced to the LilyPad Arduino Simple Board and associated terminology (port, input/output, digital/analog). After practicing how to connect the LilyPad to LED lights as a whole class, students are given a LilyPad circuitry worksheet to complete in pairs. This worksheet serves as a template for students when they design their own circuitry blueprints. Concepts are reviewed using Circuitry Jeopardy game. |
| 2 | Circuitry Blueprints & Individual Design Consultations<br>Crafting & Conductive Sewing | Students choose a plant-themed design template or create their own. Using the chosen design template, each student creates a circuitry blueprint that shows where the LilyPad, LEDs, and conductive sewing will go in relation to the aesthetic design. An instructor must sign off on the circuitry blueprint during an individual design consultation before a student can move to the next phase. Students implement their designs, first using their chosen design template as a pattern and cutting any fabric elements. Then, fabric elements are sewn together or to a background if desired. Electronic components are sewn together and to the LilyPad. Instructors provide basic sewing instruction and conductive sewing instruction as needed. |
| 3 | Coding & Debugging<br>Integration of "human sensor" patches with sewing of snaps and additional coding | Instructors help each student set up her board in Modkit and turn on all of the lights to test for functionality. Debugging of circuitry occurs if all lights do not turn on. When all lights are functioning, an instructor provides each individual or pair of students with starter code for a basic blink. Students are walked through several variations on a basic blink and given time to play with various codes for their projects. Students iteratively test, debug, and revise their code. Some students add new components if all assignment requirements have been met.<br>Students connect one half of a metal snap to an analog port and the negative ground respectively. Designs can then snap into pre-wired human sensing sweatshirts. Students work with instructors to calibrate their sensing patches using pre-written starter code and expand their code to have at least two conditions, one for when the patches are touching and one for the rest of the time. |

## 3.4 Data Collection and Analysis

Daily field notes documented what happened in the class each day, focusing on what students were learning and what they were struggling with in designing and crafting with e-textiles. We also collected students' circuitry blueprints, daily photographs of students' design progress, and code screenshots. Six students also participated in final reflective interviews, that were video recorded and lasted around 20 minutes. Topics included where students saw connections between the cultural content of Native Studies and the e-textiles unit, what aspects of their projects they were most proud of, what aspects of their projects were the most challenging, and how other individuals (family and friends) had responded to their projects. Interviews were then transcribed.

We used a multi-faceted identity lens [16] to understand how the craft element of e-textiles might be leveraged to attract girls from non-dominant backgrounds to learn computing and to address the identity gap. Analysis of girls' e-textiles artifacts and field notes allowed us to better understand their practices and participation in the classroom community. A portfolio was created for each student that combined her initial circuitry blueprint, photographs of her in-process and completed project, and any available iterations of the code for her project. Field notes and interview transcripts were coded using a two-step open coding process [7], allowing themes to emerge from the data and then be refined. Salient codes included design agency and the ability to learn from mistakes, home-school connections, and the difference between the e-textiles unit and other school-based learning environments. Analysis of field notes helped us to better understand girls' practices during the Native Studies e-textiles unit and analysis of interviews allowed us to better understand girls' perspectives on learning computing through e-textiles activities.

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# 4. FINDINGS

## 4.1 Engaging with E-Textiles: Making Connections Through Crafting

The incorporation of a craft-based, tangible design element proved crucial to attracting and maintaining girls' interest in the circuitry and computing aspects of the project. In contrast to other school-based practices like reading and mathematics where the girls were continually assessed and often found lacking in comparison to state standards, many girls had previously engaged in sewing and possessed at least a basic knowledge of the craft. Further, girls' prior sewing experiences were often closely tied to familial experiences like watching a mother sew traditional dresses or learning how to use a sewing machine from a beloved aunt, meaning that there was a strong connection between sewing and girls' out-of-school identities. Even those girls who had never sewn before had watched someone sew closely enough to grasp the basics. As a result, the e-textiles artifacts made by the girls exhibited a degree of finesse not typically seen in novice projects. Color combinations were carefully chosen and stitches were thoughtfully integrated into the overall design. Even decisions about how to code particular aspects were driven by a strong sense of aesthetics illustrating the often overlooked role that this dimension can play in technical learning [17]. For instance, Jessi's experience making an e-textile project illustrated the significance of connecting crafting to computing practices within a culturally-responsive making activity.

Jessi was often positioned by the classroom teacher as "special ed" or in need of extra assistance, a positioning that was reinforced by the fact that Jessi was repeating seventh grade. However, Jessi turned out to be a skilled seamstress with a clear vision of her craft. She was among the first to decide that the design template featuring Manzanita berries could easily be turned into Mistletoe. While Jessi initially created her circuitry blueprint using the provided design template, her finished design bore little resemblance to the original. In the original blueprint (see figure 3), Jessi planned on using three LED lights connected to ports 5, 6, and 9 on the LilyPad, which was located off to the side of her design. She had correctly labeled polarity on each of the LED lights and had drawn in her circuitry, something that can prove challenging for novices. In her completed e-textile artifact, Jessi completely altered the design from her original blueprint and doubled the number of LEDs she was using from three to six. Rather than one cluster of berries and leaves, Jessi's finished design had two clusters, with each cluster housing one red and two green LEDs. Because there are only five digitally programmable ports for output devices, two of Jessi's lights were connected to port six on the LilyPad, suggesting that Jessi also had some understanding of different kinds of circuits and their functionality. Two lights connected to the same port, like the ones Jessi connected to port 6, must function together: they cannot be programmed independently of one another, which places some constraints on the programming and aesthetic elements of the project. Jessi circumnavigated this constraint by having all six of her lights function concurrently. When the patches on the cuffs of her hoodie were touched together, all six lights stayed on. When the patches were not touching, all six lights blinked with a quick strobe-like effect.

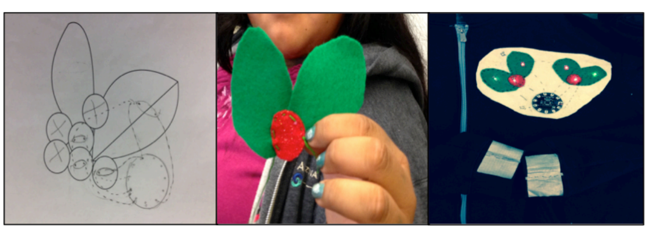

**Figure 3: Jessi's Project from Circuitry Blueprint to Completed E-Textile**

In the debriefing interview we asked Jessi whether she had any prior experiences that had helped her with a project. Her face lit up with a smile as she mentioned the weekly quilting circle held at her grandmother's house, in which she had become an active participant since coming to live with her grandmother at the end of the previous school year. As Jessi described, "On Wednesdays, my grandma took, teached [sic] me how to sew. We call it sewing night or whatever and every Wednesday her sisters come and my cousins come. The kids come out to play and then we go inside, like quilts, and they put some stuff in there or whatever and yeah. And then after that they eat". What Jessi describes is a familial event with sewing at its center. It is one of the reasons that Jessi found her way into making e-textiles through crafting. Ultimately, Jessi's engagement with e-textiles pushed her to think about how she might leverage her sewing skills. Though she thrived on the challenge of figuring out her circuitry blueprint and then reworking it when she changed her design, she was most proud of the fact that when you looked at the back of her completed project, the stitches formed a heart. As the unit drew to a close, Jessi was seriously contemplating what it would take to put lights in some of the quilts made by her aunt and grandmother in the Wednesday sewing nights.

## 4.2 E-Textile Making as "Fun Learning": Exercising Design Agency

While crafting practices like sewing served as an entry point into circuitry and computing for many girls, developing design agency turned out to be the driving factor in getting them to complete the projects. Providing girls with a constrained space proved an important element of the design activity. Rather than giving them the option to make anything, the e-textiles projects were constrained by the design and technical requirements, such as to focus on a Sonoran desert plant and to include at least three LED lights with the Lilypad Arduino. Initially, we worried that such constraints would prove too limiting and result in 26 identical projects, but this was an unwarranted concern. Each of the girls' e-textile hoodies exhibited a high degree of personal relevance and uniqueness. For instance, Kelly chose to work from an Agave plant template (she was one of six girls who used the Agave template) but decided to add a second Agave plant. In her initial design, Kelly had two large Agave plants with three lights each and the LilyPad located in the center (see figure 4). Over time, Kelly's design evolved, with one of the Agave plants becoming a much smaller, "baby" plant and being used to house the LilyPad. The number of LEDs also decreased from six to three, though Kelly was able to find time later to incorporate a fourth LED. Circuitry was carefully integrated into the design so as to be unobtrusive. The final design showcases Kelly's favorite colors, with the Agave plants constructed out of baby blue felt on a pale pink background. Two leaves of the plant had blue lights and two leaves had pink lights, which were programmed to showcase a chase effect when the patches on her hoodie were touched and to strobe the rest of the time.

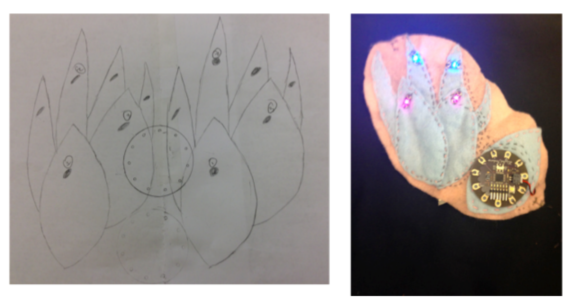

**Figure 4: Kelly's Circuitry Diagram & Completed Project**

For Kelly and many other girls, programming became the opportunity to figure out how to employ the technical features to best represent herself in her e-textile project. Before connecting her Agave design to the "human sensing hoodie," Kelly had learned how to program her lights with a pulsating fade effect, which required her to learn about variables, a more complex programming concept. However, when it came time to alter the programming to work with the sensor patches on her sweatshirt, Kelly was adamant that she did not like the existing fade effect. Working with one of the instructors (Searle), while her best friend Lisa looked on, Kelly expressed definitive opinions about how she wanted her lights to blink:

> Kelly: I just want it to, like, have, like, not light up at the same time.
>
> Instructor: So you want them to go one at a time?
>
> Kelly: Yeah, but not slow.
>
> Instructor: When they fade? Not slow?
>
> Kelly: Yeah, not slow.
>
> Instructor: So you don't want this [makes a fading gesture with her hand] anymore?
>
> Kelly: Well, I do but I want it slow.
>
> Instructor: That is slow.
>
> Kelly: I DON'T want it slow!
>
> Lisa: She wants it to go faster (Int., 2/20/15, pp.14-15).

In this excerpt, we see Kelly exercising design agency, even calling upon her friend Lisa to make her opinions clear, to achieve her desired blinking pattern and the overall aesthetic that it would help to create. Indeed, throughout the project, Kelly emphasized that e-textiles was "fun learning." Asked to explain why in her final reflective interview, Kelly said,"You have to program it and you're making something for yourself, like, you don't do that in other classes" (Int., 2/12/14, p.11). Kelly was not alone in expresing this sentiment. In field notes, themes of making with e-textiles as practical (making something wearable), playful (doing something creative with your hands), and personal (interest-driven, choices) were repeated over and over. Girls felt that they had agency in a way that was missing from other school activities.

## 4.3 E-Textiles as Boundary Crossing Objects: Linking School, Home, and Community

Throughout the Native Studies e-textiles unit and even after its completion, girls' e-textiles artifacts and the knowledge they acquired while working on their projects traveled back and forth between home and school. Girls often took their in-progress projects home for sewing advice or approval from more skilled and culturally knowledgeable relatives. Later, completed hoodies were shown off to classmates and teachers at school, to parents and siblings at home, and to the broader community during forays to Walmart. The overwhelming sentiment expressed by the girls was one of pride and accomplishment in making something that was valued in the community at large (a handmade project of cultural significance) but couldn't have been made by just anyone because of the technical skills involved in designing the circuitry and programming the e-textile artifact. Lauren's interactions with her family around e-textiles provide a compelling example because they encompassed crafting and circuitry and traveled between home and school on multiple occasions, even after the Native Studies e-textiles unit had concluded.

After winter break, Lauren was still attending lunchtime sessions, even though the e-textiles unit had come to an end. One day she recounted with glee a story about how she had helped her dad make sure that the lights on his trailer were working properly. It wasn't clear if this was something she previously knew how to do or not, so the researcher who was working with her at the time (Searle) asked, "Did you know how to do it because of e-textiles?" "Yeah," she responded with a smile stretching across her face, "My dad had crocodile clips and I knew how to hook them up" (FN, 1/23/14). While Lauren learned about electricity and circuits by sewing a light up e-textile project, she later had the opportunity to apply her classroom skills to help her father repairing his truck, applying principles of circuitry that she remembered from e-textiles, namely positive goes to positive, negative goes to negative. Then, Lauren brought this experience back to school with her as she began work on a second e-textiles project—a pale pink felt, light up heart for her mom's birthday.

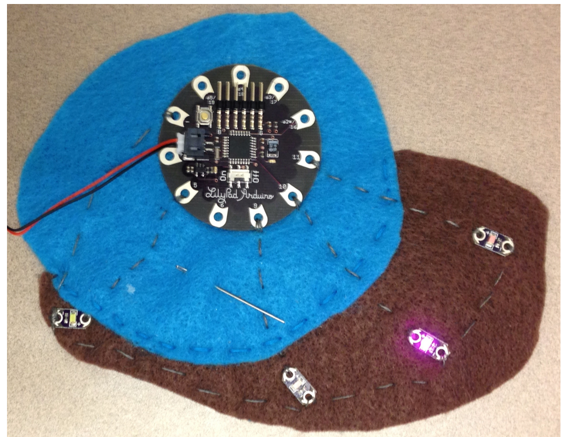

**Figure 5: Lauren's E-textile Project**

Lauren's desire to create an e-textile project just for her mom resulted from taking her original Prickly Pear flower e-textile project (see Figure 5) home over a weekend, specifically because she wanted to show her parents what she had been working on. Asked what her family's response to the project was, she replied, "They liked it. My mom wants me to make her one and I want to make her one!" (FN, 12/16/13, p.1). Provided with another LilyPad Simple board and other basic supplies, Lauren went on to create and program a light-up, pink heart, complete with pink LEDs, as a birthday present for her mom, going so far as to seek out a classroom in the school that had the programming software installed on the computer so that she could program the heart after school one day. Time and again, when asked what she liked best about e-textiles, Lauren returned to her mom's pride in her work, particularly her newly found knowledge of how to sew and how to connect circuits. In Lauren's experiences making with e-textiles we see far more concretely how e-textiles traveled back and forth between home and school spaces in ways that are far from typical for your average homework assignment. This travel was afforded by the hybrid nature of e-textiles projects—the novel, light up aspect of the project, its technical elements, and the craft involved.

# 5. DISCUSSION

In this paper, we proposed a shift from thinking about culturally responsive computing that takes place primarily on a screen to culturally responsive making, particularly as it relates to incorporating hand work and craft practices valued in many non-dominant communities. We suggested that bringing these potentially more familiar practices back into educational activities and environments might help address the "identity gap" for girls and students from non-dominant backgrounds. Our findings suggest that culturally responsive making is a promising pathway for introducing girls to computing and engineering concepts in ways that not only feel familiar but also push students to explore and expand their ideas about what they are capable of doing. Certainly, the specifics of the "identity gap" will differ depending on each individual, on the community, and on how science is being taught in schools, but our findings highlight that providing familiar points of entry into computing or other STEM activities (crafting, in this instance), giving girls a degree of agency to explore particular aspects of their identities (cultural identity, here) within some technical constraints, and facilitating connections between home and school spaces through hybrid activities like making e-textiles can lessen the disjuncture between girls' multiple identities, with "scientist" being one of them. Of course, one three-week long unit situated in a Native Studies class is unlikely to have the kind of lasting impact that is required to see a large-scale shift in the numbers of women, particularly women of color, participating in the science and engineering workforce.

Although it is beyond the scope of this paper, we have been lucky enough to engage with not only the girls whose experiences are documented here but also with an additional sixty American Indian girls and boys in the seventh and eighth grades over the course of the last two years. We have worked with them in repeated iterations of the Native Studies e-textiles unit described here, as well as in a Native Arts class and in multiple iterations of a pre-college preparatory summer camp [22]. Like Jessi, Kelly, and Lauren and the other girls whose experiences are chronicled here, the boys we have worked with have also flourished through engagement with e-textiles materials and curriculum. Though we heard a few comments about the gendered nature of craft in contrast to "men's work" like chopping wood, by and large boys also found an entry point into e-textiles making activities through crafting and the familial connection it offered. One boy recounted designing quilts with his grandmother while another showed off his prowess with an iron and a glue gun gleaned from years of watching his mother create DIY holiday projects. Perhaps even more striking was the ways in which boys, after years of being positioned as such by others, had internalized the notion that they were unlikely to succeed. The opportunities for design agency and for seeing a project through from conception to a finished project that could be publicly shown off had profound impacts on boys' self-esteem. These findings suggest that culturally responsive making activities, whether with e-textiles materials or other tools and technologies, have the potential to engage youth of all genders, from a multiplicity of backgrounds, in taking on scientific identities.

As we look to future research, we see three challenges that must be addressed. First, doing identity work with adolescent youth is a tricky space to navigate under any circumstances, and especially so when powerful, colonizing narratives about who can do "science" and what counts as "culture" are involved. We have struggled with finding appropriate spaces and places for moving beyond surface-level cultural knowledge (e.g. Sonoran desert plants) to address community-based ontologies, epistemologies, and axiologies. Potentially, this work will grow more complicated in schools where the student body is more heterogeneous, though we suspect similar strategies for supporting youth's identities as scientists will remain successful. Second, culturally responsive making activities need to move into school environments rather than remaining at the margins of youth's educational experiences in after school clubs, libraries and museums. For this to happen, not only will spaces within schools have to be reconfigured to make space for making (sometimes as simple as moving desks into group work stations), but classroom culture and pedagogy will also require shifts. Teachers will have to become equipped to use the kinds of tools and technologies described here. Finally, we will have to devote serious time and energy to scaling up so that youth from a variety of backgrounds are engaged not just in one three-week unit during their K-12 schooling, but rather in a genuine curriculum. The good news is that there are successful computer science curricula being used with diverse youth in K-12 settings, such as Exploring Computer Science [28], which can provide examples as we think about what culturally responsive making looks like in schools and how we continue to engage youth in computing and engineering beyond entry-level projects.

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