

Promoting socio-political identification with computer science: How high school youth restory their identities through electronic textile quilts

Mia S. Shaw
University of Pennsylvania
Graduate School of Education
Philadelphia, USA
mshaw12@upenn.edu

GaYeon Ji
University of Pennsylvania
Graduate School of Education
Philadelphia, USA
gayeonji@upenn.edu

Yi Zhang
University of Pennsylvania
Graduate School of Education
Philadelphia, USA
zhangyi7@upenn.edu

Yasmin B. Kafai
University of Pennsylvania
Graduate School of Education
Philadelphia, USA
kafai@upenn.edu

Abstract—While many initiatives have broadened participation of minoritized youth in K-12 computing education, far fewer efforts have focused on expanding the social, political and cultural contexts of CS identity development. In this study, we propose a "restorying" pedagogy which engaged high school youth in interrogating dominant narratives about computer science through collaborative, electronic textile quilt-making. In our social design experiment approach, we designed and implemented a workshop where 14 racially- and ethnically-diverse youth crafted and coded interactive quilt patches that were digitally "stitched" into a collaborative artifact, with each patch reimagining CS from youths' perspectives (particularly regarding what CS is, who can participate in CS, and how CS is done). By analyzing post-workshop interviews and participant artifacts, we observed that counterstorytelling through electronic quilting can act as accessible and authentic tools to support youth's political identity work, electronic counternarrative expression, and community building in computing education. In the discussion, we address how restorying can contribute towards developing self-authored identities and critical computational literacies among youth and educators, as well as political solidarity within CS learning environments.

Keywords— *Identity, electronic textiles, counternarratives*

I. INTRODUCTION

I really feel like the storytelling aspect really pulled it all together. Because when we were learning about it...my favorite part of this workshop was learning all of the history behind computer science, and being able to like, acknowledge the bad points of this history and this community, and then retelling it to what we hope for it to be or what it might be now. I really, really enjoyed that. (Tanya, post-interview, lines 99-103)

There have been increasing efforts in the last decade to bring computing education into the K-12 education framework. Part of these efforts include broadening and deepening participation for minoritized youth, both formally and informally. However,

most of these efforts have focused on students learning computational thinking content and practices. Vakil [1] reminds us that disciplinary learning environments possess cultural and political values that endorse particular ways of being, thinking, and doing that can impact the disciplinary identity work of youth, thereby promoting or limiting particular kinds of identities. The documented longstanding exclusion of women and Black, Latinx, and Indigenous students throughout computing education [2] requires a shift in attention toward understanding how computing learning environments shape disciplinary learning and identity work for minoritized learners. In order to better understand how minoritized youth negotiate their sense of self in relation to the dominant culture of computing and technology, we must provide learning opportunities where they not only learn computational thinking content and practices but can also reflect on and contextualize their computing experiences within the dominant and concealed narratives about the culture of computing, computing education, and the historical marginalization of Black and Brown learners. Consequently, attempting to enculturate minoritized youth into computing while neglecting how the culture surrounding computing education devalues their social identities can further perpetuate the marginalization of racially- and ethnically-minoritized groups.

We draw on Thomas and Stornaiuolo's [3] conception of restorying—an analytical lens used in narrative and literacy research describing how youth use digital tools to reshape dominant narratives reflecting marginalized or silenced perspectives and experiences—as a potential learning tool for minoritized youth to use "new [computational] tools for naming oppression and narrating new visions for the future (p. 352)" [4]. Also referred to as a master narrative [5], we define dominant cultural narratives as those "known by most people in a given society and serve as an influential backdrop against which more localized community narratives and personal stories are told (p. 804)" [6]. Considering that CS learning environments can reproduce dominant narratives and stories that can negatively

affect minoritized youths’ sense of belonging in the field [7] [8], restorying provides an opportunity for youth to recontextualize their experiences with computing and technology in relation to the cultural and political ideologies regarding *what* CS is, *who* can participate in CS, and *how* CS is done. Furthermore, engaging youth in the restorying practices of self-making and worldmaking builds on prior studies that engage youth in “challenging dominant and normative practices, give voice to marginalized perspectives, analyze sociopolitical factors, and initiate social change through the use of computational thinking practices (p. 484)” [9] through foregrounding developing youths’ imaginative practice, or the ability to dream up alternate futures [4].

In this paper we present findings from a 34-hour restorying workshop we developed and implemented for a racially- and ethnically-diverse group of participants at a STEM program in a local science museum, where 14-15-year-old youth designed interactive, electronic textile (hereafter, e-textiles) quilt patches that restored dominant narratives about CS based on their lived experiences. E-textiles provided a compelling context for restorying because they juxtapose high and low technologies by integrating crafting and coding while also addressing historically gendered practices [10]. Building on the framework of identity as narrative through the stories we tell about ourselves, others, and our experiences [11], ultimately 14 youth designed electronic quilt patches while engaging in restorying, thereby combining e-textiles with the historical practice of quilting as a vehicle for youth to develop counternarratives about computing. To this end, we ask: *What does designing interactive, e-textile quilt patches that restore dominant CS narratives reveal about how high-school-aged youth identify with computing?*

II. BACKGROUND

While computing identity has been a focus since early in CS education, a recent surge in publications has generated numerous promising perspectives [12], particularly studies that leverage youth’s social identities for transformative learning and positive CS identity development (e.g., [13] [14]). Identity work in justice-oriented computing education builds on sociocultural perspectives that understand learning and identity to be inextricably linked. As learners engage in the disciplinary knowledge and practices of a particular community, they undergo a transformation as they better understand who they are and who they want to become in relation to that discipline [15] [16]. Such perspectives invite understanding disciplinary learning at an individual (through learner agency), community (through relationships with family, peers, and teachers), and structural level (via institutions or culture), shifting our focus from examining identity solely at the individual level to exploring how learners author identities that can conform to, resist, or challenge the existing power structures within disciplinary learning environments [17]. As a way to empirically observe the identities youth author in the CS learning environment, we adopt a theoretical perspective of identities as both narratives [11] and “conceptual [artifacts that contain, connect, and enable] reflection over the emotional and cognitive processes of self-understanding and self-defining [across time] (p. 34)” [18]. By examining how CS learning activities shape and are shaped by youth’s social and political identities [1], we

as CS researchers and educators can better understand how to leverage their identities for transformative learning that reimagines new worlds with regards to computing and technology. That is to say, through youth engaging in computational thinking skills and practices through designing electronic artifacts that restore dominant narratives in CS based on their lived experiences, we can better visualize the CS identities youth author and the resources utilized through the counternarratives they create.

To move computing identity work from theory to practice, we adapted restorying as a tool for youth to break down and synthesize CS stories in new ways in order to reconstruct meaning from their experiences. Restorying can describe how young people use digital tools (i.e., online fan fiction, social media activism, and media production) to “narrate the word and the world, analyze their lived experiences, and then synthesize and recontextualize a multiplicity of stories in order to form new narratives (p. 351)” [19]. As youth imagine themselves into dominant stories where they do not see themselves reflected, they engage in both self-making and worldmaking by reflecting on their lived experiences within the context of broader historical systems of oppression and reimagining alternate futures [4]. While restorying has been conceptualized as an analytical framework across narrative and literacy studies, we see potential in employing it as a learning tool for engaging youth in both computational thinking practices and historicizing their computing experiences within the dominant (and concealed) cultural narratives surrounding computing. Restorying offers a model for designing learning environments that allow youth to consider their social and political identities as they consciously author new CS identities and stories related to the culture of computing and technology.

In our particular case, we used quilting as a medium for restorying and identity work drawing on historical precedents in computing and minoritized communities. The foundation of our approach drew on often forgotten historical connections between quilting and computing considering Jacquard’s 1803 loom as a predecessor for modern computing [20]. As a practice, quilting has been used as a vehicle for women—particularly marginalized women—to express their social relationships, societal critiques, and histories. Black women, in particular, have utilized quilting as both an art form and sociopolitical tool for resisting oppression and reconstructing their experiences through creating records of their cultural and political pasts [21]; through sharing stories and forming strong sisterhoods while quilting, “[the practice has] allowed [Black women] to express themselves in an artistic manner when few means existed for them to have a voice (p. 593)” [22]. As we can see, quilting has served as a vehicle for minoritized communities to develop and express counternarratives based on their lived experiences. Despite few promising studies and artistic pieces integrating computational components into quilting (e.g., [23]), there has yet to be a K-12 computing activity that explicitly leverages quilting’s potential as a tool for youth’s political identity work, counternarrative creation, and collaborative meaning-making and community building.

Inspired by Pinkard, Erete, Martin, and McKinney de Royston’s study of blending narratives with e-textiles [24], we used a social design experiment approach [25] to design a study

with the purpose of youth creating counternarrative-based quilt patches about computing through restorying dominant cultural narratives about CS. By drawing from their personal experiences with computing and identifying dominant stories about the discipline, minoritized youth designed paper-circuit-based quilt blocks that restoried their connections to CS while developing computational skills and engaging in critical literacy practices [26], thereby illustrating their use of computing to identify with the discipline in novel, more meaningful ways. The ubiquitous and affordable materials provided a preliminary exploration for how e-textiles and its ties to crafting could be used as a medium for quilting. Through a combination of crafting, circuitry, and coding, e-textiles provide an ideal vehicle for integrating quilting and computing, as learners connect sewable Arduino-based microcontrollers with conductive thread to actuators (e.g., LEDs and sensors) to make interactive craft projects [27]. Early research has demonstrated that e-textiles can be used to design culturally-relevant learning environments for youth—particularly minoritized youth (e.g., [28] [29])—to develop positive STEM and computing identities. By engaging youth in designing e-textile quilt patches that restory dominant CS narratives, we may better understand their computing identity work. Further, as they design electronic artifacts that reveal their connections to the dominant political and ethical dimensions of CS, they also reveal entirely new possible ways of doing, thinking, and being in the discipline.

III. RESEARCH DESIGN

A. Methodology

Building on a pilot study implemented in 2019 [26], the 2020 study employed a social design experiment approach [25] to better understand minoritized youth’s computing identity work. While traditional design-based research tends to work inside existing institutions with the goal of developing new teaching and learning knowledge, social design experiments aim to transform social institutions by employing principles of equity and historicity in order for minoritized groups to become designers of their own futures. With each design iteration, theories of learning are challenged and refined as new theories emerge from the study that reflect youth’s development as conscious, historical actors who understand “how particular cultural practices came into being and how they have enabled and constrained possibilities for learning” (for example, how Black and Brown groups become minoritized in computing), and “how these understandings inform future-oriented practices (p. 567)” [25]. By minoritized youth developing the historical and critical analysis skills necessary for understanding the reasons and methods behind why and how their communities have been marginalized by the dominant narratives surrounding CS, they develop tools for engaging in and imagining more equitable futures surrounding computing.

B. Participants

The workshop took place with nineteen 14-15-year-old youth in a racially- and ethnically-diverse, STEM program at a local science museum. Given that youth apply to the program from different schools across the city, we assumed that they may have had a diverse range of knowledge and/or experiences related to STEM and computing learning. Therefore, understanding how youths’ social identities impact their

computing participation can illuminate their computing identity work while they design their quilts. We did not collect demographic information from participants, but youth in the program consisted of 9 boys and 10 girls, and the racial/ethnic breakdown of youth includes the following: Black or African American (8 youth), Asian (5 youth), White or Caucasian (2 youth), Hispanic or Latinx (2 youth), and Other (2 youth) (anonymous demographic data was collected from the program manager and reflects descriptions used by the program).

C. Workshop activities

We redesigned the 2020 workshop to be implemented in two parts. During part 1, participants met weekly for two hours (10 hours total) and were introduced to computational thinking practices and activities (e.g., paper circuits, e-textile wristbands, and block-based programming) as well as CS concepts, prominent computer scientists, and dominant narratives. Due to the COVID-19 pandemic, the workshop transitioned to virtual learning using Google Meet (which encrypts all its data during video meetings) for synchronous sessions and the digital portfolio platform Seesaw for youth reflection activities and design process documentation.

Part 2 continued remotely for three hours daily during the summer program (24 hours total) with a focus on “restorying” the dominant narrative of CS through designing and making interactive quilts. The mini-lessons covered topics including the dominant and hidden history of computing, systemic issues using computing (e.g., algorithmic bias), and the use of quilting and technology for activism to challenge such oppressive forces. The workshop was updated to incorporate crafting and quilting practices in order for youth to design fabric-based, e-textiles quilt patches using Micro:bit microcontrollers, LEDs, touch sensors, conductive thread, and felt in order to explore the material and imaginative affordances for reflecting on, critiquing and reimagining dominant narratives about CS. After youth completed their individual quilt patch designs, thumbnails of their patch designs were digitally “stitched” into a collective quilt using a shared Google Document (see Figure 1), providing a collaborative artifact from which to discuss the collective counternarratives developed.

D. Positionality of authors

The first author codesigned the workshop with the fourth author and colleagues for the pilot study, co-facilitated the pilot workshop, and facilitated the workshop for this study. As a Black woman and former middle school science and STEAM maker educator, she has devoted the last seven years to designing transformative learning environments for minoritized youth. The second author participated in analyzing the interview and worksheet data and co-developing the codebook with other



Fig. 1. Collective digital quilt including participants' quilt patches.

authors. As an Asian woman, STEAM educator, and digital media artist, she has a passion for helping minoritized youth build their sense of agency and belonging by designing new media artifacts. The third author supported organizing, coding and analyzing the student data collected from the workshop. As an Asian woman, multimedia artist, and aspiring learning designer, she aims to further her research in community-based art initiatives for underrepresented youth in the arts. The fourth author is an Indo-European woman, learning scientist and faculty member dedicated to K-12 computer science education who has participated in the design and research of programming tools and activities.

E. Data collection and analysis

Since not all participants were able to remain until the end of the workshop because of the transition to online, analysis focused on the remaining 14 consenting/assenting youth. Data collected included participants' artifacts (e.g., photos and videos of youths' quilts in interaction, the collective digital quilt including youth's quilt patches, activity worksheets, and Seesaw design journals), researcher memos, and post-interviews from participants. We should note that while analysis focused on completed quilt patches from 14 participants, one of those participants was unable to join a post-interview due to scheduling issues; however, she provided enough information about her quilt patch in her Seesaw journal that we felt warranted its inclusion in the analysis.

The first three authors conducted three rounds of comparative, inductive analysis of interview and worksheet data in order to develop a codebook and framework for understanding how participants' CS identity work. For our preliminary coding scheme, the first author conducted open coding of one of the interview transcripts and applied this coding scheme to two other transcripts, discussing and amending the codes with the second and third authors as necessary until a

consensus was reached. For the second round of analysis, we conducted open coding through content analysis of all participants' quilt patches and the collective digital quilt, identifying (1) each of the dominant narratives addressed, (2) how they were restoried, (3) the symbols used across designs, and (4) how interactions were programmed and incorporated into the quilt design. Post-interview and quilt data were triangulated against youth's Seesaw data (i.e., videos of quilts, activity worksheets, and design journal reflections). After analysis memos were written among the first three authors, we amended the coding scheme to better preserve participants' interpretations of their experiences and conducted a third round of analysis across the data, discussing and further defining the codes until consensus was reached.

IV. FINDINGS

At the end of the workshop, 14 participants designed and created interactive, e-textiles quilt patches that restoried dominant narratives about CS across various social and political identity dimensions. We found that through engaging in restorying practices as well as computational thinking content, skills, and tools, (1) youth's critical reflection on the history of CS provide space for developing their political identities; (2) restorying through e-textiles served as a vehicle for youth to design, create, and share counternarratives about CS; and (3) quilting can be seen as an embodied metaphor for collective meaning-making, community building, and the mixing of seemingly different technologies.

A. Finding 1: Critical reflection and sharing of dominant and hidden CS stories

Restorying dominant CS narratives provided youth the opportunity to develop their political identities and the agency to dismantle narratives based on power and privilege within the culture surrounding CS. Out of the 14 finished quilt patches, 10 projects addressed issues related to power, privilege, and ethics in CS, whether themes tackled dominant narratives related to algorithmic bias, exclusion, sexism, racism, homophobia or ableism. For example, dominant narratives restoried across the quilt patches addressed: (1) only white people, particularly men, contributing to the CS discipline (Matthew, Nora, Amanda, Michelle, and Yesica); (2) girls not seen as capable of doing CS (Britney and Tanya); (3) people's overreliance on technology (which can still make racist mistakes, as Jordan reminds us); and (4) discrimination based on race, gender, sexual orientation, or ability (Layla and Ahmad). However, during post-interviews, most participants (10 total) expressed difficulty with understanding dominant narratives at the start of the workshop, whether it was being unaware (Matthew, Yesica, Britney, Tina, and Amanda) or confused (Amanda) about what dominant narratives surround CS or what they even are, people not actively thinking about them (Alexander), or not being sure how to address them if known (Layla). "It's like what people believe than what it actually is," Nora ascertained, reflecting how dominant narratives shape how people perceive reality [6]. Despite the mainstream influence and power dominant narratives possess within CS culture, Layla points out the challenge of resisting them.

I don't think anyone really thinks about it, I think we acknowledge it. And we know that it's out there, but we

don't know how to do anything with it. We know that there's these stories that you have to be this white, straight, nerdy male to be a computer scientist, we don't know how to do anything about it, and then you just go in there. And you're like, well, I'm going to be a computer scientist, but I don't know how to overcome all of these. (Layla, post-interview, lines 177-182)

Layla highlighted how pervasive and oppressive the dominant cultural stories of computer scientists being straight, nerdy White men are in society, acting as the “influential backdrop (p. 804, [6])” upon which minoritized youth must navigate and overcome while learning CS.

Having said that, engaging in restorying practices provided participants an entry point for challenging these stories by allowing them to reflect on their present and future selves in relation to dominant narratives in computer science. Despite believing in prominent stereotypes about CS prior to the workshop—that CS is complex or difficult (Tina, Nora, and Ahmad), boring (Matthew and Tina), or only for white men (Matthew, Layla, and Yesica)—all participants who were interviewed after the workshop expressed desire and interest in participating in CS activities in the future. Even though youth identified various challenges with the process, restorying dominant CS narratives supported most youth (12 participants) in shifting their perceptions about discipline, from learning CS’s hidden history of exclusion to expanding who they believe can participate in CS. That being said, when asked whether they identified as computer scientists, seven participants agreed while others shared varying perceptions on who gets to be a part of the CS community. Though Matthew and Nora believed that anyone—whether they use a phone or TV (Matthew) or continue learning about coding and computers—could be computer scientists, other participants identified conditions they felt were needed before they could consider themselves computer scientists, such as needing more experience (Ahmad, Anthony, Tanya, and Alexander), not feeling confident with technology (Jordan), or feeling like they consume technology more so than create it (Tina). Further, Layla and Britney both noted how learning about CS through the workshop—which included not only learning computational content and practices but also the dominant cultural narratives surrounding who gets to be part of CS—allowed them to *be* computer scientists on a smaller level with peers, providing the space for them to actively restory the narratives they were resisting. Even though youth possessed varying degrees of identification with being computer scientists, half of the group (7 participants) expressed developing more understanding of CS as a discipline, while others (5 participants) believed after the workshop that anyone could do CS.

Across these examples, youth’s identification as computer scientists reflects a conscious process of their remaking what it means to be a member of the CS discipline and community through a historical, dialogical process, illustrating ways in which youth act as historical actors designing their own futures [30] [25]. Tanya described this process as, “My favorite part of this workshop was learning all of the history behind computer science—and being able to like, acknowledge the bad points of this history and this community, and then retelling it to what we hope for it to be or what it might be now (post-interview, lines 100-103).” As a student who self-identified as “one-fourth of a

computer scientist,” Tanya used her quilt (see Figure 2) to emphasize that women are not only capable of adding to the field of CS, but have added and will continue to add to the discipline. Based on her evaluation of the dominant history of CS, she drew upon her political identity to confront the “bad points” of CS culture by highlighting women computer scientists in her quilt. She added that being able to create a visual narrative reimagining how women are portrayed in CS with e-textiles and programming made her feel proud. In this process, the silencing of alternative narratives from those marginalized in CS are visible for students to hold, confront, evaluate and transform [1], thereby transforming who they are and want to become in relation to the discipline. Through this critical and creative interpretation of CS and connecting those interpretations to their identity, youth participated in self-making practices [4] by creating counternarratives of who they are and who they might become, illustrating youth’s interpretation of the values of CS discipline while evaluating their current and future selves in relation to CS through this workshop.

B. Finding 2: Designing interactive e-textiles as sites for counterstorytelling

Engaging in computing and restorying practices through quilting via e-textiles served as an innovative medium for youth to communicate and support their counternarratives about CS. Despite preconceived notions of quilting being an “old ladies’ activity (Layla),” youth noted how designing quilt patches using the e-textiles materials (e.g., conductive thread, fabric, and LEDs) inspired new visions and uses for CS. When showing off her quilt patch to her mother, Britney commented on how her mother exclaimed, “Wow I didn’t even know that like, [you] were doing computer science every day.” Given that quilts are used “to get things across from people to people (Yesica),” integrating CS technologies into quilt patches using e-textiles can add additional aesthetic meaning to youth’s restored narratives (e.g., Jordan reminded us how LEDs could be used to attract people to the quilt patches). Through designing interactive, narrative-based e-textiles quilt patches, eight participants found storytelling through electronic quilting a novel vehicle for communicating a message to an audience, real or imagined. Youth adapting and creating agency over this new medium required a combination of learning restorying practices as well as crafting, circuitry, and programming interactions for their “re-stories”, illustrating the potential of CS to be used for counterstorytelling, as both Ahmad and Alexander noted.

In addition to communicating messages, youth demonstrated the role emotions play when mastering the tools to navigate and visualize their quilt designs. When considering the process of designing their “re-stories” through electronic quilting, Anthony recalled that it being both challenging and fun. “It was fun because, like, I could turn a story in my head and then make it something visual. But it was a challenge because of the same reason. I had to take that idea, which I could usually just say it and then, like, sew it onto a quilt (post-interview, lines 102-105).” In terms of interaction, Anthony programmed his quilt patch (see Figure 2) so that when button A is pressed, the LEDs associated with the stereotypical objects for CS light up and when button B is pressed, the LEDs associated with objects related to the interdisciplinary aspects of CS light up. However, when both buttons are pressed together, all LEDs light up and

the Micro:bit presents the secret message “Computer science equals to computer science,” implying that not one aspect of CS illustrated by the objects shown in the quilt is “more CS-ish” than the others. As we can see, Anthony used his quilt to dismantle the dominant narrative that CS is only programming by illustrating that CS can be implemented and transformed into other areas, such as engineering, robotics, and games. He expressed how the e-textile quilt patch enabled him to bring his story into life, through which he could “convey a message, without speaking.” This illustrates the potential of integrating quilting and computing for exploring abstract ideas or concepts in a multi-sensory, concrete way, promoting an alternative lens for youth to imagine new worlds [19].

At the start and during the process, 10 participants expressed frustration and nervousness during the workshop activities. However, most youth shared feeling satisfied and accomplished after successfully overcoming challenges (7 participants), as well as had fun during the workshop (8 participants). More specifically, Tanya, Layla, and Matthew expressed feeling empowered to apply restorying practices to challenges both inside and outside the CS classroom. That being said, we should note that Tina was the only participant who expressed that CS was not something she would like to do in the future, despite finding the project fun and expressing interest in participating in future workshops. Her communicating a lack of certainty regarding how it felt to reimagine CS dominant narratives and feeling as though she “uses” or consumes CS as opposed to makes things with it (despite having just created a quilt patch) highlights the differences in how youth perceive the agency (both technically and emotionally) to imagine new CS futures.

C. Finding 3: Quilting as an embodied metaphor for building a learning community of practice

Designing electronic quilts while engaging in the practice of restorying not only provided youth a novel approach for creative personal expression, but it also constructed a space for collective meaning-making and community building as represented through the digital collective quilt. In other words, the practice of quilting served as an embodied metaphor that also supported youths’ collective knowledge building and space making. Through participating in group discussions and sharing their personal stories (and re-stories) with one another while engaging in the making process, participants transformed the CS learning environment into a meaningful, collaborative space where everyone embraced restorying their own stories and imagining alternative ways of being, thinking, and doing in computing. Amanda, for example, described in that she “[liked] the different, um, the group projects, we got to share our opinions. I liked that.” All of these re-stories contributed to the practice of collective meaning-making, representing a large scale version of quilting bees [22].

While designing and making their quilt patches, youth experienced a creative way to combine diverse technologies for personal expression. This process of mixing “soft” crafting techniques with “hard” computational techniques has also been regarded as a metaphor for quilting. In her post-interview, Britney communicated this perspective with the interviewer.

Britney: Like, we're using a bunch of technology...at least for me, I had to like, look up ways to do different things with my quilt. (lines 104-105)

Author 1: Ok. Oh, so you're kind of saying like using all the different technologies together is kind of like quilting. (lines 106-107)

Britney: Yeah. (line 108)

Additionally, the collective digital quilt provided youth a third space [31] [32] to “stitch” different stories into a collaborative cultural artifact. It embraced them bringing their diverse life experiences, cultural perspectives, and personal values related to computing and marginalization in interrogating the dominant narratives about CS. This reflects how out of the various learning resources youth utilized when designing their quilts, more than half of the participants (9 total) acknowledged their peer’s stories and perspectives as helpful resources for restorying dominant CS narratives. By collective participation in the restorying process, youth reconsidered their social and political identities “outside the private self” [33] [1], and made sense of themselves and from a social justice perspective.

By being active figures in the space-making process for the workshop, four youth expressed a strong sense of belonging towards CS. They believed the historical narratives of CS could be changed progressively, despite acknowledging the negative points throughout the discipline’s history. Yesica showed hope for how things can be improved in CS (see Figure 2) by stating that, “I felt like it's a good way to like, um, show things that could improve, and, you know, they might not really improve as much, but it's still a way to show hope, and to continue pushing and fighting for the computer science that we want, in a way (post-interview, lines 106-109).” This hope empowered youth to be a part of a community that can challenge and transform the dominant stories and stereotypes surrounding CS culture. Quilting from this perspective can be regarded as a social practice that collectively constructs a new image of oneself, the communities youth desire to participate in, and the world.



Fig. 2. Tanya’s (top), Anthony’s (bottom left) Yesica’s (bottom right) quilt patches.

V. DISCUSSION

The findings from this workshop study provide promising insights into how we can engage youth in critical CS identity work. Most importantly, youth not only engaged in critical examinations but also learned about crafting and coding through creating electronic textiles. Making the e-textile artifacts also promoted CS connections to school, society, and home. Our analysis also revealed the need for introducing and interrogating dominant cultural narratives and the significance for supporting solidarity through building community, to be discussed in more detail below.

A. *The need for support in revealing and interrogating dominant narratives*

While restorying provided youth the opportunity to reflect on the dominant ideas, stories, and norms surrounding CS in their e-textiles quilts, we noticed that the majority of participants expressed initial confusion regarding understanding the concept of dominant narratives, despite being able to readily recognize them once identified during discussions. One possible explanation is that the normalization of dominant narratives makes them appear objective and apolitical through functioning like an invisible current guiding our perceptions of reality [6]. However, we must remember that ideologies promoting the dominant culture of White supremacist capitalist heteropatriarchy [34] manifest themselves within the history of the CS discipline, whether it is through the exclusion of minoritized groups in CS education [2], the rise in discriminatory design using computing (e.g., [35], [36], [37]), or silencing of alternative stories, like computer scientist Timnit Gebru's firing from Google for speaking out about diversity issues at the company [38]. If we want to support youth in imagining alternate presents and futures beyond oppressive structures, we as designers of CS learning environments need to scaffold the methods for breaking down and interrogating the dominant narratives regarding the field. Such practice involves not only developing awareness of the narratives in the first place but—and probably more importantly—it is imperative that youth develop an understanding behind how these narratives function rhetorically and systemically.

B. *The significance for promoting and supporting solidarity*

A surprising but significant element of the study was the collective meaning-making and counterstorytelling embodied through the digital quilt, which reflected a reimagined CS based on belonging, creativity, and a condemnation of oppression. Considering that participants were members of a STEM program that appears to reflect social justice aims through changing the “DNA” of STEM and targeting underserved youth, this might provide an explanation for some of the shared political values across the diverse group of youth. That being said, we found it interesting how some youth seemed to use “we” when suggesting the possibility for change in CS or when envisioning what they hoped CS to be in the future after dismantling the dominant narratives. These differences in expression of political engagement with CS harkens to the concept of politicized trust, a form of trust that “acknowledges the racialized tensions and power dynamics inherent in design

partnerships” (p. 199) through mutual political understanding, respect, and solidarity [39] [40]. Given the diversity in social and political identities related to computing in the workshop, we recognize a missed opportunity in not specifically addressing issues of power and privilege when restorying dominant narratives. True solidarity requires both political understanding of histories of oppression, marginalization, and power, as well as respectful interactions and relationships. As we consider ways to develop CS learning communities with youth (who each come from communities with distinct histories of oppression and potentially distinct experiences related to computing), it is important we consider what elements are necessary for promoting and supporting among youth a shared solidarity and commitment towards social transformation.

VI. CONCLUSION

One of the next steps is to move restorying quilts to formal computing classrooms. For this we need to prepare computing educators for engaging their students in discussions about the political and ethical dimensions through highlighting dominant CS narratives. Aside from the Exploring Computer Science program, there are few computing teacher education programs that not only address histories of oppression within the discipline but also prepare teachers for engaging their students in such discussions. Fortunately, we see the process of designing quilts that restory dominant narratives as a practice computing educators can engage in, for they can develop both their computational competence and identities as justice-oriented educators. CS teachers themselves can act as gatekeepers through exclusive pedagogical practices and classroom cultures, so we must consider providing them opportunities to also reflect on and challenge dominant cultural narratives that minoritize Black and Brown youth in CS education.

ACKNOWLEDGMENT

Special thanks to the participants from the workshop, Danielle Maurino for her help with recruitment, Gayithri Jayathirtha and Luis Morales-Navarro for their help with data collection and to Ammarah Aftab and Renato Russo for their valuable help with data analysis. Any opinions, findings, and conclusions or recommendations expressed in this paper are those of the authors and do not necessarily reflect the views of the University of Pennsylvania.

REFERENCES

- [1] S. Vakil, “‘I’ve always been scared that someday I’m going to sell out’: Exploring the relationship between political identity and learning in computer science education,” *Cogn. Instr.*, vol. 38, no. 2, pp. 87–115, 2020.
- [2] J. Margolis, *Stuck in the shallow end: Education, race, and computing*. London, England: MIT Press, 2017.
- [3] E. E. Thomas and A. Stornaiuolo, “Restorying the self: Bending toward textual justice,” *Harv. Ed. Rev.*, vol. 86, no. 3, pp. 313–338, 2016.
- [4] A. Stornaiuolo and E. E. Thomas, “Restorying as political action: Authoring resistance through youth media arts,” *Learn. Media Technol.*, vol. 43, no. 4, pp. 345–358, 2018.
- [5] M. Bamberg, “Considering counternarratives,” in *Considering counternarratives: Narrating, resisting, making sense*, M. Bamberg and M. Andrews, Eds. Amsterdam: John Benjamins Publishing Company, 2004, pp. 351–371.

- [6] J. Rappaport, "Empowerment Meets Narrative: Listening to Stories and Creating Settings," *Am. Jour. Comm. Psych.*, vol. 23, no. 5, pp. 756-807, 1995.
- [7] S. Cheryan, V. C. Plaut, P. G. Davies, and C. M. Steele, "Ambient belonging: how stereotypical cues impact gender participation in computer science," *J. Pers. Soc. Psychol.*, vol. 97, no. 6, pp. 1045-1060, 2009.
- [8] C. Ashcraft, E. K. Eger, and K. A. Scott, "Becoming technosocial change agents: Intersectionality and culturally responsive pedagogies as vital resources for increasing girls' participation in computing: Technosocial change agents," *Anthropol. Educ. Q.*, vol. 48, no. 3, pp. 233-251, 2017.
- [9] C. H. Lee and E. Soep, "None but ourselves can free our minds: Critical computational literacy as a pedagogy of resistance," *Equity Excell. Educ.*, vol. 9, no. 4, pp. 480-492, 2016.
- [10] K. Qiu, L. Buechley, E. Baafi, and W. Dubow, "A curriculum for teaching computer science through computational textiles," in *Proceedings of the 12th International Conference on Interaction Design and Children*, 2013.
- [11] A. Sfard and A. Prusak, "Telling identities: In search of an analytic tool for investigating learning as a culturally shaped activity," *Educ. Res.*, vol. 34, no. 4, pp. 14-22, 2005.
- [12] M. S. Shaw and Y. B. Kafai, "Charting the identity turn in K-12 computer science education: Developing more inclusive learning pathways for identities," in *Proceedings of the fourteenth International Conference of the Learning Sciences*, 2020.
- [13] N. S. Nasir and S. Vakil, "STEM-focused academies in urban schools: Tensions and possibilities," *J. Learn. Sci.*, vol. 26, no. 3, pp. 376-406, 2017.
- [14] S. Vakil, "Ethics, identity, and political vision: Toward a justice-centered approach to equity in computer science education," *Harv. Educ. Rev.*, vol. 88, no. 1, pp. 26-52, 2018.
- [15] P. Bell, K. Van Horne, and B. H. Cheng, "Special Issue: Designing Learning Environments for Equitable Disciplinary Identification," *J. Learn. Sci.*, vol. 26, no. 3, pp. 367-375, 2017.
- [16] J. Lave and E. Wenger, "Legitimate Peripheral Participation," in *Situated Learning*, Cambridge: Cambridge University Press, 1991, pp. 27-44.
- [17] H. B. Carlone, "Disciplinary Identity as Analytic Construct and Design Goal: Making Learning Sciences Matter," *J. Learn. Sci.*, vol. 26, no. 3, pp. 525-531, 2017.
- [18] M. Esteban-Guitart and L. C. Moll, "Funds of Identity: A new concept based on the Funds of Knowledge approach," *Cult. Psychol.*, vol. 20, no. 1, pp. 31-48, 2014.
- [19] A. Stornaiuolo and E. E. Thomas, "Disrupting educational inequalities through youth digital activism," *Rev. Res. Educ.*, vol. 41, no. 1, pp. 337-357, 2017.
- [20] J. Essinger, "Jacquard's web. How a hand loom led to the birth of the information age. Oxford University Press, 2007.
- [21] F. B. Cash, "Kinship and quilting: An examination of an African-American tradition," *J. Neg. Hist.*, vol. 80, no. 1, pp. 30-41, 1995.
- [22] A. Butler, "Quiltmaking among African-American women as a pedagogy of care, empowerment, and sisterhood," *Gend. Educ.*, vol. 31, no. 5, pp. 590-603, 2019.
- [23] A. Salter and A. Sullivan, "Blocked Connections: Quilts using QR technology and generated websites as a narrative experience," in *Electronic Literature Organization Festival - Mind the Gap!*, 2018.
- [24] N. Pinkard, S. Erete, C. K. Martin, and M. McKinney de Royston, "Digital youth divas: Exploring narrative-driven curriculum to spark middle school girls' interest in computational activities," *J. Learn. Sci.*, vol. 26, no. 3, pp. 477-516, 2017.
- [25] K. D. Gutiérrez and A. S. Jurow, "Social design experiments: Toward equity by design," *J. Learn. Sci.*, vol. 25, no. 4, pp. 565-598, 2016.
- [26] M. S. Shaw, J. J. Coleman, Y. B. Kafai, and E. E. Thomas, "Restorying geek identity: Reimagining computer science connections with youth of color through collaborative quilts," in *Proceedings of the second Connected Learning Summit*, 2018.
- [27] L. Buechley, M. Eisenberg, J. Catchen, and A. Crockett, "The LilyPad Arduino: Using computational textiles to investigate engagement, aesthetics, and diversity in computer science education," in *Proceeding of the twenty-sixth annual CHI conference on Human factors in computing systems - CHI '08*, 2008.
- [28] K. A. Searle and Y. B. Kafai, "Boys' needlework: Understanding gendered and indigenous perspectives on computing and crafting with electronic textiles," in *Proceedings of the eleventh annual International Conference on International Computing Education Research*, 2015.
- [29] A. Allen-Handy, V. Ifill, R. Y. Schaar, M. Rogers, and M. Woodard, "Black Girls STEAMing through dance: Inspiring STEAM literacies, STEAM identities, and positive self-concept," in *Challenges and Opportunities for Transforming From STEM to STEAM Education*, IGI Global, 2020, pp. 198-219.
- [30] K. D. Gutiérrez, "Developing a Sociocritical Literacy in the Third Space," *Read. Res. Quart.*, vol. 43, no. 2, pp. 148-164, 2008.
- [31] E. W. Soja, *Thirdspace: Journeys to Los Angeles and other real-and-imagined places*. London, England: Blackwell, 1996.
- [32] H. K. Bhabha, *The Location of Culture*. London, England: Routledge, 1994.
- [33] J. Goodwin, J. M. Jasper, and F. Polleta, *Passionate politics: Emotions and social movements*, 2nd ed. Chicago, IL: University of Chicago Press, 2001.
- [34] b. hooks, *Teaching to transgress*, New York, NY: Routledge, 1994.
- [35] S. Costanza-Chock, *Design justice: Community-led practices to build the worlds we need*, Cambridge, MA: MIT Press, 2020.
- [36] R. Benjamin, *Race after technology: Abolitionist tools for the new jim code*, Hoboken, NJ: Wiley, 2019.
- [37] S. Noble, *Algorithms of Oppression*, New York, NY: New York University Press, 2018.
- [38] T. Simonite, "A Prominent AI Ethics Researcher Says Google Fired Her," *Wired*. [Online]. Available: <https://www.wired.com/story/prominent-ai-ethics-researcher-says-google-fired-her/>. [Accessed: 1-Mar-2021]
- [39] S. Vakil, M., McKinney de Royston, N. Nasir, and B. Kirshner, "Rethinking race and power in design-based research: Reflections from the field," *Cog. Instr.*, vol. 34, no. 3, pp. 194-209, 2016.
- [40] S. Vakil and M. McKinney de Royston, "Exploring politicized trust in a racially diverse computer science classroom," *Race Ed. Educ.*, vol. 24, no. 4, pp. 545-567, 2019.