From Computational Thinking to Political Resistance

Reciprocal Lessons from Urban Latinx Middle School Students

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Responses

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Abstract

Working with Latinx adolescents and providing informal learning experiences through a voluntary after-school program aimed at developing their computational thinking and competencies, discussions around the election of Donald Trump emerged as it was important for many students. Emergent bilinguals internalized the xenophobic discourse that was amplified during the presidential election season. Thus, students feared deportation, discrimination, and other forms of violence. Many students experienced their friends and families facing deportation due to the increased Immigration and Customs Enforcement raids that occurred in 2016. The after-school program was a safe space in which we could provide a constructive and creative environment for students to comfortably explore these topics. In this paper, drawing on three pre-service teachers' reflections, we explore how middle school urban Latinx students navigated their oppressors through computational thinking and show case a model of a critical pedagogy in an informal science education.

Introduction

Twenty-first century science and technology related skills and dispositions contribute not only to academic success, but also to ensuring a better socioeconomic future (Holdren, Lander, & Varmus, 2010). Moreover, computational thinking, an “analytic approach to problem solving, designing systems, and understanding human behaviors” (Sengupta, Kinnebrew, Basu, Biswas, & Clark, 2013, p.352), is regarded as a fundamental requirement of all STEM disciplines (Henderson, Cortina, & Wing, 2007). However, the report *Running on Empty: The Failure to Teach K-12 Computer Science in the Digital Age* (Wilson, Sudol, Stephenson, & Stehlik, 2010) states that student participation in computer science education is decreasing while the demand for computer science professionals is increasing dramatically. The lack of qualified computer science teachers and the lack of adequate and appropriate integration of computer science into the school curricula are two important issues discussed in Wilson and colleagues' (2010) report and in others' research (Barr & Stephenson, 2011; Goode, 2007, 2008; Grover & Pea, 2013; Kafai, Fields, & Burke, 2010).

As one of the science and technology related skills and dispositions often overlooked in preparing students for the 21st century workforce, computer science does not fully reflect a diverse population. Access to computer science education is very limited for non-Asian minorities, students of low socio-economic status (SES), and girls. Thus, this becomes a profound social justice issue involving privileges for certain students over others and creates segregation in computer science education that extends to the workplace (Goode, 2007; Wilson, et al., 2010). While Latinx people make up 17.6% of the U.S. population (United States Census Bureau, 2015), they are underrepresented in Science, Technology, Engineering, and Mathematics (STEM) careers. At the high school level, Advanced Placement (AP) Computer Science A participation is low overall, but drastically lower for Latinx students. For instance, of all the AP Computer Science A test takers in the U.S. in 2015, only 9.2% were Latinx, with dramatically lower pass rates for these students (39.3%) when compared to the overall pass rate (64.4%). At the university level, only 8.5% of Computer Science degrees were awarded to Latinx students in 2012 (Ericson, 2016). In industry, this lack of diversity is both reflected and exacerbated in top technology companies. Dowd, Malcolm, & Bensimon (2009) reported that Latinxs are largely absent in STEM fields, including computer science. This correlates with the low number of Latinxs (10%) with a college degree and even lower number of Latinxs with a STEM degree (Gandara & Contreras, 2009). Many institutional barriers exist for low Latinx participation in Computer Science. An important and primary barrier is the lack of qualified computer science teachers (Grover & Pea, 2013). Qualified computer science teachers need to be proficient in both computer science content knowledge as well as pedagogical content knowledge, well prepared, and able to implement relevant, engaging, and authentic computational experiences.

Context: A Reciprocal Model for Teaching and Learning Computational Competencies

A Reciprocal Model for Teaching and Learning Computational Competencies (ARMTLCC) is a three-year long project that extends existing research in the field by propositioning a model to teach Computational Competencies. A major goal of the project is to develop a model for Culturally Relevant Pedagogy (Ladson Billing, 1995) for teaching and learning computational competencies based on the principles of culturally relevant pedagogy and implement the model in an afterschool programs for middle school Latinx students in an urban school district in Southeastern United States. The reciprocal nature of the model in the ARMTLCC project is that afterschool teachers (university students preparing to become teachers) and the Latinx students learn from and teach each other. More specifically, the teachers learn to develop and implement culturally relevant computational experiences through formal seminar-type classes and field experiences in the afterschool setting (Aghasaleh et al., 2018). The extent of teacher participation in project activities is intended to help develop personal agency, while also engaging them in reflective practice that is aimed at specifically examining how they can best meet the needs of urban Latinx students.

Figure 1 provides a graphical representation of the many connections and constructs involved in the project focused on culturally relevant computational thinking, including the a network of agents that shape the activities: the researchers and the funding agency supporting the project; the Latinx middle school students who participated in the focal afterschool program; the pre-service teachers who learned about computational thinking and culturally relevant pedagogy to develop and implement rich and engaging computer science activities; the community partners whose organization started and sustained the afterschool program where the work took place; the families who supported their students as they worked in the program and celebrated their work every semester; and the school administration who supported the program through the provision of space and time. The central project efforts include both the afterschool leadership program and the accompanying methods course for the pre-service teachers (yellow boxes), which are described further below. The curricular and instructional elements of these two contexts relied on several foundational constructs (pink ovals), including the NGSS Science and Engineering Practices, Social Justice Education, Freirian Problem Posing, and Feminist Standpoint Epistemology. These constructs

guided much of the curricular work in the two contexts, particularly as the pre-service teachers experienced and then developed computer science activities (purple ovals) implemented in the afterschool program.

Figure 1. ARMTLCC Conceptual and Executive Model

Computer Science Teaching Methods Course

The teaching methods course in this study was developed through the collaboration of the researchers with a computer scientist and with a focus on several guiding constructs, including computer science, computational thinking (Grover & Pea, 2013; NGSS Lead States, 2013), and culturally relevant pedagogy (Ladson-Billings, 2008). Computational thinking served as the major scientific focus, as it is one of eight scientific practices emphasized in the Next Generation Science Standards (NGSS) and state adaptations of those standards (GA DOE, 2016). These practices represent the fundamental activities that scientists and those learning about science engage in for the purposes of exploring and constructing understanding around different phenomena (Ford, 2008; Osborne, 2014). A seminal description of computational thinking describes it involving “solving problems, designing systems, and understanding human behavior, by drawing on the concepts fundamental to computer science” (Wing, 2006). This particular practice has received much less attention in both education research and practitioner literature (Kite et al., 2018), remaining less well conceptualized and operationalized for K12 teachers, let alone students. As the pre-service teachers were recruited across several academic disciplines, including Language & Literacy and English Speakers of Other Languages (ESOL), developing a basic understanding of computational thinking was warranted. Thus, the

course included lectures and instructional activities focused on computer science concepts, such as encryption and searching & sorting algorithms, along with working in coding platforms relevant to the project work (e.g., Scratch (Resnick, Maloney, Monroy-Hernández, Rusk, Eastmond, Brennan, Millner, Rosenbaum, Silver, Silverman, & Kafai, 2009) and Arduino (Arduino.cc, 2015)) and review of computer science education documents, such as the Computer Science Teachers Association (CSTA) standards (CST Force, 2011). These activities aimed to develop an understanding of basic concepts and proficiency with certain technical skills so that the pre-service teachers could design and implement computational thinking activities with students in the afterschool program. Although the ambiguity around computational thinking presented challenges in designing the course, it also allowed for more flexibility to combine efforts around this construct while also grounding the work in perspectives drawn from literature broadly concerning culturally relevant pedagogy.

To more fully develop the pre-service teachers' cultural awareness, the course focused on several topic areas of critical scholarship, including race, gender, sexuality, class, ableism, and age (Blanchett, 2006; Fausto-Sterling, 2000; Gonzalez, 2006; hooks, 2000; McIntosh, 1998; Nieto, 2012; Noguera, 2006; Tatum, 2003; Vargas, 2011). These foci intertwined throughout the course material, providing opportunities for the pre-service teachers to develop deeper understanding of how different aspects of culture impacted the ways students learn in and out of classrooms and how those considerations could shape learning interactions focused on computational thinking. This additional emphasis was warranted as cultural connections, when made explicit in delivering instruction, have been shown to enhance the learning experience for students, creating stronger affective connections to the content being taught (Calabrese-Barton & Tan, 2010; Swanson, Bianchini, & Sook Lee, 2014). The pedagogical approaches employed during the course included a combination of assigned scholarly readings followed by reflective writing and class discussions to explore cultural perspectives. Further, these perspectives were then emphasized as certain instructional strategies were modeled and as pre-service teachers designed their own activities to implement in the afterschool program. These activities also provided opportunities for the pre-service teachers to explore aspects of their own cultural identities and perspectives while connecting those to their identities as teachers.

Informal Education: Latinx Youth Leadership Academy

The racialized, xenophobic, and nationalist attacks by Donald Trump during the presidential campaign and after being elected president and the subsequent emboldening and emergence of the so-called alt-right, in effect a collection of white supremacists, neo-Nazis, Klu Klux Klan members, and other fringe and far right groups, have taken a toll and continue to take a toll on groups and individuals deemed racial and ethnic minorities in the United States. Of particular concern is the vitriol surrounding general, political, and policy discussions associated with Dreamers/DACA (Deferred Action for Childhood Arrivals), sanctuary cities, undocumented immigrants, and illegal immigration. For example, during the heat of the presidential campaign, anti-immigrant and nationalist sentiments were stoked by calling for a wall to be built along the southern border separating the United States and Mexico, calling Mexicans rapists, drug smugglers, and criminals, and calling for a "total and complete" ban on Muslims entering the United States. We have seen first-hand the impact and the hurt that these anti-immigrant and ultra-nationalist rhetoric, first, and later, policies have had on the Latinx youth we serve. Seemingly overnight (after one of the debates), the middle school-aged Latinx youth we serve were so overwhelmed by the antagonistic tone of Donald Trump's campaign rhetoric aimed at them, their families, and their friends that they began to show a certain form of conscientization (Freire, 1996), or a critical awareness of the quickly changing social reality of their world. This was evidenced in the various Discourses (Van Dijk, 2008; Wodak, 2008) the youth had during the time they spent with us (Aghasaleh, Enderle, Puvirajah, Boehnlein, Rickard, Bornstein, & Hendrix, 2018).

Our work with Latinx youth focuses on providing informal learning experiences through a voluntary after-school program aimed at developing their computational thinking and competencies. The design of the after-school program drew from the body of literature on informal learning, most notably from the work of Dierking, Falk, Rennie, Anderson, and Ellenbogen (2003) and from Verma, Puvirajah, and Webb's (2015) work on authentic learning. Additionally, within the limitations of the program, we used a Freirian and Foucauldian perspective to rationalize the need for informal learning experiences.

Why informal learning experiences?

In order for us to examine informal learning experiences, it is important for us to also understand formal schooling experiences of students, particularly in the United States. It is undeniable that there is great variability in the educative experience of students. That is, the type of experience that schools provide to students varies from one school to the next, and largely depends on the socio-economic conditions of the neighborhoods that schools serve. Schools in poorer neighborhoods with families having low socioeconomic status tend to be under-resourced in terms of having adequately qualified teachers, the number of teachers and support personnel, supply of classroom and library resources, and appropriate learning and teaching spaces. We view these as conditions that mimic and at times amplify the oppressive conditions faced outside the confines of the school by students of low socio-economic status. Taking a Foucauldian (1977) perspective, we say that power and in tandem oppression are ubiquitous in all worldly interactions individuals have, including interactions that occur in the school. However, oftentimes the distribution and enactment of power (oppression) within the enclosure of the school is unequal in that authoritarian school personnel control and turn students into docile bodies (Foucault, 1977). According to Foucault enclosures like schools, factories, prisons, and such are required for controlling and disciplining individuals so that they become docile bodies. Similarly, Rossatto, Rivas, Heiman, and Esparza (2015) say that students "are violated in schools by oppressive systems that practice authoritarian abuse, place needless academic restrictions on them, labels, tracks, and promotes a cultural infringement on others that fail to fit into their educational, and personal, ideologies" (p. 6). Similar to the idea of docile bodies, Rossatto et al. say that schools aim to domesticate students to the dominant cultural practices of the institution and the larger society. As such, the effects of these oppressive and hegemonic practices are intensified when they are directed toward those not belonging to the dominant culture. Verma, Puvirajah, and Douglass (2018) say that "life conditions primarily arising from poverty and low socioeconomic status, and ontological factors such as race and ethnicity contribute to these oppressive and hegemonic acts enacted toward the students" (p. 2). For example, during our professional visits to schools as part of our job as educators and researchers, we frequently see stark disparities in the students' experience between White majority schools and Black and Latinx (minority) majority schools. Unlike White majority schools, in a number of minority majority schools we have visited, students enter the school through a doorframe metal detector guarded by a district assigned police officer, are constantly subjected to uniform or dress code inspection by teachers and principals, are reproached for gathering in groups, are required to walk on the right side of the hallway, need to be escorted in groups for restroom breaks, have staggered lunch times for lack of adequate space and to guard against large gatherings, are limited to core and state mandated courses, and do not have a rich and varied selection of extra-curricular clubs or activities. Additionally, instructional practices in minority majority schools, focus on teacher centered practices that emphasize rote learning and studying for the standardized test. These and other school experiences are essentially subjecting students to disproportional and asymmetrical acts of power by the school institution. We can say that such institutionalized oppressive practices "that focus on control, management, and compliance strip students of their identity and agency and have a deeply demoralizing effect" (Verma, Puvirajah, & Douglass, p. 4).

Paulo Freire (1996) described these oppressive conditions at schools as banking. For Freire, formal schooling is like a bank. The school as an institution deposits the curriculum into the students. All

interactions that occur between the institution (the school) and the student become curriculum and what the student learns. As per the concept of banking, these interactions are called transactions, and for Freire all transactions of formal schooling are oppressive because students' brains (as an object, as a vessel) are used for collecting, accumulating, and regurgitating the oppressor's knowledge. The oppressor has power in determining what is put in the vessel and what is avoided; the teacher/the institution becomes the arbiter of knowledge. Thus, in situations like this, the recipient of knowledge, the student is treated as an object and by extension much like other objects has no consciousness. The knowledge received has no real connection to students' lived experiences. Students receive knowledge passively and are seldom given discursive opportunities to collaborate and construct knowledge as a collective (Lemke, 1990); this is similar to Foucault's idea of docile bodies discussed earlier. Because banking prevents awareness (consciousness), growth of true intellect is limited.

Informal Learning Experiences

For Freire, true intellect is cultivated only when students are conscious or become aware of their social conditions. Freire calls this conscientization. Through conscientization, the oppressed gain capacity by way of critical thinking to first become aware and then interrogate their oppressive conditions (Blackburn, 2000). This according Freire leads to emancipation or liberation. We feel that informal learning experiences, where students participate in learning under their own terms allows for the mitigation of oppressive conditions found in the formal schooling experience. According to Dierking, Falk, Rennie, Anderson, and Ellenbogen (2003), informal learning provides students with choice to take part in learning experiences that are meaningful to them, lets students take part in learning experiences on a voluntary basis, and lets students decide on the extent of their participation. They say that informal learning is "...self-motivated, voluntary, and guided by the learner's needs and interests" (p. 109). Thus, informal learning experiences move away from the oppressive conditions of the formal classroom to more liberating experiences where there is more congruency in the distribution of power among participants (Puvirajah, Verma, & Webb, 2012).

While not ideal in terms of student emancipation and liberation, our designed model of informal learning ascribes to several tenets of Freire's educative approach for "transform(ing) an oppressive reality into a liberating one" (Blackburn, p. 4.). Much like Freire, our model of informal learning was designed with student conscientization as driving factor. We wanted our Latinx students to move away from the banking concept of education to become aware of their oppressive social reality and taking appropriate actions to become emancipated. In this informal learning model, we emphasized reciprocal learning through which participants (Latinx students, pre-service teachers) learned from and taught each other. This follows Freire's assertion that both the teacher and the student create and foster a more symmetrical relationship where they can learn from each other as collaborators. As such, both the teacher and the student become subjects of knowledge creation. However, an essential aspect of this knowledge creation and conscientization is problem-posing. Our Latinx students, as will be seen later, participated in problem-posing within the informal learning context. In problem-posing education, students are no longer objects; they become subjects of the educative process where they use their minds (as a subject, as a place where conscious thought occurs) to interact and engage with the world around them and incorporate their lived experiences to create knowledge that is meaningful and authentic. In fact, in problem-posing education, all involved, all participants, become subjects. The teacher's once oppressive role is diminished, and the students' once passive role of knowledge receivers is elevated to knowledge creators. In essence, it becomes difficult to distinguish the teacher from the student in a problem-posing educative setting (Verma, Puvirajah, & Webb, 2015). Additionally, according to Freire, problem-posing education is highly discursive in that students do not need banked information, and that they already possess expertise and knowledge that through collective dialogue could be created, recreated, and refined for action in the world.

Using the outcomes of their research on an informal learning context, Verma, Puvirajah, and Webb (2015) developed a model to describe what would constitute authentic learning both within informal and formal learning environments. They describe authentic learning to be made of three acts of authentication. They define “acts of authentication as practices that legitimize an individual or a group’s participation in an activity as recognized by the participants of the activity and/or by the learned observer” (p. 270). These acts are participation in talk, participation in productive disciplinary engagement, and participation in communities of practice. Verma et al. argue that the interface between talk and productive disciplinary engagement can only occur through participation in a community of practice.

Theoretical Framework: Feminist Standpoint Epistemology

Feminist standpoint epistemology has three principals. First, knowledge is socially situated: Haraway (1988) rejected objectivity and believed that there is no “god trick of seeing everything from nowhere (p. 581).” She introduced “situated knowledge” as a response to the positivist call for objectivity that reduced everything to value-free data for the purposes of control. Second, the Other is likely socially situated to ask questions than it is for the Self. Third, research, particularly that focused on power relations, should begin with the lives of the marginalized. Feminist standpoint epistemology has informed research methodology in the social and natural sciences, philosophy of science, and political activism in the past few decades. It has been one of the most significant contributions that emerged from second-wave feminist thinking. Feminist standpoint theories place relations between political and social power and knowledge center-stage. Feminist scholars —such as Dorothy Smith, Nancy Hartsock, Hilary Rose, Sandra Harding, Patricia Hill Collins, Alison Jaggar and Donna Haraway— have advocated taking women’s lived experiences as knowledge.

According to Harding (2004) a standpoint is an achieved collective identity or consciousness which is not merely a perspective due to one’s identity (e.g., being a woman), rather a perspective is occupied as one’s socio-historical positionality. A standpoint is earned through the experience of collective political struggle that requires both science and politics (Hartsock, 1998).

Sandra Harding wrote,

Only through such struggles can we begin to see beneath the appearances created by an unjust social order to the reality of how this social order is in fact constructed and maintained. This need for struggle emphasizes the fact that a feminist standpoint is not something that anyone can have simply by claiming it. It is an achievement. A standpoint differs in this respect from a perspective, which anyone can have simply by ‘opening one’s eyes’. (1991, p. 127)

Feminist standpoint epistemology addresses an important question that “whose knowledge is the most worth?” (Harding, 1991). Interestingly enough curriculum scholars have been asking a similar question for a long time; i.e., “what knowledge is of most worth?” (Spencer, 1884).

Feminist standpoint epistemology informs our science teaching by validating multiplicity of positions that could generate knowledge. This gives voice to students to bring in their lived experiences, thought, feelings, and wonders to the science classroom. For instance, their projects on Donald Trump, rape and sexual violence, and Black Lives Matter become as *scientific* as their projects on global warming, robotics, and engineering.

In what follows, three pre-service teachers (Valeria, Matt, and Mike) reflect on their experience of working with urban Latinx middle school students learning (computer) programming with Scratch, a kid friendly picture/visual based gateway computer programming language. These reflections highlight how two typically distinct educational constructs (computational competency & culturally relevant pedagogy) are synthesized in teachers’ thinking and practice. Matt was preparing for being a middle school English teacher. Valeria was preparing to be an English Speakers of Other Languages teacher capable of working

across elementary and secondary classrooms. Mike was preparing to be a high school Physics teacher. The variation in these teachers' disciplinary areas added a richness to their collective efforts as they worked with the students and developed curricular activities to implement. Situated in a Southeastern state in the heat of the 2016 presidential election and its aftermath, many students chose to focus on the rise of Donald Trump as a sociopolitical phenomenon as a topic for their CS projects.

Young Computer Scientists Develop Programs

On the first day, we asked students about the issues they see growing up in their neighborhood. The students came up with different topics such as the 2016 presidential election, Black Lives Matter, rape, litter, etc. Their first lesson in Scratch was a simple monologue. The students were to create a monologue about their topic using *Sprite*, a collection digital objects used in Scratch that work as active characters that can move. Then we advanced to a dialog between two Sprites. After these lessons, we asked the students to create a pseudocode for their overall project about their topic. As used in program development, pseudocode is made up of statements written to show the sequential steps required to solve a specific problem or achieve a particular goal. These statements can then be translated into computer programming code. Pseudocode is like drawing a map through a problem. Within our context, it could even be thought of as a storyboard. Once their pseudocode was implemented into Scratch, the students added interactive dialog (input/output), loops and if/else statements along with other computer science elements based on the lessons taught by the teachers.

Freirian Problem Posing Is Culturally Relevant (Matt)

Throughout my time working in this program, I had multiple experiences that informed my understanding of the process of teaching computer science, as well as my personal perspective on teaching in general. One of the major concepts I learned to use was Freirian problem posing (1968) curriculum. Problem posing curriculum involves the students having an overarching problem or question that they attempt to solve throughout the curriculum. By using problem posing curriculum, the students have a framework they can use to relate all of the concepts they cover throughout the lesson/unit to their original problem. This accomplishes two things: it gives students a concrete application for the curriculum; i.e., addresses the question 'when are we ever going to use this information?'; and it gives the students an anchor to become personally invested in what they learn.

What I found interesting about the curriculum used in this program was the kind of problems used in the application of problem posing curriculum. In my experience, there is often a bias involved in what kinds of problems are focused on in particular subject areas. For instance, science classes focus on practical/engineering problems; literature classes focus on ethical/moral issues; social studies classes focus on 'political' issues. While these types of problems might neatly fit their respective content area, focusing on the obvious topics can limit student creativity and give them a false impression of how narrow those content areas are. The curriculum we developed for this project subverted this convention by having the students use computer science to tackle whatever problem they chose.

In order to give students freedom to work with any problem, we had them brainstorm their own topics. The students would get together in groups and bounce ideas off each other about different problems they had/saw in the world. These problems ranged from personal issues to global ones. This idea fit in well with the concept of culturally relevant pedagogy (Ladson-Billings, 1995) because it allowed the students to reflect on their culture (and the culture of their peers) and incorporate that culture into their learning. What surprised me the most about this experience was the extent to which the students took national and global issues and made them more personal. When asking students why they picked their

topics, the reasons they gave for their choice were often personal and emotional. The biggest example of this was the groups that wanted to focus on Donald Trump. We as instructors wanted them to focus more on ‘issues’ instead of people, so we recommended that students should focus on some of the issues Trump represented instead of the person himself. However, when we asked many of the students why they picked Trump, their reasons would often be personal, such as “he’s a bully”, “he doesn’t like women”, or “he’s racist”. While those reasons could be abstracted to broader issues (combative politics, patriarchy, and racism), the students all chose to internalize those character flaws in Trump himself instead of think of them as broad issues. Another assumption I mistakenly (potentially prejudicially) made was that most of the students at the afterschool program would choose topics related to their shared Latin American culture. An example of this preconception came from the teachers who ran the afterschool program, most of whom were Latinx. Upon hearing how our program would use problem posing for the students’ projects, they thought that many of them would pick soccer-related issues. However, when the students were brainstorming their topics, soccer rarely (if ever) came up, and none of the students selected it for their topic. Upon reflection, I recognized that despite their shared Latin American culture being the students’ reason for being at the after-school program, the students were also a part of many different cultures, some of which they may feel are more important to them personally than their Latin American heritage. After seeing the students brainstorm and select their topics, I was even more grateful that we had them select their own topics instead of having them focus on instructor-selected problems that would have little to no relevance to their day to day lives.

One experience that I want to highlight is a lesson about Loops we did with the students. The intended curriculum for the lesson, like most of the lessons in the program, was to have the students explore a computational thinking concept (in this case Loops) through their topics. I had the idea that this could be accomplished by having the students create a ‘song’ in Scratch based on their topics. I had multiple reasons for this. One was that Loops are commonly used in musical composition, and the Google CS First lessons (Google CS First) on loops all incorporated music. The second reason was that everything they had done in Scratch up to that point was dialogue/narrative driven, and I felt it was important to demonstrate how versatile coding can be. My final reason was a bit more basic: many of the students liked to explore the sound features in Scratch (often at the expense of working on their intended project), so I thought that incorporating that into a project would be a good use of their already-present interest. Unfortunately, the lesson did not go as well as I had planned. Some of the students struggled to come up with a song or sounds that fit their topic, while other students who were not as interested in music were not engaged in the lesson. My teaching partner and I compensated for this by modifying the lesson for some groups to where they could include more of a narrative aspect in their project to focus it. My partner had the great idea of having some of the students record lyrics that fit their topic as a way to incorporate their topic into their projects. This experience taught me that by applying my personal ideas and preferences to a lesson, I can unintentionally make it exclusionary for my students who do not share those preferences. By reflecting on all of my experiences in this program, I now have a framework that I can use to meaningfully engage in learning with students of any background.

Loops of Donald Trump (Valeria)

Students in the after-school STEM program explored topics of computer science while using a program called Scratch. Scratch is a platform that allows students to create their own projects that include games, animations, and interactive stories. Students can personalize their projects using a variety of coding scripts that dictate the movement, looks, sounds, and a variety of other features involved in each project.

Programs like Scratch can be used as a tool for students to tell their stories, and also express themselves creatively. Working with Scratch, students can use a language that they are comfortable with.

This is valuable when we think of upholding the connection between the curriculum and students' home cultures. In many cultures, family history is passed down through generations via oral storytelling. Parents and grandparents are valuable members of their communities since they keep these histories alive. Scratch was used in the classroom to give students a new way to expand upon traditional storytelling methods like essay writing or journaling.

Figure 2. Scratch Program

This semester in the program, we used Scratch to introduce students to a variety of computer science concepts. The students learned about Loops. In computer science, Loops are operations that make an action happen repeatedly. In Scratch, this repetition can be dictated by certain commands. You can have something “repeat until” one action occurs, or you can have something “repeat forever”. Students use the “control” scripts in Scratch to create their own Loops. Many actions can be placed in a Loop including motion, sound, and appearance.

Since being introduced to the Scratch platform, students were interested in experimenting with sound features. Every time students opened Scratch, a variety of sounds could be heard from the students' computers, whether or not the project we were working on included music. Because of this, we decided to have students create their own songs related to their project topics.

A few weeks after the 2016 presidential election, students worked on their Loop projects. Students used sounds, recorded music, and voiceovers to create songs related to their topics. One group with the topic of Donald Trump, decided to title their sound Loop project “F*ck Trump”. The students in the group approached me and were apprehensive about sharing their controversial title. They said, “You’re going to be mad!” I saw the title, and I let them know that their feelings were valid and I felt similarly. Then, I urged them to explain their choice of strong language, and explore those problems that caused them to feel that way. The students gave me some reasons, “He’s tearing apart our communities; he’s a woman abuser; and he’s racist.” After writing down these reasons, the students used Scratch to record a group member speaking this list of issues into a microphone. Using coding from Scratch, the students played the dialogue on a loop including background music, and created a background using their own design.

The topic of “Donald Trump” explored in this Scratch project was increasingly relevant throughout the semester. Discussing the election of Donald Trump was important since post-election, many students felt fear. It has been reported that hate crimes increased since the election (Yan, Sgueglia, & Walker 2016). Two teachers were removed from a nearby high school (the high school many of the after-school students will attend once they graduate) for making anti-immigration comments following the election. Emergent bilinguals often internalize the xenophobic discourse that surrounds non-native English speakers. The students in the after-school program are very savvy when it comes to their knowledge about current stories in the media. They are constantly exposed to social media, which often presents the most extreme, negative, and even false societal views. This xenophobic discourse was amplified during that year’s election season. Thus, students feared deportation, discrimination, and other forms of violence. Many students experienced their friends and families facing deportation due to the increased Immigration and Customs Enforcement raids that occurred in 2016 (The Southern Poverty Law Center & The Georgia Latino Alliance for Human Rights, 2016). The after-school program was a safe space in which we could provide a constructive and creative environment for students to comfortably explore these topics. Having students explore their oppressors through the lens of computational thinking was one way that we explored critical pedagogy in the after-school program.

Students used Scratch to creatively explore problems relevant to their everyday lives. Computer Science has long been a field dominated by white men (Exploring Computer Science, 2016). However, students in the after-school STEM program bring a wide variety of funds of knowledge (Gonzalez and Amanti, 2005) to this field. Computational thinking involves viewing problems through the lens of critical thinking by looking at the many facets that relate to one issue. By encouraging students to problem pose through addressing connections, computational thinking can help students explore the world around them through a critical lens. The time has come for marginalized students, and specifically the students in this program, to be given the opportunity to explore this field.

Pseudocodes: Computerless Computational Thinking (Mike)

Figure 3. Pseudocode

Pseudocode gave students a framework for thinking computationally and systematically about how to use the tools and commands in Scratch to create their projects. Using the “gradual release of responsibility” Buehl (2005), the co-teacher and myself modeled for students how to use pseudocode to sketch their programming ideas before using Scratch. I did not feel like the lesson was going that well or that my instruction was very effective until we passed out chart paper to students and they began to write down their pseudocode. To my pleasant surprise, students understood how they were mapping out ideas to use in the project as they were very engaged with creating a chart. Students who were struggling with the direction of their project and what commands they should use in Scratch greatly benefited from pseudocode. At that point, they were able to look at their own ideas and think about structuring the project in a more holistic way outside of simply doing fun things in Scratch. The implementation of pseudocode enhanced students’ understanding of their thought process when working with Scratch, and condensed the features of Scratch to allow students to focus on just a few commands at a time. Pseudocode also helps teachers explore thinking and learning about computational thinking as the “abstraction, automation, and analysis” model, which was outlined by Lee et al. (2011, p.33). Abstraction occurred when students began to look at the bare essentials of Scratch and view it outside of a computer program; automation occurred when they went back to the computers and used technology to create the projects in a labor-saving manner; and analysis happened as students reflected on the process of taking the pseudocode and programming it in Scratch.

Pseudocode provides a method for students to approach problem solving in a way that reflects computational thinking, instead of using primarily trial and error to figure out ideas and discover commands. Students were given free time to explore Scratch when they were first introduced to the laptops. Exploration often consisted of trial and error after wondering how to do a command in Scratch; e.g., students would try to figure out how to add sound or different images. This was appropriate and necessary as an introduction to Scratch. As students learned more specific commands, it became necessary to move away from trial and error approach. Pseudocode allowed students to map out ideas with the Scratch skills that they had already developed. They were also able to focus on a few commands, making the interface less intimidating. Throughout the semester, teachers and researchers reviewed and reflected on the students’ pseudocode charts. We gained insight not only into how the students were thinking about Scratch, but also on their social views and thoughts about local and global issues. Here are three examples of projects that highlighted both students’ approach to creating projects in Scratch as well as their views on social issues.

One group created a project based on the issue of rape. The project was titled, “No Rapes,” and featured a dialogue that portrayed a nuanced and mature understanding of the feelings and emotions of rape and sexual assault victims. The dialogue had one Sprite discussing how victims feel ashamed and “worthless” after being raped while the other Sprite spoke about the subject in a nonchalant and almost dismissive tone. This reflects how the subject of rape and sexual assault can often be discussed by adults in our society on social media, political discussions, and news channels. Victim shaming and dismissive attitudes often appear in these adult discussions. On the other hand, these students demonstrated an understanding of rape and the project did not demonstrate any juvenile attempts at humor one might expect from middle school students. Teachers and researchers were concerned about the sensitive subject matter using such direct language. One of the students in the project strongly opposed using any other word than rape in the title, such as sexual assault. This student also originally created a list of serious topics during the problem posing activity. In addition to the subject of rape, this student listed drug abuse and prisons as other issues they would like to pursue.

Another group created an interesting project that depicted a scenario pitting United States president-elect Donald Trump against Mexican cartel leader Joaquin Guzman, better known as El Chapo. The students originally decided to focus on the election and Donald Trump, but their project morphed into Trump vs. El Chapo when the class began to use pseudocode. The presidential election and Donald

Trump were popular topics during the problem posing activity, which took place in September 2016 during the United States election season. Students expressed a strong preference for just about anyone over Donald Trump, and he was often portrayed as an arch-villain. The Trump vs El Chapo project illustrates this, as the students presented an evil Trump and an almost heroic El Chapo. I was fascinated by the students' responses when I asked them why they feel El Chapo should be seen as a positive figure, one student claimed that El Chapo, "Does a lot for poor people." This philanthropic view of a drug lord reminds me of the many different opinions about Pablo Escobar, a figure described anywhere from a sociopath and terrorist to some philanthropist and ethical police of the underground drug world depending on who is speaking.

A third Scratch project that illustrates this group of students' social awareness focused on the environment and cleaning up the community. The group members were initially working in different groups whose topic concerned Donald Trump and the presidential election. As the attendance of their other group members declined, these students formed a new group. Once the three began to work together consistently, they decided on the new topic of environmental awareness by ways of cleaning up trash and keeping the parks clean. Subsequently, their engagement rose significantly. One student in particular, who was already savvy with Scratch and caught on to new concepts and commands quickly, really became passionate about the project and engaged with the program. Their family even came to view the Scratch project during the final day of presentations and they were eager to come and see their child's work. The project really took shape after introducing pseudocode, as the students were thinking more about the process and less distracted and intimidated by Scratch and using the computer. One of the students who struggled with Scratch used pseudocode to simplify the process and focus on a few commands they were familiar with and understood well.

Each of these Scratch projects became more focused and refined after students used pseudocode to map out their ideas and program commands. Pseudocode not only helped students think about their projects in a more systematic and computational way, it also allowed the teachers and researchers to analyze the students' thinking behind their Scratch projects and assess the way of computational thinking. Pseudocode can be applied cross-curricularly and offers an effective framework for students to take an epistemological approach to learning, and for teachers to assess how their students are thinking about concepts and ideas on a more computational and systematic level that will ultimately contribute to deeper learning.

Culturally Relevant Coding for Personal Expression

The innovation and creativity students showed through their projects helps us see the power of culturally relevant pedagogy and Freirian problem posing. Freirian problem posing enabled students give voice to the concerns and issues central in their thinking about their communities. As seen from the stories above, pseudocoding and the creation of Scratch programs provided students a different platform to express their ideas. As we continue to rethink schools as places that welcome contributions from all students, coding and pseudocoding can provide another avenue for students to express their ideas, and one that does not have to solely reside in a science class.

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