# Justice-Centered Computing Curriculum Design in Informal Learning

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## Abstract

Some computing education researchers have shifted focus from broadening participation to justice-centered computing education (JCCE). JCCE teaches computing through its social-political implications, empowering students to create more just futures. While prior research theorizes and explores its classroom application, we know little about the collaborative processes instructors use to design and adapt curricula for such learning. We engaged in a 3-month curriculum co-design project as part of a research-practice partnership between a CS education researcher and an after-school STEAM instructor. Through duo-ethnography, we analyzed our curriculum design process. We highlight key emerging challenges and how we resolved them through the design process. Our findings focus on balancing students' technical proficiency with justice-centered pedagogy, showing that justice-centered curriculum design requires educators' ongoing content learning, reflection on positionality, and adaptability to students' needs, including those with disabilities. These findings bridge the theoretical discussion of justice-centered computing with the practical realities of curriculum design.

## CCS Concepts

• **Social and professional topics** → **K-12 education**; **Model curricula**; **Informal education**.

## Keywords

curriculum design, justice-centered computing education, qualitative methods, research-practice partnerships, informal learning

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## 1 Introduction

Recently, some researchers have shifted their work away from broadening participation in computing to justice-centered computer science (CS) education, exploring teaching beyond access and equity, engaging youth in imagining a more just computational future [25, 39–41, 45, 47, 49, 50, 64, 68]. Justice-centered computing education (JCCE) integrates critical analysis of systemic inequities, ethical awareness, and intentional curriculum design to empower learners to use technology for equity and social transformation. For example, scholars like Vakil [64] advocate for ethical considerations in CS pedagogy by creating inclusive learning spaces that celebrate diversity, interrogate the broader socio-political implications of computing technologies, and empower students to be agents of change. Similarly, Erete et al. detail how to oppose systemic oppression through a transformative justice approach to informal CS learning [25].

Prior work has responded to these visions with pedagogical examples of JCCE (e.g. [4, 25, 43, 56, 64, 69]). For instance, Arawjo et al. [3] present a vision of JCCE deeply situated in culture and relationship building. They assert that CS classes should foster relationship building by intentionally designing activities that encourage relationship building among students with different backgrounds. Such learning helps dispel stereotypes and build meaningful relationships among students from other cultures and nations [3]. Moreover, Vogel [65] views JCCE through the lens of bi/multilingual students. Through critical translingual computing education, Vogel's approach challenges traditional language hierarchies and promotes linguistic justice. It encourages students to develop positive linguistic identities and question dominant language ideologies in computing, empowering them to become agents of change.

Although this prior work on theory and pedagogy is rich, it also reveals a struggle to design and implement curricula to facilitate such learning [18, 41]. Institutional barriers such as rigid teaching standards and federal, local, and state policies impact how teachers approach curriculum design and implementation [9]. Michie [31] remarks, "when you're handed a booklet of state goals or district guidelines, it's easy for a curriculum to become, not something you wrestle with or debate, but something you unwrap." For some, curriculum design can feel passive—rather than thinking critically about the sociopolitical implications of subject matter and its impact on students' lives, external forces end up dictating what is taught and how it is taught [6, 9, 27, 31].

While we know that such constraints exist, we do not have a nuanced understanding of how they arise in the curriculum design process or how teachers overcome them. In this paper, we examine these gaps, posing two questions:

- What challenges arise in the *process* of justice-centered curriculum design?
- How do educators resolve these challenges?

To answer these questions, the first author, a computing education researcher, formed a research-practice partnership with an afterschool STEAM instructor. We engaged in a 3-month co-design project to develop a justice-centered computing curriculum for the


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upcoming AI literacy unit in the afterschool program for students in grades 3-5 (7-11 years old). We conducted a duo-ethnographic study, analyzing the challenges and resolutions in our justice-centered curriculum design process. Our research identifies key challenges in designing justice-centered computing curricula and offers concrete strategies to address them.

## 2 Theoretical framework

We draw upon justice-centered education theories from both the education and computer science fields. Below, we summarize these theories and the empirical work that builds upon them.

### 2.1 Foundations of justice-centered education

Although there are many conceptualizations of justice, like design justice, disability justice, and social justice, we situate our work in *educational* justice, drawing from the ideas of Paulo Freire and bell hooks.

Freire [27] and hooks [34–36] argue that justice must begin in the classroom, where community building and critical consciousness empower students to transcend their marginalization and become agents of change. They assert that to create an inclusive community, educators must first begin by dismantling existing power dynamics in the classroom. Freire critiqued the *banking model of education*, in which students are passive recipients of knowledge, and instead advocated for *problem-posing education*, which positions both students and teachers as active learners and teachers. This type of learning and teaching democratizes the student-teacher relationship. Cultivating such a learning environment requires teachers to engage in the necessary reflection to assume the roles of both teacher and learner. Over time, Freire argued, students learn to embrace the nuance and complexities in their questions and view their relationship with their teacher as reciprocal. Similarly, hooks' concept of engaged pedagogy [36] asserts that educators have a duty to challenge systemic inequities in the classroom. She emphasizes that educators must empower students to co-create their learning, facilitating discussions that connect the subject matter to students' lived experiences, particularly the intersection of the personal and the political.

### 2.2 Justice-centered computing education and curriculum design

There are many theories of justice in computing education. Often inspired by the ideas of Freire and hooks, researchers and practitioners advocate for a vision of computer science that centers technical mastery, engages with socio-political implications of computing, interrogates the ways computing systemically upholds injustice, and empowers students to be agents of change to combat such injustice. For example, Vakil [64] argued that justice-centered CS education must acknowledge ethics, identity, and the political dimensions of computing. Similarly, Erete et al. [25] interpreted justice-centered CS through a transformative perspective. Additionally, Arawjo et al. [3] present a vision of JCCE deeply situated in culture and relationship building. These examples show growing efforts among some researchers to reimagine computing education where technical mastery and critical inquiry about computing challenge students to dismantle and reshape unjust systems.

Although several emerging JCCE theories exist, they do not offer insights into the curriculum design process to facilitate such learning. For example, Erete et al. advocate for a transformative justice approach that focuses on dismantling systemic oppression through creating community-centered learning environments. Although they provide insights on *what* JCCE curriculum should look like and *how* students responded to such learning, there is little insight into the *design process* educators engaged in to facilitate such learning. Prior work also indicates that educators struggle to balance academic rigor and social critique in the classroom [55, 64]. Designing a curriculum that incorporates these principles requires educators to address the complexities of systemic inequities while also ensuring that students gain technical skills. However, Erete et al.'s work does not address how such challenges were navigated in the curriculum design process.

Prior work in justice-centered education broadly illustrates that facilitating such learning is not just about adopting theoretical frameworks but also navigating real-world constraints that impede such learning opportunities. Some works show, for example, that a lack of institutional support limits impact, as many see justice-centered education as politically motivated and irrelevant to academic goals [16, 37, 53]. Furthermore, the capitalization and corporatization of STEM have marginalized much of the justice-centered work in social sciences and the humanities, limiting the exchange of ideas [53, 55]. Similarly, the dominance of traditional norms and epistemologies creates hegemony and push-back to integrating justice-centered education frameworks [53, 55].

Such challenges occur in JCCE as well. There is mounting pressure from the tech industry to encourage educators to teach students technical content [40]. Additionally, computing is often seen as neutral, with many in society easily blaming harmful biases on algorithms rather than the humans who create the algorithms, embedding their own biases [10, 13]. Furthermore, there are few avenues for educator preparation in computing education, let alone ones that integrate justice-centered frameworks. JCCE theories and frameworks acknowledge many of these challenges; however, they do not address how to design a curriculum that transcends these challenges. Additionally, there is a lack of support for computing educators [29, 54, 60]. Some teachers feel isolated; others lack opportunities to advance their CS knowledge. Yadav et al. found that CS teachers have low self-esteem. Moreover, many states and school districts do not require CS learning [19, 30, 67], and some do not value it [67], thus limiting the opportunities for professional development [5, 28, 71].

Prior work in justice-centered curriculum teaches us much about what curricula should include and facilitate; however, there is little understanding of how to design for such requirements. Justice-centered education requires intentionality, clear learning goals that align with students' learning needs and prior experiences, and encourages critical analysis [17]. We know that assessments in justice-centered education should evaluate transformative learning rather than traditional testing. Bell & Griffin [9] suggest using reflective writing assignments, participatory assessments, and portfolio-based evaluations as evidence for students' growth in developing critical consciousness. Carlisle et al. [14] argue that community-based and student-led initiatives help reinforce the connection between learning and social action, while Bajaj et al. [7] advocate for meeting students' needs (e.g., food, clothing, cultural celebration, school supplies) both in and outside the classroom. Furthermore, culturally relevant and sustaining pedagogies such as translanguaging [65] and including cultural artifacts [23, 24] help empower students by validating their cultural and linguistic identities within learning environments. Additionally, some emerging books on teaching methods offer many justice-centered lesson plans that center youth identity, dialogue, and critical consciousness [40]. However, previous work does not provide insights on how educators can plan for such learning. Our paper offers insights into the collaborative JCCE curriculum design process and provides implications for curriculum design scaffolds.

## 3 Context

We conducted our research in one particular organization, the Refugee Support Organization (RSO). RSO was founded by resettled refugees who identified unmet needs in social services for refugees and immigrants requiring multilingual support. RSO emphasizes education, offering culturally and linguistically accessible programming for children of all ages. Our study occurred in the STEAM afterschool program, which serves elementary students from diverse backgrounds, including immigrant and refugee families, BIPOC[1] communities, and English learners. The program promotes hands-on, inquiry-based learning in a collaborative, multicultural environment that fosters critical thinking and languaging skills—strategies for effectively using and navigating multiple languages. The 40 students in the program are supported by a team of academic case managers, a STEAM instructor, and a program coordinator, who work together to provide educational and social support tailored to each student's needs.

### 3.1 Positionality

**Researcher Positionality:** I have volunteered with RSO for three years, 1-2 times a week. As a computing education researcher, the director invited me to teach lessons and consult on integrating computing into their curriculum. Together, we formed a research-practice partnership focused on designing computer science learning experiences for refugee youth.

In my work with RSO, I often take on both researcher and participant roles. We collaboratively identified, designed, and implemented interventions, combining my expertise in CS education with our shared experience working with students. I view my subjectivity as an asset, aligning with Finley [26] and Koopman [42], as it enriches my research. Rather than aiming for generalizability, my work creates transferable knowledge applicable to other contexts.

**Instructor Positionality:** My positionality as a multilingual educator is highly impacted by successful engagement with computing in learning spaces. While curriculum design in STEM education often focuses on how best to teach content, I believe it is equally important to consider how emerging technologies can be introduced to educators working with multilingual learners, particularly when their students speak various languages. By equipping teachers with these tools, we can better serve students who are most at risk of marginalization in English-only instructional settings, including multilingual learners. The intersection of computing and language learning holds promise, not just as a tool for instruction but as a means of identity affirmation and community building in multilingual classrooms.

My role as an instructor at the Refugee Support Organization (RSO) is a direct embodiment of these commitments in action. In this classroom, modern technology meets the lived experiences of immigrants and refugees, creating a space where language learning happens out in the open. Through hands-on instruction, adaptive teaching strategies, and language interventions, I strive to reinforce multilingualism within the minds of our scholars as a source of academic and personal confidence.

**Mentor Positionality:** My role on this project was to support the researcher's partnership with the organization, their growth as a teacher and instructional designer, and their growth as a researcher. I approached this work with a bias towards systems thinking, wanting to understand RSO as an organization with power in it and how that shaped the pedagogical opportunities that were viable. In parallel, I brought many years of teacher education experience, explicitly about justice-centered computing education pedagogy and the many tensions that teachers face in bringing critical perspectives about computing into their learning settings. I expected those tensions to be heightened in a culturally diverse setting of immigrant and refugee youth, for whom there was likely far less shared cultural context or conceptions of justice. I managed the frames I brought to support the researcher by trying to focus my own opinions and judgments on the research elements of the work, but limiting my engagement on the organization itself to curious questions and scaffolding the researchers' power mapping work.

## 4 Methods

We used three sources of data: the curriculum we created, transcripts of our audio-recorded design sessions, and a 2-hour-long transcript of a duo-ethnographic reflective conversation between the instructor and researcher. In this section, we (the first and second authors) discuss the curriculum design process, provide an overview of duo-ethnography, outline our approach, and detail our analysis process.

### 4.1 Design Process

The curriculum design process consisted of 4 design sessions conducted synchronously in online video chat. During **Session 1**, the instructor and researcher met to establish goals, timelines, and communication preferences, deciding to design an AI Literacy curriculum over the next three months. The instructor led the design, and the researcher provided expertise and resources on computer science pedagogy. In **Session 2**, the instructor presented a draft week-by-week curriculum outline, which the pair discussed and refined, creating a detailed curricular calendar for the upcoming unit. During **Session 3**, they collaboratively developed learning and instructional objectives for each week of the unit, refining activities and making adjustments to ensure alignment with the overall goals. Finally, they met with the afterschool program director in **Session 4** to present the curriculum. After addressing concerns about flexibility, particularly from a justice-centered perspective, they received approval for the unit.

[1]Black and Indigenous People of Color

## 4.2 Duo-ethnography

For the remainder of this section, we provide an overview of duo-ethnography and analyze the methodology through the lens of justice-centered education. We explain why we chose this methodology and how we conducted our duo-ethnography.

*4.2.1 Origins of Duo-ethnography:* Duo-ethnography is a qualitative method derived from auto-ethnography. This post-positivist research method strays from empirical generalizations toward detailing autobiographical life histories [48].

*Auto-ethnography* can "improve understanding and knowledge of social and cultural processes more generally" [21]. This social and cultural process can be valuable in other contexts and thus valuable for research purposes. Auto-ethnography is rooted in social justice and emerged in tandem with identity politics [2]. Together, they represent the belief that community members should be free to tell their own stories and histories rather than an outsider projecting their beliefs onto said community.

*Duo-ethnography* is "a collaborative research methodology in which two or more researchers of difference juxtapose their life histories to provide multiple understandings of the world" [51]. The social justice origins of auto-ethnography remain central in duo-ethnography as one of the first duo-ethnographies called for social justice in schools through a dialogue about sexual orientation and schooling [57]. Lowe and Lawrence [48] detail 5 key tenets of duo-ethnography:

**A focus on 'currere':** Derived from the idea of curriculum, *currere* emphasizes how each individual has skills, beliefs, and abilities that represent a curriculum during their life [70]. Focusing on *currere* entails focusing on your regressive (past) experiences, progressive (future) experiences, analytical (present) experiences, and synthetical experiences (integrating the regressive, progressive, and analytical) [8].

**The self as research site:** Sawyer and Norris assert that the self shouldn't be the center of the research in a duo-ethnography [59]. Instead, the self should be seen as the "research site in relation to the lived cultural worlds" by constructing and reconstructing our experiences related to the social phenomena we are exploring [48, 59]. Therefore, in duo-ethnography, the self is ever-evolving, and one must recognize the fluidity of identities and how they ebb and flow through dialogue to ultimately interrogate common beliefs about society [48].

**Polyvocal & dialogic:** Aligning with Bourdieu's [11] idea that "we must relinquish the single, central, dominant, in a word, quasi-divine, point of view that is all too easily adopted by observers ... we must work instead with the multiple perspectives that correspond to the multiplicity of coexisting, and sometimes directly competing point of view", duo ethnography aims to make each individual voice more explicit, thus rejecting the conventional idea of the blended voice often observed in many multi-authored research papers [48].

**Requires trust:** Duo-ethnographies require vulnerability; thus, ensuring participants trust one another helps ensure they are not holding back. Bourdieu argues that, "A research presentation ... is a discourse in which you *expose yourself*, you take risks ... The more you expose yourself, the greater your chances of benefiting from the discussion" [12]. It is important that participants feel comfortable not only speaking their minds but also challenging one another. If there is no trust, it could compromise the quality of data [15]. One way to develop trust is through shared research goals and established rapport with one another [48].

**Disrupts Metanarratives:** Metanarratives are "global or totalizing culture narrative schema which orders and explains knowledge and experiences" [63]. Therefore, to disrupt metanarratives is to disrupt dominant and hegemonic discourses and consider and develop other ways of thinking. Because duo-ethnography is dialogical, it is well suited for disruption as it brings multiple narratives into conversation, challenging monolithic interpretations of knowledge.

*4.2.2 Our approach* We are new to this methodology and, therefore, approach it with humility. We understand that duo-ethnography is a rare methodology in CS education, and we hope that readers remain open to new epistemic perspectives.

We chose to use duo-ethnography for a variety of reasons. Firstly, we align with Vygotsky's notion that learning is social and relational [66]. Likewise, duo-ethnography highlights the interconnectedness of human experiences through dialogic reflection. Secondly, duo-ethnography helps uplift marginalized voices by aligning with standpoint theory. Standpoint theory is a feminist epistemology that argues knowledge is shaped by social and material position. Therefore, marginalized perspectives provide unique insights into systems of oppression, perspectives that are often obscured by dominant groups [20, 33]. Ultimately, duo-ethnography, like justice-centered education, disrupts dominant narratives by illuminating power and inequity. Using this methodology enables us to push back against epistemic violence, the erasure of marginalized voices by dominant knowledge systems [22, 62].

*Data Collection and Analysis.* To analyze our data, we transcribed the design sessions and the reflection conversation. Then, we performed a thematic analysis, adopting Hammer and Berland's [32] interpretive perspective of thematic analysis. Duo-ethnographic data analysis, like a lot of qualitative analysis, happens in dialogue [15, 48, 58]. We identified challenges we faced during the design process and discussed them in the reflection. We discussed disagreements until we reached a consensus. There were few disagreements, often centering just *how* much detail to share. Ultimately, we relied on Chang et al.'s [15] warning about qualitative analysis, which advised that although data excerpts are essential to our research, they cannot replace explanations and discussions of our claims [15, 48, 52, 59]. Heeding this advice helped us discern significant portions of our dialogue, which we ultimately focused on.

# 5 Results

In this section, we present our findings. We organize our results around five curriculum design challenges that emerged and how we overcame them, sharing reflections from our design and reflective conversations as evidence. The curriculum is yet to be taught. Thus, we focus on the challenges encountered during the curriculum design process. When appropriate, we **bold** important passages for emphasis.

However, before we discuss our results, we provide context about the curriculum we produced to help the reader understand the difficulties we present in our results. Table 1 demonstrates the weekly curriculum breakdown. We scaffolded the curriculum around several activities:

- *AI Device Presentations*: In week 1, students complete a research activity exploring different AI devices. In groups, students use a resource guide to learn more about AI devices. In each subsequent week, one group presents about the AI device they researched. The instructor presents during the first week to model such a presentation.
- *Reflection journals*: Each lesson culminates in students reflecting about what they have learned thus far, applying it to their own lives.
- *Scratch & Teachable Machine Workshop*: Students learn about the interplay between data, machine learning, and AI by training machine learning models to detect actions of their choice (e.g., rock, paper, scissors hand motions). They then create an interactive application in Scratch using the model.
- *Ethics*: In week 4, the instructor introduces critical perspectives about AI, like bias and fairness. In groups, students engage with the ethical implications of AI, creating mind maps of its benefits and challenges.
- *AI's society impact*: In the last two weeks, students reflect on AI's societal implications and their feelings about AI. In groups, they create a position poster to express their views on AI, advocating for or against its use in a specific context, such as school or home.
- *Assessment*: The cumulative assessments are their position posters, self, and course evaluations through a survey.

## 5.1 Challenge 1: Limited knowledge of AI and computing

The initial challenge when designing this curriculum was that the instructor had limited computing knowledge, as she had never formally studied it. She had some experience using AI technologies, but knew she did not understand AI to the level she needed to teach it. Since JCCE principles grounded us, she knew that teaching AI meant not only teaching students what it was and how to use it but also critiquing its personal and socio-political implications.

We addressed her knowledge gap through our collaboration. She relied on the researcher to learn the foundational knowledge about AI and computing. The researcher also provided resources, including AI teaching resources, such as MIT's AI playground, and research papers about critical AI education.

The following excerpt demonstrates how the instructor recognized her knowledge gap and sought to fill it through a partnership with the researcher. The instructor conducted this in the service of helping students understand AI and allowing students to engage critically with it, as well.

**I:** **Building personal background information about AI was challenging. I know how AI affects society, but I don't understand *what* AI is.** I knew students were interested in learning more about AI, but I needed to **build my own literacy before teaching students.** I need to first understand how to use AI and how AI functions before learning about AI. So I reached out to you and asked for help.

The resources you sent me helped me learn more about AI and how to teach it. I was interested in the lessons you wrote about in the paper you shared and the *Critically Conscious Computing* book you recommended to me last summer. I had time to prepare because we started planning months ahead of time. In the summer, I did not have time to do this kind of learning, so even though I wanted to teach about AI, I could not.

The instructor's reflection showcases how she actively pursued ways to develop her AI literacy and how the collaborative design process was essential in supporting her growth. Her recognition of the importance of background knowledge and the steps she took to address it underscores the necessity of structured, long-term support for educators learning to teach new technical content.

## 5.2 Challenge 2: Resource constraints in accessing AI tools and devices

Since our students had varying experiences with computing technologies, including AI, ensuring equitable access was paramount. To achieve this, we wanted to have time in the curriculum where students engaged with tangible AI technologies such as voice assistants, robots, AI games, and chatbots. However, due to funding constraints, facilitating this lesson was challenging. At the time of this design process, the afterschool program was running on a very low budget. The instructor only had access to materials that the organization already owned. Therefore, there was no budget to buy AI technologies for students to explore, further perpetuating the disparity in access to hands-on computing experiences.

To address the resource need, the researcher leveraged their professional network to crowdsource AI devices for temporary classroom use, allowing students to interact with AI technologies. The conversation below illustrates the instructor's uncertainty about which AI technologies to use, given the financial barrier and students' diverse familiarity with AI technologies. The collaborative design process led to showcasing one AI technology per week, allowing students to interact with multiple AI technologies without creating logistical challenges or reinforcing access disparities. This approach ensured that AI education remained engaging, structured, and equitable despite financial constraints.

**I:** I think I still need more guidance about what AI technologies to use as examples when teaching. Most people know what the technologies are… well, I don't really want to assume that.

**R:** There is a lot of diversity in students' familiarity with technology. **Some students have access to devices such as an Alexa at home,** but I know many do not. It might be interesting if, every week, we bring in a different kind of AI technology to show students, and they can interact with it.

**I:** **We cannot provide every student group with tangible AI technologies. There is no budget.** It's hard because I want to be able to be hands-on with learning these things, but we cannot. We do not have money to have each of those in our classroom.

**R:** Money is always a roadblock. What if we **focus on one technology every week**? "AI Technology of the Week"—we

**Table 1: Weekly Curriculum Overview for AI Unit**

| Week | Topic | Device Presentations | Instructional Objectives (IO) | Learning Objectives (LO) Students will ... | Activity |
|---|---|---|---|---|---|
| 1 | Introduction to AI | Instructor | Introduce AI through engaging videos or stories. Students explore AI devices in groups. | Discuss the differences between AI & human intelligence & identify AI in daily life. | Instructor-led presentation; AI device exploration; discussion on AI examples; student reflections |
| 2 | AI in Daily Life | Group 1 | Understand the role of AI in everyday life. Students reflect on ideal AI designs. | Identify AI tools they use & design an ideal AI device. | class discussion & reflections on AI in daily life. |
| 3 | Scratch & Teachable Machine | Group 2 | Train a simple machine learning model & integrate it into a Scratch project. | Understand how AI models are trained, and develop an interactive AI system. | Hands-on coding with Scratch & Teachable Machine; train models. |
| 4 | AI Across Fields | Group 3 | Explore AI applications in healthcare, education, & other fields. Discuss fairness & bias. | Analyze benefits & risks of AI, engage in ethical discussions. | Critical reflection on bias & fairness; mind maps on AI's impact. |
| 5 & 6 | AI & Society | Group 4 & Group 5 | Evaluate AI's societal implications & formulate critical perspectives. | Articulate arguments for/against AI. | Group position poster for/against AI; peer feedback; gallery walk; final assessment. |

> could have students do a reflection every week. We introduce the technology at the beginning of the week and then they reflect on how they would redesign the technology, how they use or would use the technology in their daily life, or if it would it make life easier. I can see what devices I can get my hands on.

This approach reinforced that equitable AI education was not solely dependent on access to expensive tools but on intentional curriculum design that fosters critical inquiry and engagement. By integrating structured research, class presentations, and redesign reflections, we created a JCCE environment that prioritized access and agency, despite financial limitations.

## 5.3 Challenge 3: Supporting multilingual students

One aspect of justice-centered education is situating learning in students' lived experiences while leveraging their assets. Given that our students were multilingual and English learners, language fluency posed a great challenge to planning the curriculum.

One aspect of language that was of central concern was computing terminology, especially about AI. Many aspects of AI literacy rely on Western-centric conceptualizations of data representation, governance models, and familiarity with the tech industry. AI technologies such as voice assistants and facial recognition software are riddled with bias, relying on English fluency and centering whiteness. Many of our students do not have AI technologies in their homes, which led them to express that they have never interfaced with them. Therefore, when we were designing the curriculum, we found it difficult to establish a strong foundational knowledge of computing and AI, especially given that the goal of the unit was not only to understand AI but also to critique it in the context of students' lived experiences and its societal implications.

This conversation illustrates the iterative design process we followed to conceptualize a resource packet. We consistently leveraged our prior knowledge of students' needs, adjusting our approach based on observed challenges in literacy, research skills, and AI familiarity.

**I:** In the beginning of the unit, students could do some research exploring different AI technologies.

**R:** We could present students with a chart. I can see it in my head… a chart of AI technologies, with a picture of it and its name underneath. We can have students pick one and do some research about it.

**I:** I thought the end product could be a reflection or impromptu presentations about AI technologies. We can use the list to help students identify the device they want to learn more about. Then, in groups of 2 or 3, they can use the iPads to research the AI technology.

**R:** I have been toying with the idea of curating a list of resources. Rather than letting them go free with the internet, we can give them a resource packet, where we can guide them to find the information.

**I:** That is a very good idea.

**R:** Students are still learning how to do research. I have also noticed that **language and literacy are barriers, causing students to shut down** because they do not know where to even start. They know what question to ask, but typing it into Google and navigating the browser is a challenge, often stopping them from carrying out the research. We can have a PDF on the iPad with links for students to click on to start their research. So, we eliminate the barrier of typing out questions. Students can even opt to use the browser in their home language.

**I:** Do you think their research should still be guided by questions or interfacing with different AI technologies? If they are exploring Siri, should we let them free rein?

**R:** Rather than giving them the document with links to click on, we could even make a resource guide on each technology. **We can tailor it to students' literacy levels** and link the terminology we are learning in class to the terminology used in the resource guide. It will be a ton of work on our part, but I know it will be worth it. This way allows us to curate the information, ensuring the resource guide will help them answer the guiding questions.

**I:** I'm a bit confused. Are the students only using the resource guides for one day?

**R:** No, students will explore the resource packet for the whole first week.

**I:** **Students will get to look at the packet in front of them,** alongside further research, and students prior knowledge of these AI technologies, they will then answer related questions. The packet is structured and scaffolded. What if we also add more information about the activities and platforms we will use in the unit, and not just isolate them to the AI technologies? That way, the resource packet anchors each lesson. **Students will consistently refer to it. This will help reiterate the terminology.**

This design process revealed how we intentionally scaffolded multilingual students' engagement with AI. We positioned language as a resource for learning rather than a barrier. The resource packet provided an equitable entry point to AI literacy, ensuring that the class had a shared foundational knowledge of AI before engaging with critical topics. This highlights one approach to engaging multilingual students in developing AI literacy by connecting linguistic accessibility and critical engagement with AI.

## 5.4 Challenge 4: Accounting for students' marginalized identities in AI critique

A central goal of justice-centered computing education is to critically examine AI's role in systemic oppression and empower students to be agents of change. Since marginalized communities are disproportionately affected by artificial intelligence, we did not want to further this harm by enumerating all the ways AI harms them. We found it challenging to design avenues for critical engagement without perpetuating existing harms. For example, we could cause harm by introducing algorithmic bias in banking, showing that it disproportionately affects Muslim communities.

Below, we reflect on the intentional scaffolding we built into the curriculum. We organized the curriculum so that students built foundational AI knowledge before they began critiquing it. At the beginning of the unit, students learned about AI, and then in Weeks 3 and 4, they engaged with AI in structured, inquiry-driven ways. This method allowed students to arrive at their own ideas about AI and its harms. Ultimately, the final project challenged them to further interrogate the personal and socio-political implications of AI (see Challenge 5). Below, we discuss the experiences underpinning our curriculum design decisions. For example, we emphasize that we do not want to ascribe a 'good' or 'bad' label to AI but instead encourage students to develop their own ideas and opinions on AI throughout the unit.

**I:** I was thinking about where we would begin and how to build AI learning into this one-and-a-half-month slot, week by week. We knew that building background knowledge was key, but instead of front-loading all that learning at the beginning, we decided it should be **woven throughout the unit**. So we provided them a resource packet, which gave them an approachable way to start their research.

Ultimately, the unit is structured for students to spend the first two weeks building foundational knowledge. In week three, they dive into machine learning, and by week four, we shift the conversation to AI's impact on society. That is when we ask the students to reflect on their personal experiences and think about AI beyond what we have conversed about in class. We want them to consider, **"How is this technology utilized in the real world? How does it help? How does it harm?"** and let them come to their own conclusions.

**R:** I was really conscious about not framing it in a way that tells students, "Okay, you're Black, you're Muslim—here is how technology has been designed to disadvantage you." That felt too much. **I wanted them to come to those realizations on their own** in a way that made sense to them. **We also did not want to frame AI as simply "good" or "bad."** We leave that ethical conversation for later after they have had time to deeply understand AI and its applications.

For example, with multilingual learners, technology such as Alexa may not recognize their accents or support their home language. That is a real-world example of bias. If your whole family speaks a language Alexa does not understand, the device is useless in your home.

**I:** That was one of our big goals. **We wanted students to develop their own informed opinions about AI** so that in the future, if they have the choice to use it or not, they actually understand what they are opting into.

And beyond that, we wanted to balance individual choice with a sense of community. **We want students to be leaders, but we also want them to recognize that they are part of something bigger.**

We demonstrate how we used sequencing to support critical inquiry while mitigating student harm. It gives students time to build technical fluency and self-efficacy before engaging in ethical critique. We scaffolded the curriculum in order for students to develop a shared AI foundational understanding. We also helped guide students in avoiding oversimplified ethical framings of AI, while encouraging them to engage with the complexities and nuances regarding AI, its uses, and its impact on their lives and society.

## 5.5 Challenge 5: Scaffolding assessments

Scaffolding assessments are a central component of JCCE as they support students in developing a deeper understanding of the material while reducing barriers to learning. We found designing scaffolded assessments to be quite challenging. Being multilingual, many of the activities that intrinsically came to mind needed to be further tailored to equitably engage our students. Below, we show how we iteratively designed the final project. This design decision allowed us to facilitate deep discussion around AI and its social-technical and personal implications without creating unnecessary stress. Rather than placing students in a high-pressure environment of debate, the position poster project encouraged collaboration, allowing them to develop and refine their perspectives over time and through the community.

**I:** For Week 4, I was thinking the culminating project would be a debate. I don't know if this is the best idea for our students.
**R:** What is the debate topic you're thinking of?
**I:** Should AI be used in decision-making?
**R:** That question bodes well for those of AI and society, but I think it's a bit too. We also talked about **students struggling with public speaking. I think a debate might be too much right now, especially given that there's little time to prepare.**
**I:** We are trying not to pick activities that pose barriers to participation.
**R:** Rather than a debate, we can have them make position posters about emerging debates about AI and society. Like, should students be allowed to use Chat GPT for their homework?
**I:** Yeah, I was hesitant about the debate; I do think it's a useful activity, but not for our students. Or perhaps we can revisit it in the summer when we have more time to scaffold it.
**R:** The posters allow students to work together and explore the nuance.
**I:** Let's do the poster. The poster prompts are tailored to students' experiences. **This can help raise their critical consciousness** and learn from one another. We can do a gallery walk of the posters, and students can give each other feedback. This is where the debate happens, not formally, but informally, talking about students' opinions. They might disagree with each other, and that conversation is where they can mold their own opinions and ideas of AI and society.

This case demonstrates that JCCE curriculum design must consider not only students' engagement with the pedagogy but also scaffold assessments that support their engagement with the socio-technical implications of computing in society and their own lives. Scaffolding assessments for such inquiry is particularly challenging compared to other types of assessment design, as these issues require students to navigate technical concepts, self-reflection, and deeply rooted ethical and social justice concerns. Traditional assessments, such as tests and presentations, may not provide the support needed, especially for students with varying support needs, like English language learners, who may focus more on task mechanics than on critical reflection. This is especially counterproductive when students are grappling with complex ethical and technical ideas around systemic bias and socio-technical systems.

Furthermore, the curriculum design should be flexible and responsive to students. Leveraging existing relationships with students allowed us to adapt the curriculum to be more inclusive and responsive to students' needs, giving them the space to meaningfully express themselves and critically engage with justice-centered AI topics. Our design process surfaced design principles, such as designing in response to students' needs and prioritizing pedagogical approaches that foster critical consciousness without imposing cognitive or emotional strain.

## 6 Discussion

Our work explicitly examined the curriculum design process, offering new methodological insights for justice-centered computing curriculum design.

Our duo-ethnography highlighted that collaborative curriculum design centering equity mediates the challenges between technical and justice goals. We discovered that JCCE requires more than just a critical lens; it demands intentional, responsive curriculum design that accounts for real-world constraints. Addressing challenges such as instructor knowledge gaps, financial limitations, language barriers, and the complexities of AI critique required collaborative design, scaffolding, and adaptive pedagogy. Positioning educators as both learners and facilitators strengthened instructional capacity while leveraging community resources, enabling hands-on engagement despite funding limitations. By treating language as an asset rather than a barrier, we developed scaffolded AI literacy tools that ensured equitable access to foundational computing knowledge. Moreover, we learned that critical engagement with AI must be carefully sequenced. Students need time to build technical fluency before interrogating AI's societal impact, preventing harm while fostering agency. Finally, rethinking assessment through linguistically approachable pedagogies reinforced that access in computing education extends beyond content learned to how students engage with learning.

These findings highlight that translating JCCE theory into practice requires not only reimagining what computing education includes but also how it is structured, ensuring all students, regardless of background or prior experience, can critically and meaningfully engage with AI.

Our work shows the importance of educator content learning in the JCCE curriculum design process. Prior work in JCCE often focuses on student engagement and curriculum implementation [3]. Our findings build on this previous work, suggesting that educators should engage in content learning to effectively implement justice-centered CS curricula. Further, JCCE requires both CS content knowledge and an understanding of the social and political implications of computing. Prior work suggests that educators often only possess one of these proficiencies [1, 25, 64]. Our findings build on this, emphasizing how both an educator's self-directed learning and partnerships with experts (e.g., research practice partnerships) can bridge such a content gap. This finding highlights the need to facilitate, support, and empower educators' continued learning to ensure they have the competencies necessary to facilitate justice-centered CS learning.

We discovered that reflexivity is central to addressing justice-centered challenges during curriculum design. Practitioner reflexivity is an ongoing process in curriculum design. These findings build on bell hooks' notion of *engaged pedagogy* and prior work in JCCE theory that discusses the importance of educators examining their own positionality [25, 27, 34, 36, 64]. These reflections provide a tangible example for researchers on how teachers engage in such introspection and adapt their approaches in response to issues of power, identity, and social justice in computing education.

Our work also suggests that JCCE curricula must be responsive to student needs and changing social contexts. Through our linguistically and culturally relevant assignments and assessments, we demonstrate curricular evolution as a concrete way to bridge JCCE theory and practice, by ensuring that curriculum and assessments are designed to accommodate diverse learning needs and provide equitable access to learning. Our work builds upon prior work in culturally responsive computing [44, 46] and anti-racist assessments [38], giving insights into how curricular evolution can help design culturally relevant and anti-racist pedagogies and assessments [27, 61].

This research has limitations, including its focus on a small-scale, 3-month co-design project within a specific after-school STEAM program, which may not fully translate to other educational settings. Additionally, while emphasizing educator learning and reflexivity, the study does not explore how these processes can be sustained or scaled in larger systems. Finally, the research addresses specific challenges but may not cover all potential barriers in justice-centered curriculum design.

Our research also supports several implications for practice, policy, and research. We demonstrate how educators collaborating with people who have content knowledge helps bridge such gaps. Future research can explore how to obtain and sustain such collaborations, even in formal educational settings. Moreover, policy can advocate for funding, providing more time and resources for JCCE professional development.

We hope our research contributes to the growing conversation on JCCE by highlighting the nuances and constraints of curriculum design processes. By centering educator learning, reflexivity, and collaboration between educators, researchers, and policymakers, we can work towards designing justice-centered computing educational experiences. Our goal is to support a vision of computing education where students and educators are equipped to critically engage with computing and technology, using it as a tool for transformative social justice.

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