



# Teachers' Perspectives on Culturally-Relevant Computing: Principles and Processes

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## Abstract

Culturally-relevant computing has been discussed as a way to promote K-12 Computer Science education and address ongoing challenges related to diversity, equity, and inclusion. What is not well understood about the practice of culturally-relevant computing, however, is how to bring together existing cultural frameworks and Computer Science curricula effectively. To help address this area, focus group interviews were conducted with ten ( $n = 10$ ) in-service Computer Science teachers working in the multicultural context of Hawai'i. The focus group sessions were designed to reveal teachers' perceptions of the principles and processes involved in designing and implementing culturally-relevant CS lessons and resources. Results revealed a number of key themes, including important variations in the practitioners' philosophical and operational approaches to culturally-relevant computing. The paper ends with a detailed discussion of the findings and their implications for designers, practitioners, and researchers working in Computer Science education.

**Keywords** Computer science education · Culturally-relevant pedagogy · K-12 · Computing

## Introduction

Like many states in the U.S., Hawai'i suffers from a shortage of qualified Computer Science (CS) teachers (Nguyen & Mordecai, 2020). This shortage has resulted in many educators being asked to teach CS with minimal formal training. Teachers without formal training in CS education (CSE) tend to face a number of challenges including pedagogical issues, lack of community, and little understanding of course content (Yadav et al., 2016). This has

created a situation where in-service teachers need in-depth professional development and on-going support, coaching, and mentoring (Cuny, 2012). A challenge for school districts interested in providing these supports is finding ways to connect CSE to existing instructional goals and curricular frameworks (Century et al., 2013; Qian et al., 2018).

One promising approach to making such connections is culturally-relevant pedagogy. Culturally-relevant pedagogy “empowers students intellectually, socially, emotionally, and politically by using cultural referents to impart knowledge, skills, and attitudes” (Ladson-Billings, 1994, p. 17–18). Such an approach to teaching values explicit connections between students' home culture and the subject matter they are learning (Gay, 2010; Ladson-Billings, 1995). It views diversity as a pedagogical asset (Gutiérrez et al., 2000) and strives to create learning environments that connect in deep ways to the life experiences of students (Nasir et al., 2014). Given concerns about diversity, equity, and inclusion in STEM-related fields (Blikstein & Moghadam, 2019; Committee on STEM Education, 2018), researchers have explored how culturally-relevant pedagogies help students from marginalized communities succeed in science (Chinn, 2007; Djonko-Moore et al., 2018), technology (Kaopua et al., 2016; Mejias et al., 2018), engineering (Wilson-Lopez

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et al., 2016) and math (e.g., Enyedy & Mukhopadhyay, 2007; Hubert, 2014).

Related work in CSE has focused on culturally-relevant computing (Eglash et al., 2013; Kafai et al., 2014; Madkins et al., 2019; Nakajima & Goode, 2019; Scott et al., 2015; Scott & White, 2013). Culturally-relevant computing aims to activate a student's prior knowledge while focusing on building content and delivering that content in ways that provide students with social and civic empowerment (Engerman et al., 2021). According to Kafai et al. (2014), culturally-relevant computing leverages local practices of ethnocomputing. Ethnocomputing has been described as the “co-constituting relationships between computing and culture” (Lachney et al., 2021, p. 112). It is a body of research examining how computing ideas can be embedded in cultural activities (Babbitt, 2014). In their definition of culturally-relevant computing, Kafai et al. (2014) argued ethnocomputational practices are used to create design tools that make explicit the mathematical and computational principles already present in the cultural practices of particular groups. Such ideas have led practitioners and researchers to develop CS-related activities and resources that are culturally-relevant for learners (Buechley et al., 2007; Nakajima & Goode, 2019; Scott & White, 2013). Importantly, Kafai et al. (2014) emphasized that culturally-relevant computing should position learning about culture in and of itself as an outcome, one that is just as important as learning about computing.

What is not well understood about culturally-relevant computing are the principles and processes of bringing together existing cultural frameworks and CS curricula in ways that 1) promote both CS and cultural outcomes, and 2) result in outputs that are meaningful to classroom teachers. For example, there are a number of helpful CS courses and guides available nationwide (e.g., CS Fundamentals, Everyone Can Code); however, these CSE resources are not necessarily culturally-relevant by default. To make them culturally-relevant to their specific educational contexts, teachers must work to integrate CS lessons and resources into a culture's unique language, history and values. What is not well understood about this work, however, are the principles and processes educators' use or should use to integrate CS and culture. By better understanding the principles and processes involved in this kind of interdisciplinary work, culturally-relevant computing initiatives can avoid simplistic conceptions of culturally-relevant pedagogy such as cultural celebration or trivialization (Sleeter, 2011) and help ensure solutions are usable and effective in the hands of practitioners.

To help address this need, this paper reports on findings from research examining CS teachers' perspectives on the topic of culturally-relevant computing in Hawai'i. Part of a larger initiative to provide upper elementary educators the resources and preparation needed to integrate CSE into their teaching, this study uses participatory design research

(Spinuzzi, 2005) to examine how in-service CSE teachers work to design culturally-relevant computing modules aligned to Hawai'i's unique educational context. Participatory design, with roots in early 1970s Scandinavia (Ehn, 1989), aims to actively include end-users in the design process in an effort to understand that community's needs and co-design tools that meet those needs (HingTing & Di Loreto, 2017). By analyzing data collected through focus group interviews with CS teachers, this study aimed to better understand how in-service CS educators working in a diverse multicultural context think about and approach culturally-relevant computing. Understanding this perspective will be an important step toward promoting culturally-relevant approaches to CSE.

## Literature Review

### Cultural Relevance and Learning

Cultural relevance has been emphasized for teaching and learning in various subject domains such as math, language, science, music (e.g., Acharya et al., 2021; Christ et al., 2018; Doyle, 2014; Ebe, 2012). The importance of cultural relevance also has been discussed in different educational settings, a physical classroom (Morrison et al., 2008), online courses (Lawrence, 2020), and special education (Fiedler et al., 2008). Recognizing that learning is socially and culturally mediated (Groulx & Silva, 2010), these studies argue connecting learning to individual learners, their communities, and their experiences is essential. For example, Acharya et al. (2021) explained “how mathematics is deeply connected to people, their practices, and the environment that collectively determine their cultural and social identities and values” (p. 18), emphasizing cultural relevance in math teaching and learning. Researchers have also argued that culturally relevant teaching is necessary for diverse students to be motivated and succeed (Adams et al., 2018; Dee & Penner, 2017; Mensah, 2013). Accordingly, the work of bringing culture into the learning process has been an interest of many educators and researchers and has been discussed in various terms such as culturally responsive teaching (Gay, 2013), culturally relevant pedagogy (Ladson-Billings, 1995), and culturally sustaining pedagogy (Alim et al., 2020). While it may be argued that these terms may have slightly different meanings, the core idea of these terms is based on a belief that teaching and learning should be connected to culture.

### Culturally-Relevant Pedagogy and Related Concepts

Culturally-relevant pedagogy “empowers students intellectually, socially, emotionally, and politically by using cultural referents to impart knowledge, skills, and attitudes”

(Ladson-Billings, 1994, p.17–18). Such an approach to teaching values explicit connections between students' home culture and subject matter (Gay, 2010; Ladson-Billings, 1995). It views diversity as a pedagogical asset (Gutiérrez et al., 2000) and strives to create learning environments that connect in deep ways to the life experiences of students (Nasir et al., 2014). Educators can make learning more relevant and effective by using students' "cultural knowledge, prior experience, frames of reference, and performance styles" (Gay, 2010, p. 29). Culturally-relevant pedagogy is often tied to Moll and González's (2004) concept of *funds of knowledge*, the "historically accumulated and culturally developed bodies of knowledge and skills essential for household or individual functioning and well-being" (p. 133). In addition to being culturally-relevant, pedagogy at work in indigenous communities is culturally sustaining (Alim et al., 2020; Paris & Alim, 2014) and culturally revitalizing (Kana'iaupuni & Ledward, 2013; Kawakami, 2004; McCarty & Lee, 2014). This important work addresses access, social equity, cultural appropriateness and representation while also supporting indigenous self-determination through the preservation and revitalization of place, history, culture, and language (Benham, 2007; Smith, 2013). Over the years, a great deal of research has demonstrated the value of culturally-relevant pedagogies in helping students from marginalized communities succeed in STEM-related areas including science (Chinn, 2007; Djonko-Moore et al., 2018), technology (Han, 2009; Ka'awa & Hawkins, 1997; Kaopua et al., 2016; Mejias et al., 2018), engineering (Wilson-Lopez et al., 2016) and math (e.g. Enyedy & Mukhopadhyay, 2007; Hubert, 2014).

### Culturally-Relevant Computer Science Education

Concerns about a lack of diversity, equity, and inclusion in the field of CS have led to research in culturally-relevant computing (Eglash et al., 2013; Kafai et al., 2014; Nakajima & Goode, 2019; Scott et al., 2015; Scott & White, 2013). According to Kafai et al. (2014), culturally-relevant computing leverages local practices of ethnocomputing to create situated design tools in which interactive computational models make explicit the deep-seated mathematical and computational principles already present in the cultural practices of particular groups. Such ideas have led practitioners and researchers to develop CS-related activities and resources that are culturally-relevant for learners. For example, Buechley et al. (2007) used electronic textiles (e-textiles) to introduce electronics and programming, noting the remarkable degree of energy and passion students devoted to designing something for their own cultural milieu. Another example is from Scott and White's (2013) culturally-responsive multimedia program, which worked with young girls from disadvantaged settings to examine

the extent to which cultural-relevance assisted with retention and affected students' vision of themselves as future technologists. More recently, Nakajima and Goode (2019) reported a study of educators implementing a new curricular unit in their high school CS classes. In this unit, the students used household tools and materials to design and construct "personally meaningful computational artifacts" (n. p.). The authors concluded that projects involving e-textiles can support cognitive and cultural shifts around learning CS. Importantly, Kafai et al. (2014) emphasized that culturally-relevant computing should position learning about culture in and of itself as an outcome, one that is just as important as learning about computing. In their study, examples of cultural learning outcomes included students' identity development within their culture and place, as well as increased understanding of the history and emergence of their respective communities. To summarize, ensuring culture is an *outcome* of CS education initiatives is a way to answer calls for more culturally-sustaining (Alim et al., 2020; Paris & Alim, 2014) and culturally-revitalizing (Kana'iaupuni & Ledward, 2013; Kawakami, 2004; McCarty & Lee, 2014) practices.

### Methodology

A qualitative participatory methodological approach (Creswell & Creswell, 2017) using focus groups was selected as the study's method. Using focus groups allowed the researchers to group interview participants and employ structured questions while encouraging open discussion among participants. The approach helped minimize power relationships between the participants allowing for more authentic and revealing dialogue (Denzin & Lincoln, 2018; Queirós et al., 2017).

### Participants

Ten in-service educators participated in the focus groups. The participants were recruited from public and private K-12 schools in Hawai'i. The only selection criteria for participation was experience teaching CS in Hawai'i and/or supporting teachers in implementing CS lessons. On average, the participants had nearly 20 years of experience working in education ( $M = 19.90$ ;  $SD = 6.98$ ). The most experienced teacher had over 35 years of experience and the least experienced teacher had nine years of experience. In terms of working in CSE, participants averaged 8.40 ( $SD = 8.94$ ) years of experience. The most experienced participant had 20 years of experience working in CSE, whereas the least experienced educator had less than a year of experience. Table 1 displays a summary of general information about each of the focus group participants.

**Table 1** Participant Summary

| Focus Group | Focus Group - Interviewee | Years in Education | Years in CS Education |
|-------------|---------------------------|--------------------|-----------------------|
| 1           | 1                         | 21                 | 3–4                   |
|             | 2                         | 27                 | 2–3                   |
|             | 3                         | 16                 | < 1                   |
| 2           | 1                         | 20                 | < 10                  |
|             | 2                         | 17                 | 7                     |
|             | 3                         | 9                  | 7                     |
| 3           | 1                         | 35                 | 20                    |
|             | 2                         | 20                 | 17                    |
|             | 3                         | 17                 | 17                    |
|             | 4                         | 17                 | 2                     |

## Research Questions

To examine how educators work to design culturally-relevant CS lessons and resources aligned to Hawai'i's unique educational context, the researchers posed four research questions. The study's first research question asked, "How do educators understand the concept of culturally-relevant computing?" The rationale for asking this question was based on the premise that the concept of cultural-relevance and, relatedly, the concept of culturally-relevant computing, may mean different things to different people (e.g., instructional designers, practitioners, researchers). For example, there may be differences in the definitions posed by academics and the day-to-day definitions or understandings used by practitioners. By exploring this question, the researchers hoped to better understand how in-service CS educators think about this important and multi-faceted concept.

The study's second research question asked, "What principles should guide the design of culturally-relevant CS lessons and resources?" The researchers hypothesized that educators would have valuable opinions about the principles that should guide how individuals or groups go about creating culturally-relevant CS lessons and resources. By identifying these principles, the researchers hoped to enable others to A) examine existing lessons and resources for alignment to these principles and, B) influence the creation of future efforts to design culturally-relevant CS lessons and resources.

The study's third research question focused on process: "What process (approaches) should guide the design of culturally-relevant CS lessons and resources?" The rationale for asking this question was to understand how in-service educators suggest teams go about creating CS education lessons and resources that are culturally-relevant. Where do they start? What steps do they follow? Providing some insight into how educators work may

reveal opportunities for content creators, designers, and researchers to support and scaffold educators' existing efforts more effectively.

The study's final research question asked about the current state of culturally-relevant computing: "To what extent are existing CS lessons and resources culturally-relevant?" This question was designed to determine how in-service CS educators are interpreting the current state of culturally-relevant computing.

## Focus Group Procedure

Participants were invited to participate in one of three focus group sessions conducted during the Fall 2021 semester. These sessions were conducted virtually using video conferencing software. The focus group sessions involved approximately 60 min of discussion about CS education in Hawai'i with a particular emphasis on the concept of cultural-relevance.

Each session began with a brief overview explaining the purpose of the study and that six open-ended questions would be asked. Participants were encouraged to discuss the questions amongst themselves and reminded that there were no "right or wrong" answers. After addressing any questions, participants were asked to complete a consent form, at which point the focus group session began. Each focus group included six open-ended questions moderated by a researcher. Probing questions were used throughout pauses in the discussion. Each session was recorded for transcription purposes only.

## Data Analysis

The transcripts of the focus group sessions were individually and independently coded by the researchers using Saldaña's (2009) first and second coding cycles. The purpose was to look for patterns and themes within the data. In the first coding cycle, structural coding was conducted based on the study's research questions. Structural coding is a way to initially code and categorize data and is especially appropriate for studies involving multiple participants and semi-structured data (Saldaña, 2009). The researchers used the results of the first cycle—which were produced individually and independently—to discuss and refine themes. Using these themes, a second cycle of individual and independent coding was conducted by the researchers. Once the second cycle was complete, the research team finalized the coding. Analytic memos were used during both coding cycles to document the process and further the discussion between researchers.

Results

Ideas from the focus group interviews fell into four broad categories based on the study’s research questions: perceptions, principles, processes, and the current state. The following section elaborates on these findings in detail. Table 2 outlines the findings in the order they are discussed.

Perceptions of Culturally-Relevant Computing

In terms of participant’s perceptions of culturally-relevant computing as a concept, two main ideas were highlighted. These ideas included 1) distinguishing content relevance (the what) from approach relevance (the how), 2) recognizing culture as multifaceted and classrooms as multicultural.

Distinguishing Content Relevance (the What) from Approach Relevance (the how)

Perhaps unsurprisingly, focus group participants emphasized two aspects of culturally-relevant computing: relevance and culture. When asked what comes to mind when thinking about culturally-relevant lessons and resources “in general,” most of the participants started by emphasizing *relevance*. In the literature, relevance has been defined as having distinct meaning and purpose for students by emphasizing the connection between curricular content and skill with life (Williams & Wilson, 2012). Analysis of the ideas shared by participants regarding relevance revealed two potential forms: *content relevance* and *approach relevance*. Examples of content relevance included “something that matters to students” or a topic “sparking interest.” Examples of approach relevance seemed to involve the ways in which teachers facilitate their lessons. In other words, approach relevance was more about the strategies employed by the teacher regardless of a lesson’s content or focus. One teacher talked

about the importance of activating background knowledge and another mentioned “connecting to student experiences.” In another comment, a teacher argued that relevant lessons and resources should be timely and “usable for students.”

One interesting discussion emerged when participants explored the intersection of age and content relevance. Several participants noted that what is deemed culturally-relevant likely varies based on one’s generation. “Cultural relevance is differentiated,” noted one participant. This participant went on to make a connection to the traditional schoolyard game Hopscotch, a game that requires players to jump through a series of rectangles drawn on the ground: “Most kids don’t know why those lines are painted on the floor...so it’s not relevant [to students].” He then cited video game environments like Roblox and Minecraft as examples of tools he felt were relevant to the current generation of learners. This perspective was likely based on his experience teaching CS to elementary students.

Recognizing Culture as Multifaceted and Classrooms as Multicultural

The second aspect of culturally-relevant computing emphasized was culture. Participants were quick to acknowledge the multifacetedness of “culture” as a concept. Several participants made immediate connections to ethnic backgrounds. One participant noted, “I’m half Mexican, so I would think of...how that can be applied to a lesson.” Participants also mentioned Hawaiian culture and Hawaiian studies are part of the state’s curriculum. While acknowledging the importance of Native Hawaiian culture to education in Hawai’i, several participants recognized that their classrooms were multicultural. They felt culture extended beyond ethnicity and/or heritage, pointing out other forms of culture including pop culture, American culture, and even internet culture. For example, one teacher talked about how she uses

Table 2 Perceptions, Principles, Processes & Current State Related to Culturally-Relevant Computing

|                                                                               |
|-------------------------------------------------------------------------------|
| Perceptions                                                                   |
| Distinguishing content relevance (the what) from approach relevance (the how) |
| Recognizing culture as multifaceted and classrooms as multicultural           |
| Principles                                                                    |
| Managing variations in prior knowledge                                        |
| Recognizing stereotypes and understanding multiple perspectives               |
| Promoting empowerment for teachers and students                               |
| Processes                                                                     |
| Connecting to standards and integrating other subject areas                   |
| Ensuring relevance and engagement                                             |
| Current State                                                                 |
| Facing common barriers (time, workload, resource availability)                |

social media platforms such as Twitter and Instagram “when I’m trying to look for something that’s culturally relevant.”

One participant took the concept of culture in a slightly different direction by focusing on the cultural origins behind CS lessons and resources: “If you look at where most educational resources come from...they really come from white, Caucasian, corporate America.” This participant felt that acknowledging and exploring where CS lessons and resources come from is part of culturally-relevant CSE. He added such lessons and resources amount to “telling a story from a certain perspective.” He went on to share the following:

*“When I think about culturally-relevant lessons, I look at stories that are being told from different perspectives, from different cultures, different ethnicities, and even telling the same story but just telling it differently from different eyes. That’s it, that’s a huge part of it. And making people aware is opening up to how other people think and other people’s experiences.”*

In yet another interpretation of culture, one participant described a recent event at his school held for CS Week—a week-long celebration and exploration of CS concepts and practices for the whole school (K – 12). Involved in planning the event, the participant shared, “If you break it down to high school, middle school, and elementary, each one of those [grade levels] has their own culture.” The participant described how the school’s CS staff went through a process of “adapting that information to each level [so] that it was relevant to those students.” This quote emphasizes how what may be considered culturally-relevant varies by age and grade.

## Principles of Culturally-Relevant Computing

A number of important ideas emerged when asking participants about the principles they felt should guide the design of culturally-relevant CS lessons and resources. These principles included 1) managing variations in prior knowledge, 2) recognizing stereotypes and understanding multiple perspectives, and 3) promoting empowerment for teachers and students. We elaborate on each of these principles below.

### Managing Variations in Prior Knowledge

One of the first principles to emerge from the focus group discussions was the need to manage variations in prior knowledge—the knowledge available in a person’s long-term memory at the onset of learning (Simonsmeier et al., 2022). Skilled educators are able to connect their lessons to students’ prior knowledge and, when necessary, adjust them as needed. Some focus group participants felt that they had to “build background knowledge” before they could engage

with the concepts and practices within culturally-relevant lessons. This was due to the perception that students lacked prior knowledge of CS *and* culture. As one participant pointed out, “not everyone is Hawaiian.... so there are a lot of connections to make.”

One poignant moment emerged when a participant with experience teaching English as Second Language, spoke about how English Language Learners are often “placed in a situation where it’s extremely stressful [because] they are out of their element.” This was an analogy to underscore how learners unfamiliar with certain CS or cultural concepts or practices might feel “out of their element” under some circumstances. The participant went on to explain how offering culturally-relevant CS lessons and resources could be seen as a way to de-stress the learning context and “bring them into the educational picture.”

One group of participants working in a particularly rural area of Hawai‘i picked up on the importance of managing prior knowledge. One teacher from this group stated, “that’s something we struggle with here at our school.” Another teacher at the school went on to explain, “Unless the materials are island centric, or Hawai‘i centric, sometimes the kids don’t have the background knowledge to interpret. And, therefore, you have to spend additional time building the background knowledge, providing examples, creating metaphors that make sense for them, prior to even engaging in the content of the material.” Later in the interview, when reflecting on an interdisciplinary unit involving geography, this same teacher shared, “The kids do not have a very good understanding of the geography of where they live....so I learned a lot about how much they didn’t know.”

As these examples suggest, the participants felt managing variations in prior knowledge was a critical aspect of culturally-relevant CS lessons and resources. The value of leveraging students’ prior knowledge has been recognized across domains and learning contexts (e.g., Hailikari et al., 2008). The current finding reinforces this value, while speaking to the nuances of managing students’ prior knowledge in two distinct areas: CS and culture. The goal of managing prior knowledge is to enable learners to build upon what they already know in order to assimilate new knowledge and skills whether they be related to CS or cultural outcomes.

### Recognizing Stereotypes and Understanding Multiple Perspectives

A second principle to emerge from the analysis was recognizing stereotypes and understanding multiple perspectives. Stereotypes are defined as universal generalizations about a social group (Beeghly, 2015), and research has shown they occur at conscious and unconscious levels (Arendt, 2013; Smith & White, 2002; Starr, 2018).

The focus group participants recognized that culturally-relevant CS lessons and resources are susceptible to stereotyping both in terms of culture and the field of computing itself. On the cultural side, one participant noted, “Stereotypes are difficult because kids really latch onto them.” Continuing this line of thought, one participant referred to her own lessons on Native American tribes. Upon reflection she argued that professional teachers need to make sure “we’ve respected any culture we’re representing and that we haven’t simplified them down to something that is a...stereotype.”

Stereotypes were also mentioned in the context of CS as a school subject and as a field. Participants made mention of both students and teachers possessing preconceived notions about who belongs and is capable when it comes to CS. One participant mentioned gender and CS, “I see it here at/on our campus where there are people who think that they cannot do this.”

The participants’ thinking about stereotypes and CS went beyond simply recognizing them. Several participants shared ideas about how teachers might address them by emphasizing the importance of multiple perspectives. One participant felt strongly that much of CSE today involves, “telling a story from a certain perspective.” Helping learners recognize that all lessons and resources have a perspective was raised as part of efforts to support culturally-relevant CSE. Another teacher explained he felt CS was a way to recognize “stories that are being told from different perspectives, from different cultures, different ethnicities, and even telling the same story but just telling it differently from different eyes.” This part of the discussion ended with one participant emphasizing the importance of “having people understand that this [what they know] is a perspective. This is a viewpoint, but it’s not necessarily a truth.”

### Promoting Empowerment for Teachers and Students

The third principle revealed was one of promoting empowerment. The concept of empowerment was mentioned in the context of both teachers and students. For example, one participant stated, “teachers need to feel empowered” so that they can teach CS effectively and efficiently. Another participant emphasized the importance of designing CS lessons and resources that are flexible enough to “allow the teacher to spin that activity into something that is culturally-relevant.” What should be noted in this comment is the idea that it is the teacher, as opposed to the lesson or resource itself, that has to work to make the experience culturally-relevant. This suggests there might be a tendency to over emphasize *designing* culturally-relevant lessons instead of *implementing* culturally-relevant lessons. This is a reminder of the central role teacher empowerment needs to play in operationalizing culturally-relevant CS lessons and resources. Building on this idea, the participant went on to describe

these hypothetical lessons as giving teachers “a foundation...almost like a blank canvas.”

Participants also stressed empowering students as a principle that should guide the design of culturally-relevant CS lessons and resources. One teacher highlighted how it is important to make sure students feel that they can learn these CS concepts and practice, and that knowledge is going to “help you [students] change something.” The participant also explained that empowerment was more than getting students to feel empowered about learning CS. Rather, it was about empowering them to feel like they can leverage CS concepts and practices to do what they want to do—what they feel is relevant to them and their community. This tied nicely to one participants’ observation about “how important it is to allow for individual voice.... and to represent yourself.”

Accordingly, participants suggested ways to empower students such as “...making sure that student voices (are) heard” and “having access to create content themselves.” There was also an emphasis on the importance of enabling students to share their work with genuine audiences. This was part of ensuring culturally-relevant CS lessons and resources embraced the principle of empowerment. One participant noted that it was critical to “help students present or to share their knowledge of some type of project, or something they’ve been working on.” Another participant summarized this same concept nicely: “...giving a place for the student to present something that was created, or a skill developed, is a great way to not only foster community partnerships, but... also make the child feel like it was all worth it.”

### Processes of Culturally-Relevant Computing

The next area of focus centered on notions of *process*, or the steps participants felt should be followed when designing culturally-relevant CS lessons and resources. In general, the process steps emphasized by participants fell into two broad categories: 1) connecting to standards and integrating other subject areas and, 2) ensuring relevance and engagement. We elaborate on these steps below.

#### Connecting to Standards and Integrating Other Subjects Areas

Some participants felt standards were an important starting point. One participant said most teachers he has worked with begin by asking, “What is the standard? What is the goal?” Interestingly, participants were split on whether culturally-relevant CS lessons and resources should start with CS standards, cultural standards or standards from some other domain. One teacher stated, “We’ll start with either science or social studies...then connect in the CS;

it's not the CS first and then connect." Another teacher offered an alternative approach, sharing the following: "For me, the process of creating a culturally-relevant CS lesson would begin by identifying the CS skill or skills that I want to target. Then I would choose a topic that I felt was culturally approachable with my class, something that I feel that they have a bit of background knowledge in."

A teacher from another focus group emphasized the importance of *integration*. This participant stated, "I think you have to integrate. So, when you look at CS, if we can get CS embedded into social studies, even though it's really such a math-based curriculum, then you can really get into some high-level perspective, storytelling type of things." Building on this comment about integration and social studies, another participant responded by saying, "Pulling CS into a social studies class, I think is doable, but the teacher always has to be open enough." The point here was the need to get teachers from different content areas working together in order for integration to emerge. In a similar vein, a participant from another focus group felt teachers "...get the meat of our lessons for CS around math and science, social studies."

### Ensuring Relevance and Engagement

Another key aspect of the process emphasized by participants was the step of ensuring culturally-relevant CS lessons and resources are relevant and engaging to students. One participant stated, "It's got to have a connection to us in some manner, right... whether that's a connection to my race, whether that's a connection to my generation, whether that's a connection to my school, to my city, to my background, to my history. If it doesn't have a connection, it's not going to be considered culturally-relevant to me."

When thinking about the process, other participants focused less on designing specific lessons and resources for classroom implementation, and more on the overall approach of the CS curriculum. "I look at it as engagement.... How can they be more engaged?" When pressed for details about what was meant by engagement, the teacher differentiated between listening and active listening, asking, "What would *really* bring them into the lesson in the first place?"

One group of participants summarized the process of designing culturally-relevant CS lessons and resources like this: "What's the meaning? Find the connections and then make things relevant." Another teacher in the same group added, "Find the meaning, make connections, and predict." When asked about what was meant by the verb "predict," the teacher felt it was important to help students see the connections between what they were learning and the future: "let's look at the future, to what we're looking at going forward."

### Current State of Culturally-Relevant Computing

The fourth area of focus asked participants about their perceptions of the current state of culturally-relevant computing. It was clear from the analysis participants were facing a number of common barriers related to teaching culturally-relevant computing.

#### Facing Common Barriers (Time, Workload, Resource Availability)

When asked about the extent to which existing CS lessons and resources are culturally-relevant, participants agreed it is limited. One participant described it as "very small, very pocketed." Another participant felt the current pool of culturally-relevant CS lessons and resources was not enough. As an example, one experienced participant commented on the diversity of artwork available on [Code.org](https://code.org). This participant felt some change was starting to be seen in terms of diversity but that it "still feels very one-sided at this point."

When asked about why there might be a lack of culturally-relevant CS lessons and resources, the participants articulated a number of possible reasons. One reason was workload. The participants felt that creating culturally-relevant CS lessons and resources was challenging and time consuming. One educator pointed out that many resources in the Hawaiian context are books that are not available online. She went on to share that many resources that might be used to make cultural connections were not always available and hard to access. Another participant shared a research unit she implemented about the gods and goddesses of ancient civilizations. This particular unit involved ancient Egypt, Greece, and Hawai'i. She pointed out that it was easy to find online resources about Egypt and Greece, but the resources about ancient Hawai'i were not at her students' reading level. She went on to explain, "then it turns back to me, going [to] the book, rewriting the material at their reading level, and then giving it to them." Reflecting back on the point of the unit, she concluded, "...it won't really be a research project because it's only one source."

When contemplating the lack of culturally-relevant CS lessons and resources, one concern raised was the feeling that examples of culturally-diverse *implementations* of CSE are needed. The participants felt that providing pre-built examples would allow students and teachers to learn how to integrate CS concepts and practices with valued cultural concepts and practices. But without concrete examples or exemplars, the teachers felt unsupported in the challenging task of situating existing CS lessons and resources within the cultural context of their classrooms. One teacher shared, "When I look at the elementary teachers and the [Code.org](https://code.org) and other resources, like robotics that they do, it seems to

be more just content based. Not much culture, just teaching content.”

## Discussion

The purpose of this research was to better understand how in-service CS educators working in a diverse multicultural context think about and approach culturally-relevant computing. In the space below, we discuss how the results of the focus group analysis call attention to three important questions the field of CSE should explore when designing and implementing culturally-relevant computing. For clarity and structure, we refer to these as the “what drives what” question, the learning dilution question, and entry point question.

### The “What Drives What” Question

When it comes to designing culturally-relevant CS lessons and resources, one lingering question emerged over and over: Should CS learning drive cultural learning or should cultural learning drive CS learning? We have labeled this the “what drives what” question. The educators interviewed for this study seemed to have mixed opinions. Most participants agreed that culturally-relevant CS lessons and resources should start with standards, but what standards? Options include CS standards but many participants felt standards related to science, social studies, and even Hawaiian studies were valid, even preferable, especially for teachers with less experience teaching CS. A single answer to the “what drives what” question is unlikely and perhaps even undesirable. In the end, answers may depend on teacher preferences, content knowledge, and philosophies. For now, we encourage the field to explore this question further and to share their explorations of “CS first” or “culture first” approaches to culturally-relevant CS lessons and resources.

### The Learning Dilution Question

A topic related to the “what drives what” question has to do with learning dilution in culturally-relevant contexts. Overall, there seemed to be a general consensus that balance and integration were critical characteristics of effective culturally-relevant CS lessons and resources. That said, one veteran CS educator with a great deal of professional development experience used a cooking analogy as a warning: “I got a 10 pound pot. I’ve got 10 pounds of carrots and I’ve got 10 pounds of potatoes. I really like potatoes. I don’t know much about carrots. What’s going to happen in that pot?” He used this analogy to express his concerns as a CS professional development facilitator, that culturally-relevant CS lessons and resources have the potential to minimize their CS focus if not carefully designed and implemented. He

summarized his point by saying he is concerned about the possibility of inadvertently diluting learners’ exposure to CS concepts and practices. Of course, the same concern might be raised in reverse—suggesting cultural learning might be minimized when integrating with CS concepts and practices. In short, educators tend to “cook” with the ingredients they know and understand.

The “what drives what” and the learning dilution questions are valid and suggest possible directions for future work. First, it is recommended that the “what drives what” question be explored deliberately in the context of culturally-relevant CS education. What does an optimal balance of CS and culture look like? Is there a way lessons and resources can be designed and implemented such that dilution can be avoided? If so, what might these lessons and resources look like? Furthermore, research will be needed to understand how teachers with varying levels of experience with CSE and cultural education implement the same lessons and resources.

One intriguing idea to merge from the researchers’ discussion is the concept of designing culturally-relevant CS lessons and resources that are “bi-directional.” In other words, these would be lessons and resources based on CS *and* cultural standards combined. What would make these lessons and resources different is the ability for educators to find, access, modify, and implement them from either a CS-first or a culture-first perspective. Are bi-directional lessons and resources even possible? If so, what might they look like? At this time, further research is needed to explore the pedagogical and practical potential of lessons and resources that are “bi-directional.”

### The “Entry Point” Question

The last topic to emerge has to do with leveraging existing CS lessons and resources for culturally-relevant purposes. There was a poignant sense that participants wanted more support in connecting existing CS materials, from well-known CS curricula, to valued cultural content and practices. For lack of a better label, readers might consider these cultural “entry points” or clearly designated parts of existing lessons and resources that suggest one or more ways for educators to make cultural connections. Ideally, these entry points would allow educators to make cultural connections that are content relevant and approach relevant to their students. For example, referencing the [Code.org](#) curriculum, one educator talked about the need to integrate well-marked cultural connections. He felt this would make it easier for educators already immersed in the [Code.org](#) curriculum to integrate culture-oriented mini-lessons. In this way, his colleagues could make the work they are already doing more culturally connected. While an intriguing idea, research will be needed to A) identify possible cultural entry points, B)

investigate where (and how often) they should be integrated, and C) understand how they should be designed to accommodate multiple cultural perspectives.

### Considerations for Future Work

In reflecting on the study's main discussion points (the “what drives what” question, the learning dilution question, and the “entry point” question), there seems to be a design tradeoff between structure and agency. As Collins (1996) described, designing any kind of learning experience involves cost-benefit tradeoffs, and designing culturally-relevant CS lessons and resources will be no exception. For this reason, the field is encouraged to consider the cost-benefit trade-offs associated with the structure and agency inherent in specific culturally-relevant CS lessons and resources.

On the one hand, it seems there is a need for structure. Given a shortage of qualified CS teachers, many instructors are being asked to teach CS with little or no formal training in CS methods. For this reason, offering well-structured culturally-relevant CS lessons and resources might be an appealing scaffold for many educators. The trade-off with such an approach is finding ways for well-structured lessons and resources to work *across* cultures. There is a danger that lessons and resources that are too structured lose their ability to support teacher and student agency, and, as a result, empowerment. This is important because research has shown that agency is not something people have but rather something people do or achieve (Priestley et al., 2015). Agency results from the “interplay of individual efforts, available resources and contextual and structural factors” (Biesta & Tedder, 2007, p. 137). For this reason, the field of CSE must investigate when lesson structure interferes with notions of agency, empowerment, and multicultural applicability. Three contexts in which this tension will likely emerge is when answering the “what drives what”, the learning dilution, and the “entry point” questions.

### Limitations

The work shared herein is limited in several ways. First, it centered on three focus groups consisting of in-service educators working in Hawai'i. Hawai'i has a unique historical, cultural, social, and geographic context which must be considered when interpreting the perspectives of the focus group participants. Second, the educator-participants averaged nearly twenty years of experience in education—mostly in Hawai'i—so their experiences and opinions may not generalize to less experienced educators or those working outside of Hawai'i. Finally, the researchers

themselves, who conducted the focus groups and analyzed the resulting transcripts, are part of the broader CSE community in the state of Hawai'i. In terms of positionality, the research team represents an average of over 20 years of experience in instructional design in variety of educational settings. Furthermore, they have worked among the ethnically diverse student populations of Hawai'i from 9 to over 20 years. Ethnically, the researchers represent a similar diversity of cultural grounding as a Native Hawaiian, Korean, Malaysian-born American and American. For all of these reasons, they may have brought their own biases and cultural assumptions to the study.

### Conclusion

The purpose of this study was to better understand how in-service CS educators working in a diverse multicultural context think about culturally-relevant computing. Through focus group interviews, the study identified some of the nuances related to educators' perceptions of culturally-relevant computing as a concept. In addition, the study identified principles that should guide the design of culturally-relevant CS lessons and resources. These principles included managing variations in prior knowledge, recognizing stereotypes and understanding multiple perspectives, and promoting empowerment for teachers and students. From there, the study described several steps associated with the process of designing culturally-relevant CS lessons and resources. These steps included connecting to standards and integrating other subject areas, as well as ensuring relevance and engagement. Following this, the paper discussed three important questions facing the field of culturally-relevant computing: the “what drives what” question, the learning dilution question, and the entry point question.

The researchers hope the study's findings and subsequent questions will contribute to ongoing efforts to advance the theory and practice of effective culturally-relevant computing experiences in K-12 settings. Researchers believe an important component of broadening participation in CS is “the enactment of a culturally responsive pedagogy in computing learning spaces” (Goode & Ryoo, 2019, p. 718). Ideally, the findings presented here will help researchers, practitioners, and policy-makers, better understand teachers' perceptions of how culturally-relevant pedagogy might be leveraged to increase diversity, equity, and inclusion in STEM-related fields such as CS.

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**Consent** Informed consent was obtained from all individual participants included in the study.

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