Supporting Computer Science Teachers to Customize Culturally Relevant Instructional Materials: Challenges and Iteratively Designed Solutions

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Abstract

Culturally relevant pedagogy (CRP) is being increasingly included in district-wide learning goals. Here, we report our analysis of the initial challenges teachers faced when integrating CRP into a middle school computer science (CS) curriculum. Qualitative analysis of co-design sessions with teachers experienced with the curriculum identified two primary challenges; (1) Getting to know their students within the often challenging context of teaching CS to multiple grades and hundreds of students and (2) brainstorming CRP themes within the technical and pedagogical constraints of the original lesson materials. We present our iteratively designed solutions to these challenges. We feel this work will be of interest to CS teacher educators, teachers, and researchers working to deliver culturally relevant curriculum into CS classrooms.

Objectives or purposes

Culturally relevant pedagogy (CRP) (Ladson-Billings, 1995) is being increasingly included in computer science (CS) curricula (Chinaka et al., 2021). Scratch Encore is a culturally responsive, intermediate Scratch programming curriculum with structured lesson plans that support specific learning outcomes alongside open-ended activities that promote self-expression and creativity (Franklin et al., 2020)). In order to address long-standing issues of equity and diversity in computing and construct nuanced culturally relevant educational opportunities, our research team worked to design ways to support teachers to re-imagine Scratch Encore lessons in ways that incorporate and amplify the voices, values, and identities of the students in their classrooms. We call this process *Harmonizing*.

However, *Harmonizing* existing curriculum in ways that retain the structure to support learning objectives while meeting culturally relevant goals presents challenges. In this paper we present the challenges we observed when iteratively designing scaffolds through a series of participatory sessions (Coenraad, 2022) with experienced Scratch Encore teachers. Here, we present the challenges we observed in the first steps of the *Harmonizing* process, as teachers chose culturally relevant themes to integrate into their Scratch Encore lessons. This work represents initial steps toward developing a national professional development experience for

teachers of all grades levels that use Scratch Encore to *Harmonize* instructional materials to reflect the cultural and community resources present in their classrooms.

Perspective(s) or theoretical framework

In response to the Computer for All movement and the growing demand for CRP, leading organizations and research groups have developed programming platforms tailored to young learners, along with computer science (CS) curricula to empower K-12 teachers entering this field. The effective implementation of CRP at the classroom level relies on supporting and preparing teachers so that the process of creating and teaching culturally responsive CS materials is not daunting or prohibitively time-consuming.

Pre-existing culturally responsive CS curricula have undoubtedly empowered teachers to deliver inclusive and equitable learning experiences to their students, e.g. Scratch Encore (Franklin et al., 2020), curricula developed by Code.org (Kalelioğlu et al., 2015), and Exploring Computer Science (Goode, 2010). However, a fixed set of culturally responsive materials will not remain applicable across times, locations, and the diverse needs of different student populations. Education researchers need to develop specific supports, in the form of professional development and classroom scaffolds for CS teachers nation-wide to dismantle inequality.

Methods

We ran a series of synchronous, online co-design sessions involving four experienced Scratch Encore teachers that represented four different states located in the Midwest and the Mid-Atlantic areas of the United States. Our research team consisted of five researchers representing two universities, one located in the Midwest and one located in the Mid-Atlantic.Participants were all experienced teachers with 4-8 years of CS teaching experience. Two teachers self-identified as male, one teacher self-identified as female, and one teacher self-identified as nonbinary. Our research was overseen by a university institutional review board and teachers were compensated $1,500.00 for their time and expertise.

The participatory design sessions occurred twice a month for five months during the spring of the 2022-23 school year. Each session lasted around 60 minutes and was held virtually on Zoom. The focus of the sessions was for the teachers to provide expert feedback on iterative designs of Harmonizing scaffolds and guidance and suggestions on a future nationally focused professional development experience on harmonizing Scratch Encore lessons. As part of these sessions, teachers were reviewing scaffolds created by the team, completing potential Scratch Encore harmonizing activities, reflecting on if the materials we were designing were helpful, and providing feedback on how to improve them.

Data and Analysis

Ten hours of transcribed video from the ten Zoom sessions were qualitatively analyzed. Two of the authors independently coded the first two transcripts, representing the first month of the design sessions using an inductive coding process. They then reconciled any differences until reaching 100% agreement. The same two researchers repeated this process for each of the following months, reconciling any coding differences and adjusting the code book four more times, once for each of the months of sessions.

At the conclusion of this first cycle coding, the two researchers gathered themes across codes through a series of analytic memos. Axial coding was used to refine these dominant themes (Saldaña, 2021). The themes were then presented to the entire research team for further refinement and agreement.

Results

The first step of the *Harmonizing* process involves brainstorming themes that will resonate with students while providing opportunities to demonstrate and employ the focal programming concepts of the lesson. As we co-designed with teachers, it became apparent that this step presented multiple challenges. For example, Chad (all teacher names are pseudonyms) shared during the first month of harmonizing that "*I think it took me longer to think of what I wanted to do for the project than it did to actually make the project*." This signaled clearly to the researchers that the *Harmonizing* process extended beyond just making a new *Harmonized* Scratch project and editing the supporting student materials. Specific scaffolds were required to support teachers in brainstorming culturally relevant topics.

Our analysis revealed that there were two primary challenges that teachers experienced during the first steps of the *Harmonizing* process. Here, we report on these challenges and the scaffolds that were co-designed to support teachers in meeting these challenges.

Challenge 1 - Getting to Know your Students

The participating teachers shared that it can be challenging getting to know their students. This challenge is not uncommon amongst CS educators who may see their students rarely or who may teach across all grades and students within a school. This may result in CS teachers seeing a student for only 45 minutes per week or having rosters of 600 or more students a semester. Within our cohort of teachers, Molly shared:

> *I just think a lot of us don't know our students. I have so many students. I would really have to be making a lot of assumptions about them or their families or their community… when you have 500 students a year, it's hard to really say that you know anything about them.*

Chad went on to add, "*I definitely… I kinda piggyback on what Molly said… You know, for me, like, I see my kids 45 minutes once a week.*"

Challenge 1 Response

The research team responded to this challenge by iteratively developing, with teacher input, two supports. First, a student facing "About Me" activity that would allow students to share their interests, cultural backgrounds, family traditions, and intersecting identities. This activity was a modification of the Scratch Encore Module 1, Scratch Basic. It included questions such as "What are events, holidays, or traditions that you especially enjoy and/or are important to your family?" and centered an activity in which students were asked to build a Scratch sprite, a visual representation of themselves to use in a basic project. These student sprites can then become a resource available for the teachers to integrate into other Scratch projects. Both Chad

and Paul shared at different times how powerful it could be to include sprites that students had built to represent themselves in their CS curriculum. Chad shared:

> *I definitely like the idea of them being able to input their own sprites, because, like, your idea of being able to check in. Just have their sprites in the background when you're doing an example project. The kids would absolutely go crazy if they saw their own sprites, you know, as part of the teachers project.*

While Paul shared, "*because [the students] are used to seeing the normal sprites, it is fun to see the sprites that you added.*"

The second teacher support for the challenge of knowing your students was a repository that gave teachers a place to gather, organize, and store student responses to the About Me activity along with student-created sprites. This was a very popular support. Molly, who taught approximately 500 students over the course of the year, shared:

> *I think [the repository] is worthwhile, because otherwise, as I said before, I'm just guessing, because I cannot know those hundreds of children. So yes, it is worth it, for me, to find out what they're interested in. So I think some form of this would be really beneficial.*

Chad, who served a dual role in his school as a CS teacher and a librarian, was excited to think of uses for the repository outside of his CS teaching, sharing, "*Even as a librarian… my book selection. I'm automatically - I'm in my head - I'm like - Wow, I just got a bunch of different things I can look for to add to my library.*"

Challenge 2 - Identifying Specific Culturally Responsive Topics

The second challenge associated with brainstorming culturally relevant themes involved teachers choosing themes that aligned with the learning outcomes and pedagogical constraints of the original lesson materials. This challenge is rooted in Scratch Encore's well-structured lesson plans and clearly defined technical learning objectives.

Our analysis indicated that this second challenge took three forms. The first was that teachers tended to brainstorm general topics, rather than the specific topics that were required to create the sprites and backgrounds needed for *Harmonizing*. Secondly, teachers, being experienced Scratch users, were drawn into *Harmonizing* projects in complex ways. Sam shared their difficulties:

> *I want to do fancy things, but need to keep it simple, not distract them [students] with tips and tricks they haven't learned yet or that we don't want them to focus on in that particular lesson.*

Thirdly, teachers struggled to find images to use as sprites that would meet their culturally relevant goals for the *Harmonizing process*. Again Sam shared their difficulties:

I still really struggled to find appropriate sprites to make it more inclusive. The sprites that I… I don't feel like I did a great job in the inclusive piece in this because of the sprites that I settled for, because I was just… It was taking me too long.

Challenge 2 Response

The research team responded to this second challenge in three ways. First, we developed a Brainstorming Hierarchy (Figure 1) to support teachers in brainstorming down to the level of sprite and background ideas before building their *Harmonized* Scratch project.

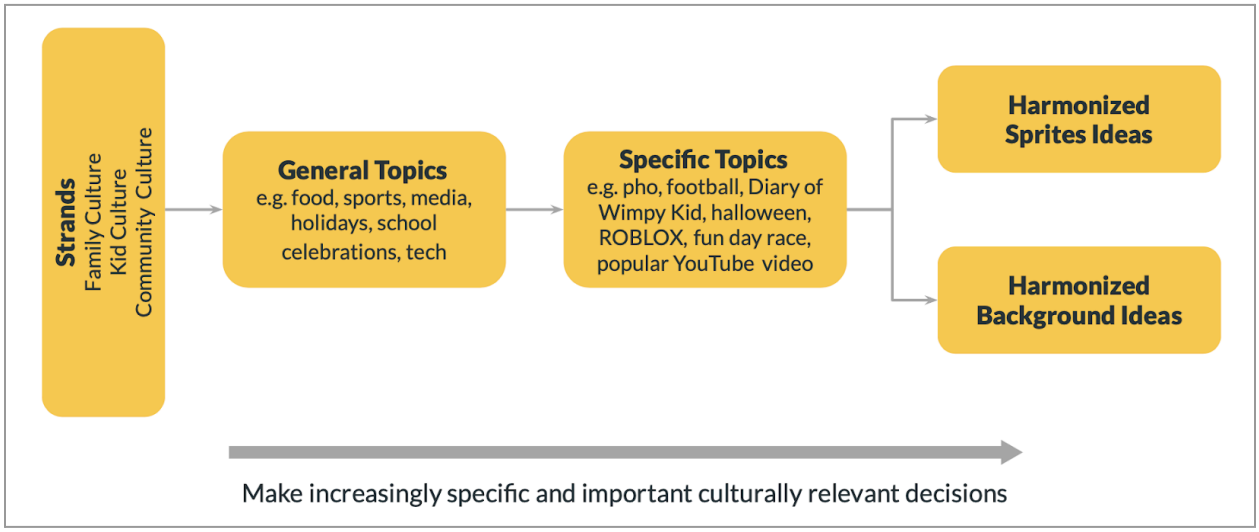

Figure 1: *Harmonizing* Brainstorming Hierarchy

Second, we created a Project Checker worksheet to help teachers review the technical elements in their *Harmonized* Scratch projects in comparison with the original projects. Teacher's found the Project Checker very illuminating. Chad shared, "*it pointed out that we were kind of getting lost in the weeds, and kind of going above and beyond.*" Chad went on to add, "*even something where I didn't think I did that much . . . to see that I had, you know, 3, 4, 5, unique blocks, and I was missing a few blocks.*" Sam also expressed how they useful they would find the Project Checker

Having data from the original project upfront would be helpful. It helps people like me [who want to do fancy things in their Scratch projects], sort of bring themselves in a little. Because I was again making it more complicated than it needed to be. So I had included a couple of blocks that weren't there [in the original projects], and then I didn't include a couple of blocks that were there.

Finally, we developed a tutorial with multiple strategies and step-by-step instructions to edit sprite costumes in Scratch. Teachers found that the editing tips we shared were very simple

and useful. In a conversation between Paul and Chad about how useful this tutorial would be for teachers new to the Scratch Encore curriculum, Chad shared:

> *And when Paul was saying about the costumes, I even thought, "Okay, if [beginner Scratch Encore teachers] don't know how to, you know, separate the leg and make the leg move, how can I add movement with adding another costume?" And I simply just… I added the other costume but all I did was just use the little rotation tool, which a lot of them [teachers] know how to do when they rotate pictures and all the things that they do well elsewhere. I just made the little guy [the sprite] rotate a little bit to make it look like it was moving. Because I tried to think, again, stay simple, without trying to throw too much out.*

Scholarly significance

Our research begins to address the complex problem of customizing a highly structured curriculum to include culturally responsive themes highly specific to individual teachers and their students. This customizing work is essential to address longstanding issues of equity and diversity in CS classrooms. Our work will be of interest to CS teacher educators, teachers, and researchers working to deliver culturally relevant curriculum into CS classrooms.

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References

Chinaka, L., Leonard, H., Kirby, D., Sentance, S., Deutsch, M., Dimitriadi, Y., & Goode, J. (2021). Culturally relevant and responsive computing in the classroom: A guide for the curriculum design and teaching.

Coenraad, M., Palmer, J., Eatinger, D., Weintrop, D., & Franklin, D. (2022). Using participatory design to integrate stakeholder voices in the creation of a culturally relevant computing curriculum. International Journal of Child-Computer Interaction, 31, 100353.

Franklin, D., Weintrop, D., Palmer, J., Coenraad, M., Cobian, M., Beck, K., ... & Crenshaw, Z. (2020, February). Scratch Encore: The design and pilot of a culturally-relevant intermediate Scratch curriculum. In Proceedings of the 51st ACM technical symposium on computer science education (pp. 794-800).

Goode, J. (2010, March). Connecting K-16 curriculum & policy: Making computer science engaging, accessible, and hospitable for underrepresented students. In Proceedings of the 41st ACM technical symposium on Computer science education (pp. 22-26).

Kalelioğlu, F. (2015). A new way of teaching programming skills to K-12 students: Code. org. Computers in Human Behavior, 52, 200-210.

Ladson-Billings, G. (1995). Toward a theory of culturally relevant pedagogy. American educational research journal, 32(3), 465-491.

Resnick, M., Maloney, J., Monroy-Hernández, A., Rusk, N., Eastmond, E., Brennan, K., ... & Kafai, Y. (2009). Scratch: programming for all. Communications of the ACM, 52(11), 60-67.

Saldaña, J. (2021). The coding manual for qualitative researchers. The Coding Manual for Qualitative Researchers, 1–440.