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When is an Owl More Than an Owl? An Interaction Analysis of a Computer Science Co-design Conversation on Cultural Relevance

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International Society of the Learning Sciences

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Abstract: The learning sciences community is currently exploring new ways to enact productive and equitable co-design research-practice partnerships that are sensitive to all the concerns and needs of stakeholders. The paper contributes to that still-growing literature through an interaction analysis of a co-design discussion involving school district partners that unfolded about cultural relevance and sensitivity in relation to the use of a specific image in an elementary school coding lesson. The episode involved looking moment-by-moment at how district educators recognized and acknowledged that a specific design decision could be harmful for a minoritized population of students enrolled in the district. However, once a key change was made to be more culturally responsive and considerate, new and unexpected pedagogical challenges appeared. This case serves to illustrate some of the unexpected tensions that can appear in real-time when unanticipated questions about cultural relevance are foregrounded during lesson and materials co-design.

Introduction

Given already full curricula and numerous standards, a set of design strategies are emerging that move away from introducing computer science ideas to students as a standalone topic in schools. This appears heavily in what is sometimes referred to as "STEM+C" (STEM plus Computing") approaches, whereby computer science and computational thinking are used pedagogically to support other expected content and practice learning goals, while also helping students develop in their computational thinking proficiencies. For example, computational thinking has been introduced as a way to understand natural selection in high school biology classes through algorithmic explanations (Peel et al., 2019). While some generative new frameworks (e.g., ibid, Weintrop et al., 2016) are appearing on how to integrate computational thinking with STEM content, there are still a number of other practice-based considerations and decisions that need to be made to support STEM+C integration in schools, many of which are still only partially known to learning scientists. Thus, learning scientists have been embracing research-practice partnership and collaborative design ("co-design") with classroom teachers and other school-system partners (e.g., school district coordinators, students, school librarians) (see Severance et al., 2016 for an example) in order to develop and refine STEM+C integration approaches.

This current paper originates from a research-practice partnership that involves co-design of STEM-C integrative lessons and resources with district and school educators. The goal of this larger project has been to design activities and materials (in the form of lesson plans, computer programs, and artifacts for teachers and other school educators) that could integrate specific elementary mathematics topics as they are treated in the district's adopted mathematics curriculum with district-required computer science instruction for elementary students. The paper focuses on an event that occurred during co-design activities in which an important conversation unfolded about culture and a minoritized group of students enrolled in the partnering school district. This episode was recorded on video and noted immediately by one of the researchers as a notable and extended (i.e., lasting several minutes and reappearing a second time on the same day) explicit conversation about cultural awareness and sensitivity. The purpose of this paper is to illustrate how that conversation about culture was laced with multiple underlying tensions. As will be illustrated below, the tensions relate to how different stakeholders responded to an explicit call for cultural sensitivity; some individuals were immediately concerned, and others needed more time. Another tension in this episode related to how the decision to make changes in the design of instruction to be more sensitive culturally were complicated by how the mathematics content and computational thinking were to be integrated as well.

Literature Review: Cultural Relevance and Computing Education

Above, we situated the work of this research-practice partnership co-design project as orienting toward integration of mathematics and computational thinking in elementary school and designing supports for paraprofessional educators who lead instruction in the computer lab. The district schedule allows for one computer lab lesson per week. However, through an approach informed by the theory of expansive framing (Engle et al., 2012), our co-design and partnership is organized to create and link multiple contexts of mathematics and computing and the classroom and the computer lab. For now, we turn to a body of literature that pertains to this analyzed episode is the intersection of cultural relevance and computing.

First, we assert that culture is already omnipresent despite it not often explicitly foregrounded in conversations about computer science, computing, or computing education. We follow Rogoff (2003) and others (Nasir et al., 2020) in asserting that all human activities are inherently cultural in nature. Current models of professional computer science and computing professions are already inherently cultural, but they center the experiences, preferences, and values of specific populations who tend to be more heavily represented in computing professions and computing coursework; often, it is the group that is racialized as White and (cis)gendered as male (National Academies of Science, Engineering, and Medicine, 2021). Observations of how computer science and computing education have been highly gendered have been made repeatedly over the years. Turkle and Papert (1992) made a call for epistemological pluralism in how students learn to do computer programming and relied on (White) feminist critiques of epistemological styles that are often associated with gender (e.g., planning vs bricolage). Kafai, Richards, and Tynes (2017) have also explored issues of computing and gender, noting ways in which women, across races, are not always provided the same forms of access to computational communities. One approach to change that has been to emphasize different practices and artifacts that can integrate computing that are not necessarily associated with masculinized norms of computing (such as robotics). One notable example in learning sciences research is electronic textiles (Buechley et al., 2013), through which computing and computational thinking take place in the context of creating and enhancing fabric crafts. Others include recognizing gendered craft activities such as weaving or knitting as already using computational thinking (Keune, 2022; Lee & Vincent, 2019).

In addition to gender, computing education can also be reimagined along ethnic and racial axes. First, computing education experiences can be designed so that they take reside in online and physical spaces that are designed specifically to welcome and empower historically minoritized racialized groups. *Digital Divas* (Pinkard et al., 2017) and *COMPUGIRLS* (Scott et al., 2013), along with nonprofit organizations such as *Black Girls Code*, are all compelling examples that are intersectional and speak to both gender and race. Race and ethnicity can also be made an explicit part of computer science education by helping minoritized youth to recognize and critique inequitable social structures that tend to align with race and ethnicity. This approach can create opportunities for students to raise their critiques and develop counternarratives (Vakil, 2018). Another way that race and ethnicity have been considered, especially in US-based work, has been in the intentional linking of computing with heritage practices. For example, Searle and Kafai (2015) have embarked on work with indigenous communities in the United States to combine Native craftwork with computing. Similarly, Eglash and colleagues (2006) have sought to elevate ethnocomputing by recognizing the rich computational reasoning that resides in practices such as cornrow hair braiding and beadwork.

These aforementioned projects provide aspirational models of what could be culturally relevant and responsive designs for computer science learning environments and learning tools. Our current paper is slightly different in emphasis in that we ask: what tensions arise within a research practice partnership when working together to resolve an issue of culturally relevancy within the context of a co-design session? Where we add to this literature is from the perspective of co-design and from the real-time encounters and engagements with cultural relevance and responsiveness as they appear during design conversations. The phenomena we analyze and share here provides a vivid image of what actual conversations about cultural relevance and sensitivity looked like and what were some of the underlying tensions related to both cultural sensitivity and the integration of math and computing content.

Theoretical framework

The interpretive and theoretical framework informing this paper is situated in what Philip et al., (2016) has called racial-ideological micro-contestations. Racial-ideological microcontestations (heretofore shortened to 'microcontestations') are an ontological innovation (diSessa & Cobb, 2004) from design-based research that names a class of interactional phenomenon during which the learning of disciplinary content knowledge is an overarching concern, but issues of race are invoked such that there are multiple simultaneous stances invoked including those that are epistemic, affective, and moral. They are moments when fluency on matters of race and matters of disciplinary content are simultaneously and prominently raised. Microcontestations have been presented in the context of a data literacy activity in a high school classroom that directly involved students of

multiple racial identities and discussions of how data and their referents accord with racial dynamics related to geographies and media preferences. Specifically, in the source example, a high school class discussed a geographic data visualization and a conversation ensued about why there was a difference and how it was associated with a neighborhood that consisted heavily of one historically-marginalized racial group. At various times, students tried to provide explanatory stories around the data visualization on the basis of what they knew from their own racial membership and express solidarity. The teacher intervened and made attempts to redirect conversation to respond to some emergent tensions. In that source case, the lens of microcontestations revealed some missed opportunities that could have shifted the interactional dynamics between students and between teacher and student were noted. By making issues of race and content prominent in interaction, this lens serves to spotlight some tensions and complexities that learning scientists must consider and respond to in the design of learning experiences.

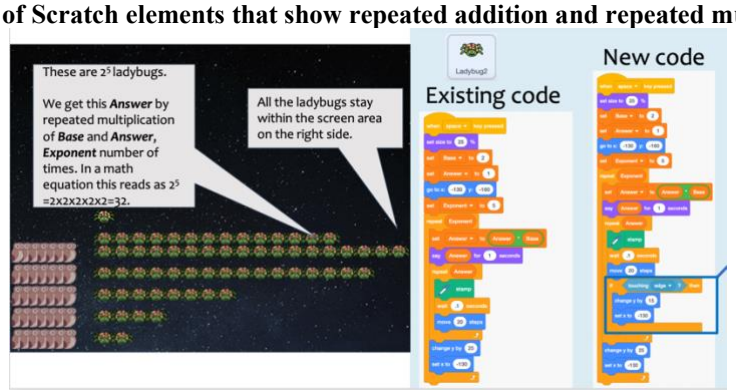
Methods and Data Sources

The Co-Design Research-Practice Partnership

The larger project is a multi-year research-practice partnership in which a university-based team is working with a rural-serving school district to develop supports for paraprofessional educators who are tasked with teaching computer science as part of their computer lab responsibilities. The computer lab specialists (their official title) had historically been responsible for overseeing instruction on matters like basic computer literacy, internet safety, keyboarding, and search. With the adoption of statewide computer science standards for K-12, districts throughout the state have explored a range of approaches to address those standards while recognizing that instructional time was already full and that budgets could not be expected change to allow for new permanent full-time teaching staff to be hired.

As a partnership, this project is of the co-design variety. In preparing for and enacting co-design, a number of discoveries are being made about optimal design arrangements. Of specific note is that "design" was a loaded term that needed to be re-examined when district partners saw this as more comfortably viewed as "adaptation" (Lee et al., 202). Design is a valued and highly-involved practice, especially in learning sciences. A tacit ideal of co-design is that the collaborative aspects of design work occur under the presumption of simultaneity and equal participation. That is, co-design is thought to be a time for all parties to meet and invest equal amounts of time to develop common vision and mutually worthwhile solutions. District partners, while enthusiastic about the project, were very limited on time given so many other responsibilities for their schools and classrooms. This was especially true for the classroom teachers and computer lab specialists who were part of the co-design team. Given that, joint sessions were done as periodic meetings with all parties present, sometimes via zoom and sometimes in person depending on circumstances (note: this project began in the remote work portions of the COVID-19 pandemic). A sequence had been developed and agreed upon that the university and district participants would generate together ideas for where there were the most content needs and what were the existing constraints (schedules, pre-requisites, availability of technical resources) and ideate on what could be intersections of computational thinking and the identified mathematics topic. For example, the topic of interest to the episode below is exponents. Teachers noted that students regularly mixed exponents with multiplication, and that this was a challenging topic for their students. Through co-design conversations, the decision was made to address this by working with Scratch-based visualizations of exponents as repeated multiplication and that multiplication can be thought of as repeated addition, with these having very different effects (see Figure 1 below).

Figure 1. Depictions of Scratch elements that show repeated addition and repeated multiplication.



Once this was identified, the university team would work separately with the involvement of district personnel providing intermittent feedback on the creation of the materials and artifacts. In this example, it was Scratch programs, slides, posters for the classroom and computer lab, and lesson plans. When another simultaneous design meeting was held when the classroom teachers and computer lab specialists could also attend, the material drafts were provided and discussed. One important activity to help evaluate this was role-play by which classroom teachers and computer lab specialists taught the lessons to each other during the sessions and offered commentary or suggestions. It was during this role-play that the analyzed episode appeared.

The region where this project is set is, according to 2020 Census records, about 85% non-Hispanic White. Hispanic/Latinx individuals (White and non-White identifying) make up about 11% of the local population. Less than 2% is of Asian ancestry and all other Census-tracked racial groups were less than 1% each of the local population. All of the district personnel and teachers on the co-design team are White. The local research team was predominantly White, with two of four graduate research assistants present who were international students of South Asian origin. Political preferences were not discussed, but the region had historically voted for conservative candidates in local and national elections by a 2:1 ratio (e.g., in the 2020 US presidential election, the region voted about 65% for Donald Trump and 28% for Joseph Biden). Two other research personnel from a different institution and region were present as well for the observed design activity. These other individuals (East) Asian and Black respectively.

Interaction Analysis

Interaction analysis is a methodological approach that appeared early in the learning sciences literature (Jordan & Henderson, 1995). Basically, it leverages the availability of interactional records such as video and audio recordings and focuses on short time-scale moments (often on the scale of a few minutes). These interactions typically involved speech between multiple individuals and the use of various artifacts and nonlinguistic modes of interaction (e.g., gesture, body position, etc.). The aim of it was to understand social meanings as they were expressed and negotiated in real time. Because of the complexity of human interaction, the standard techniques for conducting interaction analysis as a form of inquiry involved reliance on various forms of transcription and multiple iterative group reviews of the original video footage. Techniques such as competitive argumentation and progressive hypothesis refinement have been offered for supporting the interpretive work. While it is more involved, these will all involve many iterations of review, applying and challenging interpretive lenses, and identifying observable evidence or warrants for interpretations that persist. The validity of an interaction analysis is based on its reporting with transparency provided on the interactional episode, the interpretation, and the justifications for those.

Consistent with that approach, we iteratively reviewed, transcribed, re-transcribed, and intensively discussed the episode and video footage in several ways (watching it without sound, watching it focusing on a single person, etc.) over a period of multiple months with multiple trained analysts to generate the interpretations offered below. Of note for this reporting, we are being intentionally vague about the individuals' specific roles within their schools, district, or universities to further reduce risk of reidentification.

Results

The analyzed episode took place during a design meeting that involved district personnel, classroom teachers from multiple participating schools in the district, computer lab specialists from multiple schools, and researchers. The entire group of participants were split into two with one half congregating at one table and the other congregating at another. A stationary video camera was placed at one end but not controlled by a researcher. Given that, the angle and audio quality was not ideal – some speakers could only be seen from behind or leaned in and out of camera view - but the quality was sufficient for this analysis. At the table were multiple classroom teachers and computer lab specialists, one central district office employee, and members of the research team hailing from two universities. For ease of reading, the episode is broken into three sequential "scenes".

Identifying the concern

Prior to this meeting, a set of materials including lessons, slide decks, and a *Scratch* program had been prepared by a member of the local the university team. The local university team had not been aware of the specific potential cultural insensitivities prior to this meeting with the teachers, specialists, and district personnel. The concern is that the choice of Sprite in the Scratch program could cause discomfort for a group of students.

The episode took place in the midst of one of the school district team members, Lisa, role-playing instruction using the Scratch program that had been developed to represent repeated addition and repeated multiplication. She had been asking others at the table who were role-playing as students to open the pre-developed Scratch program (see Figure 1, above) and to begin making specific edits to explore multiplication and

exponents when another school team member, Daphne, interjected. Her register and posture changed to indicate she was not role playing as a student but speaking as a colleague. Eleanor also worked in the school district. Alex and Taylor were members of the university team.

1. Daphne: You know the problem with the owls, is we have Navajo students, and owls in the Navajo-
2. Eleanor: yes
3. Daphne: -are like really bad luck, and like, like it's intense, it's a like a big thing.
4. Lisa: (turns to the left where university team members are sitting, sighs) Did you hear that?
5. Alex: Yeah?
6. Lisa: (to Daphne, hands raised, palms up): wait but you can't-
7. Daphne: -Like they freak out over it
8. Lisa: -you, can't (raises pitch and punctuates words with beat motions) you find something wrong with every kind of creature? (drops hands on desk)
9. Daphne: -Yeah
10. Lisa (laughs, looking left towards university team members): I don't know
11. Taylor: Oh, we probably should change that.

In this transaction, Daphne changed the interaction to be one of educators and designers. She expressed immediately that in the student population at the school district, there were indigenous students who were part of the Diné/Navajo nation. In line 3, Daphne stresses this is something for the group to be aware of, stating three times ("really bad luck", "it's intense", and "big thing"). This was apparently new to Lisa who was surprised and turned to the university team members. The reason for this could be that this was a correction to note for revision of the materials. However, after, she does express an initial objection (line 6) to Daphne ("wait but you can't"). Daphne was still continuing to stress the seriousness of the use of the owl sprite (line 7).

This was the first known instance in which race or ethnicity had appeared as a topic of discussion during the day. While this was the first mention of a topic explicitly related to a racially minoritized population, the initial response was surprise from Lisa. Her initial responses (lines 5 and 7) were to suggest that this might be something that need not be modified ("you can't..."). She then added in a slightly higher linguistic register as if channeling an exaggerated voice that it would be possible to "find something wrong with every kind of creature". This was not stated with any markers of anger but more of disbelief. The higher linguistic register, accompanied a slightly exaggerated slapping of hands on the desk, making this statement appear as ambiguous regarding whether it was mock frustration for humor or an invitation for solidarity from others who might feel similarly. Again, the political preferences of individuals were not known. However, the initial response from Lisa bore resemblance to what some of the interaction analysts noted was common in political discourse in the United States about matters of inclusion and equity in the country – that one observation related to race be immediately generalized ("something wrong with every kind of creature"). Specifically, the sensitivities that are urged in order to be more inclusive of historically marginalized communities are seen as unnecessary additional asks for others to accommodate or anticipate. It is also possible that Lisa was expressing frustration on shifting topics to the sprite selection when she was trying to role-play teaching, and this was an interruption.

Seen as a contestation, what was at odds here was whether the racial and cultural concerns that were raised and marked by Daphne were important enough to merit changes. There was a tension with respect to whether this was a concern, but it was expressed in a partially exaggerated way, allowing for this to be dismissed as a comment or as an entry for someone else to express their solidarity in thinking this was not a matter requiring a response. It was mock generalized to "every kind of creature". If sprite selection was indeed a problem for everyone, then it may seem like responding to this instance was prioritizing one group over another. For members of the university team, however, this was seen as something that required response and correction (Line 11).

Elevating the concern

Shortly after, Lisa was seeking clarification on the implications of what would need to happen next. The role play had been halted, and she leaned toward Daphne to ask the following before Daphne interrupted again.

12. Lisa: So, does that mean we have to-
13. Daphne: Yeah, no, like I had t- take um, I had one in my class this year that was Navajo. Um…[student name]
14. Lisa: Ohh (tilts head to the side)
15. Taylor: I guess one suggestion is that-
16. Daphne: And then remember when I had-

17. Daphne: maybe you weren't here when I had [another student] and she was like Navajo.
18. Taylor: What do you guys think of about a [alternative] sprite. What animal do you think would be good?
19. Eleanor: (turns to educator on her left) Because in their tradition owls are bad omens, and it's like a curse if I understand it correctly.
20. Daphne: (looking towards Eleanor and then back to computer): Yeah, it's - I don't know all the details on it, I just know it's like a big thing.

In line 13, Daphne then expresses a personal connection. She adds that she had a Diné/Navajo student in her "class this year". Lisa seemed to recognize the name of the student and change tone with "Ohh" (line 14). At that moment, her arm that is upright then bends at the wrist as if any tension being held with the erect arm just dissipated, and Lisa tilted her head sideways in what appeared to be an expression of understanding and empathy.

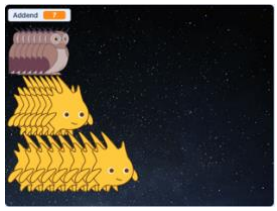
Some side conversation also took place from a university team member who is trying to find another sprite to use (line 15 and 18). During this time, Daphne has some overlapping speech (line 16) and also adds another point of personal connection when she "had [another student] and she was Navajo." At this point, Lisa looks down and appears to accept this is a matter that can be addressed. At the other end of the table, Eleanor overheard this and turned to the educator sitting to her left to explain that "owls are bad omens". Daphne, who was not being addressed but could hear Eleanor speak, turned and added that she did not know much about it. What she did know it was important ("a bi:::g thing", line 20).

This portion of the exchange suggested that once a specific individual was identified (line 13), Lisa had been engaged and stopped remarking. This was a marked change from the earlier response to the caution that this was potentially problematic for a group of people. Also, what was revealed was that the need for sensitivity was shared, but the exact reason for *why* it was a sensitive matter was not widely shared. Eleanor seemed to know some, but no one knew immediately why it was potentially harmful.

Discovering unexpected ramifications

Several minutes (not included here for space) were then spent with different individuals at the table suggesting alternative sprites and offering opinions (such as whether they liked them, if it was cute in appearance). Eventually, a sprite ("Gobo") was selected to replace the owl in the Scratch program and the lesson role-play continued. However, the next interruption that involved stepping out of the role play was initiated by Lisa.

Figure 2. Depiction of the Owl and Gobo sprites



21. Lisa: So far on this sheet, if we go with this one, can we have it move 20 steps versus 10 steps because they're just kind of so close together. So, I just changed mine to 20 just to see what it would look like it
22. Alex: The problem with that could be is they are going to change to a number to [inaudible]
23. Lisa: That's right
24. Daphne: you could change it later, after, like for this particular one, you could do 20 and then
25. Lisa: But see I would do this then..I'd tell them [inaudible] it gets erased
26. Daphne: I get what you're saying

The concern that Lisa raised was that the Gobo sprite was wider. When it was stamped, the Gobo overlapped whereas ("they're just kind of so close together") when it was the owl, there was no occlusion on sprite stamps. Lisa suggested that the number of steps to move laterally should change from 10 to 20 so that there would be no overlaps when stamps were made. However, Alex then observed that this was going to be a problem for later parts of the lesson. When there were larger values for the number of stamps, they would not fit on the stage in Scratch. Lisa (line 23) realizes what Alex was saying would be a problem if this was a permanent change. Daphne suggested it be done temporarily, "you could change it later..." (line 24). However, Lisa expressed that this could

be counter to what they intend for students as the change could be made for the one example, but then "it gets erased" so that they could complete the other examples. Daphne acknowledges that this is a problem (line 26).

As far as the contestation goes, a change had been made once it was agreed that this change in sprite was appropriate. However, this created the new tension of how the pedagogical strategy and Scratch program were designed to link the mathematical idea of exponents as repeated multiplication as demonstrated by Scratch code would be represented. While the change to the Gobo sprite responded to the need for cultural sensitivity, it ended up challenging the pedagogical and integration strategy as represented in the curriculum material being developed and tested.

Discussion

The entire episode is longer and has more discussion of sprites and sharing what was discovered about the meanings of owls in Diné/Navajo communities, which will need to be reserved for a longer paper. However, this microcontestation episode as presented spotlighted some concerns that learning scientists and research practice partnerships involving design should consider for future work.

First, is that it is very possible for designer ignorance and general assumptions that given tools were sufficiently appropriate factored into this. No members of the university team had been a priori aware of the importance of owls as a bad omen, and there was also little awareness of how many students of Diné/Navajo background would be in the school serving a predominantly White student body. As demonstrated by Taylor in her response, it is something that, once discovered, is a matter that would be taken up immediately and seriously. However, why did this situation come about? Because this was in Scratch, a well-known tool for introducing computer programming, a blanket assumption seemed to have been that the tool was already vetted enough. The added responsibility to think about tools meant to increase issues of exclusion as having potential shortcomings was not in immediate awareness. The research community is still recognizing how educational technologies that are meant to be neutral or safe to use can still end up embodying mechanisms of exclusion (Litts et al., 2021). It is a caution worth keeping in mind.

Second, this did not appear to be a concern that produced a uniform response across design team members. Daphne had seen this as a point of immediate concern whereas Lisa needed some more time to see that this was a pressing concern. We caution the reader to exercise restraint in how different actors are viewed in this episode. We firsthand had seen how Lisa is generous and helpful in a range of interactions and in this project. Her initial response was compelling not because it was her that had expressed it, but it is very likely the same one that large segments of people in the broader geographic region and nation would have. This is not to be accepted as how we may wish things should be, but it is how things are currently. If partnerships and collaboration are a priority for our work, we have the opportunity to recognize this and find productive ways forward. In this case, it appeared a key turning point was when Daphne connected the impact of the owl symbol with a specific student that both she and Lisa knew. Once it was a specific person for whom all were invested in educating and supporting, the seeming reluctance to making changes in the sprite eased.

Third, while it was known as a cause for concern and should be acknowledged, the reasons for why it was a concern were not fully known. Daphne could confidently assert that the owl was problematic, but Eleanor needed to introduce why it was problematic. This was a key learning moment for all to understand the owl's meaning to the Diné/Navajo. The question this raises is what level of knowledge we want educators to have that equips them to be inclusive and sensitive to matters of cultural diversity, exclusion, and harm. We are not equipped to know the long-term impact of this incident for the actors involved. We can assert that the sprite has been changed, but it is unknown if how work around issues of culture and historically marginalized communities will be understood or centered. It could be possible that simply new behaviors are put in place to respond to immediate concerns, but the underlying matters and thoughts about race and racism that limit progress are not being addressed. Rather, they are just becoming harder to see in public in some settings.

Finally, there was an entanglement here that the math and computing integration had with the owl. While the sprite selection may have seemed arbitrary and interchangeable, it turned out that its precise size on the screen supported specific uses in line with pedagogical intent. The owl was small enough to appear a certain number of times in the space given and help to illustrate repeating processes represented computationally. What the owl selection serves to illustrate here is that whether or not the harm or risks are known, the infrastructure in which something as simple as a screen sprite is placed and which it supports quickly become intertwined. It is not simply a matter of cosmetic change in response to cultural concerns. Rather, it implicated many other changes that had to be made.

Thus, in a brief moment when a Scratch program was being built in service of a co-design, a seemingly neutral owl was selected as a sprite to help realize a model of computation and mathematics. However, an

interaction analysis of a computer science co-design conversation about how it would be problematic showed us that the selection of an owl had far more below the surface than had been anticipated.

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