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# The Tragedy of Lost Ideas: Examining Epistemic Injustice in Pair Programming

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**Abstract:** This paper explores an episode of epistemic injustice that develops between two students with help from two teachers. Our analysis seeks to demonstrate not only *that* epistemic injustice has occurred, but also, how, and why it matters. In particular, we explore the idea of credibility deficit as helping to account for how and why one student's contributions were routinely sidelined or ignored, and how that repeated positioning led to the ultimate act of testimonial injustice and its outcome, a wrong in the form of a loss of opportunity to learn.

## Introduction and framing: Situating the problem

Despite the many calls and enthusiasm for "equity-oriented" instruction, it continues to be true that American schools are generally organized in an unsafe manner for students of non-dominant cultures to learn, engage, and thrive (Dumas, 2014; Martin, 2019; Ryoo et al, 2020). This is particularly true in STEM, where success is often associated with overall smartness (Leyva, 2017). At the same time, STEM fields often contribute to and are organized by persistent structural racism seen both in instructional practices and in the ways that resources and opportunities are made available to some students but not others. Combined, this ensures that only some students are recognized as successful, and that those who are denied such recognition are doubly damaged by narratives that claim failure in STEM to be central to overall failure.

This well-documented situation is often the focus of research and reform efforts. However, as Martin (2019) has pointed out, the extent to which such reform efforts engage beyond a surface-level concern with test scores vary widely. Efforts to transform education must take broader institutional and instructional practices seriously, for without such attention, the very same patterns that lead to inequities can flourish (Ryoo et al 2020). Reforms should focus not on how to ensure that students are successful within existing structures, but rather, should ask how existing structures should be transformed to promote success. As Ryoo et al (2020) say: "CS education should not simply thrust minoritized students toward status quo and middle-class ideas of working as uncritical programmers, but instead encourage students to utilize their diverse lived experiences and voices to ask the critical question: computing *toward what ends?*" (p. 339). Without focus on transforming these structures, classroom spaces continue to be unsafe for some students; without attention to students' interaction, broader narratives about success and status permeate interactions.

Care about others' humanity should be sufficient justification to ensure that classrooms and schools—sites of mandatory participation—are both safe and sustaining for students. But in addition, it has been well established that our experiences drive the identities that we develop—how we participate and learn, what we believe about ourselves, and what decisions we make about our future (Nasir & Cooks, 2009). Thus, the ways we organize classrooms have implications not only for the moment, for the year, but for a lifetime.

In this paper, we examine a 45-minute interaction between two boys, one Black and one white, who are working on an open-ended programming challenge that requires both mathematical and computational thinking. In our analysis, we ask how the relationship between two pair programmers changed dramatically over the course of a 45-minute episode, leading to an outcome of *epistemic injustice*. Specifically, we ask: How did the interactions between two students serve to systematically position an older and more knowledgeable student as less competent? And what are the implications for identity development and learning?

## Conceptual framework

To conceptualize the unsafe nature of STEM environments for minoritized students, we draw on Miranda Fricker's concept of *epistemic injustice*. According to Fricker (2007), epistemic injustice is harm done to someone as a knower due to their identity. Identity markers, such as race, gender, class, or accent can increase or decrease trust that a person knows a certain type of information. Although there is more than one form of epistemic injustice, here we focus on *testimonial injustice*, when a knower tries to convey knowledge, or give testimony, but is not seen as credible. Certain identities in certain contexts can create a *credibility excess* or *credibility deficit*, where a speaker's word is either unfairly inflated or deflated due to who the speaker is. Fricker also highlights the many wrongs of testimonial injustice. First, to be wronged as a knower is an intrinsic injustice because it

 

undermines a person's worth, identity, and capacity to reason. Not only is undermining a person as a knower often hurtful, but further, as Fricker states, "[I]n contexts of oppression the powerful will be sure to undermine the powerless in just that capacity, for it provides a direct route to undermining them in their very humanity," (p. 44). In addition, persistent undermining will cause a knower to lose confidence in what they believe and why they believe it, which results in the knower literally losing knowledge. And finally, such prejudice can have a self-fulfilling power that can cause the person subject to the prejudice to start to believe and behave as if such prejudice is true. Overall, testimonial injustice is one of the ways that we can understand why some people are systematically ignored, dismissed, or undermined in interaction, and what repeated instances of this injustice can do over time. In this paper, we will show the ways in which one student subject to testimonial injustice not only conceded to the prejudice he was subject to, but in the process lost knowledge.

Although epistemic injustice is largely a philosophical concept in its origin, it has a clear utility in studies of learning and interaction. For example, Miller et al. (2018) state that epistemic injustice is highly relevant to the context of implementing Next Generation Science Standards (NGSS). Specifically, they argue that if minoritized learners are not granted epistemic agency in science, not only will they lose confidence in themselves as knowers, but there will be a net-loss in the science community due to the lack of opportunities for these groups to foreground their knowledge and shift our collective scientific understandings (Miller et al., 2018). In mathematics, Tanswell and Rittberg (2020) critique a norm of mathematical practice that presents mathematics as acontextual. Further, university math programs often use a streaming model to weed out lower performing students, which diminishes the social aspects of mathematics (Tanswell & Rittberg, 2020) and instead promotes an individualistic, competitive environment, which runs contrary to many minoritized communities that value collectivism (Bills & Hunter, 2015). Hunter et al. (2016) show that when students are allowed to make sense of math by communicating in a shared language, students can mathematically reason at an advanced level, but students rarely receive the opportunity due to the credibility excess of the English mathematical vernacular. Since human learning is inherently contextual (Lave & Wenger, 1991), any practice that ignores the context of the learner is a source of epistemic injustice (Tanswell & Rittberg, 2020). Building on these efforts to investigate and understand how interactions between students in learning contexts establish epistemic injustice, our analysis explores moments in which credibility deficits are established, with what we argue to be an ultimate outcome of epistemic injustice.

## Methods

We use interaction analysis (Jordan & Henderson, 1995) and positioning theory (Harre & van Langenhove, 1999; Anderson, 2009), to explore a 45-minute episode of pair programming in which two boys were engaged in a debugging activity. Details about the data, the activity, and the analytic methods employed are detailed below.

### Data

The episode comes from the second day of a week-long free coding camp called *Code Your Art,* which introduced middle-school students to coding through NetLogo (Tisue & Wilensky, 1999). The students were engaged in a pair programming debugging task called "Paint a White Square" which called for students to modify "buggy" lines of code that resulted in a blue background with a white strip down the middle, rather than a white square (Figure 1). Modifying the code to create the correct image required thinking about the syntax and logic of NetLogo, as well as mathematical properties relevant to the model. However, there were many possible solutions to debugging this model that resulted in a display of a white square in the middle of the screen. After creating the white square, students had two challenge problems: to create a white square of a different size, and to create a white square somewhere else on the screen.

The specific data that we analyze for this piece comes from screencapture software from one boy (Sam's) computer, which was passed back and forth between the pair. The screencapture software includes both what is happening on the screen and the video that is captured by the embedded computer camera. This meant that whoever was typing on the computer was directly captured by the embedded computer camera, and often both students' faces were seen on the computer camera, particularly when they were both leaning in to look at the screen. The two students who are the focus of the analysis are Prince, a Black rising 9th grader, and Sam, a white rising 6th grader. Their partnership was based on their proximity of seating in the class, and the two boys had no prior relationship before the summer camp. Our analysis also includes the task that students were working on, and the adults who interacted with the pair, including Victor, a white male undergraduate teaching assistant (TA), and the lead teacher Ms. Turner, a Black female math teacher with over 20 years of teaching experience. The exercise lasted about 45 minutes.

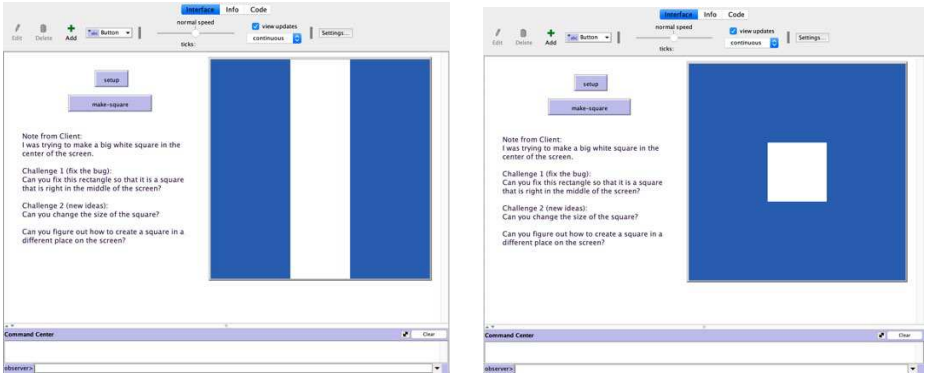


Figure 1. (Left) The model after pressing "Setup" and then "make-square." (Right) The target solution

## Analytic framework

The analytic methods that we brought to bear on this episode come from principles of interaction analysis and from positioning theory. Interaction analysis (Jordan & Henderson, 1995) is a method of video analysis that draws a unit of analysis around the person and their context. Interaction analysis assumes that "knowledge and action are fundamentally social in origin, organization, and use, and are situated in particular social and material ecologies" (p. 41). This means that analyses must take seriously not only what individuals do, but also, how their participation is shaped by and responsive to the actions and affordances of other people, tools, and practices. Following these practices, our analysis began with repeated viewings of the 45-minute episode, followed by creation of a content log of the entire interaction. These initial viewings helped to make us aware of a shift in participation that we found both puzzling and troubling; what began as an apparently cordial and relatively cooperative activity shifted over time with one student becoming increasingly silent. We thus decided to look in detail at the interaction between the two students to try to better understand what happened.

For our closer analysis, we drew on positioning theory (Harre & van Langenhove, 1999; Anderson, 2009). Positioning takes place at two levels--as a moment-by-moment process through which people make bids for and establish their relative status, and in relation to broader narrative and storylines, which are both implicitly and explicitly leveraged as resources to situate particular discourse moves (Hand, Penuel, & Gutierrez, 2012). At the moment-by-moment level, positioning can be seen most easily in talk, as students and the teacher speak to each other about academic content, about themselves, and about their current work (van Langenhove & Harre, 1999). When looking over longer time periods, students can be positioned as being certain kinds of people in relation to broader storylines that are made relevant through the emergent participant framework (Goffman, 1974; Goodwin, 1990; Herrenkohl & Guerra, 1998; O'Connor & Michaels, 1996) of a classroom which shapes the ways that students are expected, obligated, and entitled to participate with content and with others in the classroom.

## Findings

Figure 2 offers an overview of the content of the 45-minute episode between Sam and Prince. From the outset of the episode Prince and Sam demonstrated active engagement in the white square debugging task, as they took turns analyzing the problem presented and determining potential solutions to pursue during the first phase of problem solving. However, their first interactions with the code were generally cooperative, rather than collaborative. For example, Sam first independently explored the model and attempted two common solutions that involved changing specific symbols and numbers in the code. When those initial strategies didn't work, he rotated the laptop towards Prince and said "here, you try." Prince did so, and ultimately proposed a different strategy after exploring the model himself. As we detail below, while the content of their conversation focused on programming solutions, the interactions between the boys also served to establish their relative status. This positioning began through interactions between the two boys, and then was reinforced through interactions with the TA (Victor) and the lead teacher (Ms. Turner). Close analysis of these interactions suggests that Prince was repeatedly positioned as a non-knower. However, Prince's response over time shifted noticeably from first strongly rejecting those bids, to quietly not contesting them, to finally verbally acknowledging them. We unpack these interactions that, we argue, establish Prince's *credibility deficit in the interactions*, leading to an overall experience of testimonial injustice, and harm to Prince's identity as a knower.

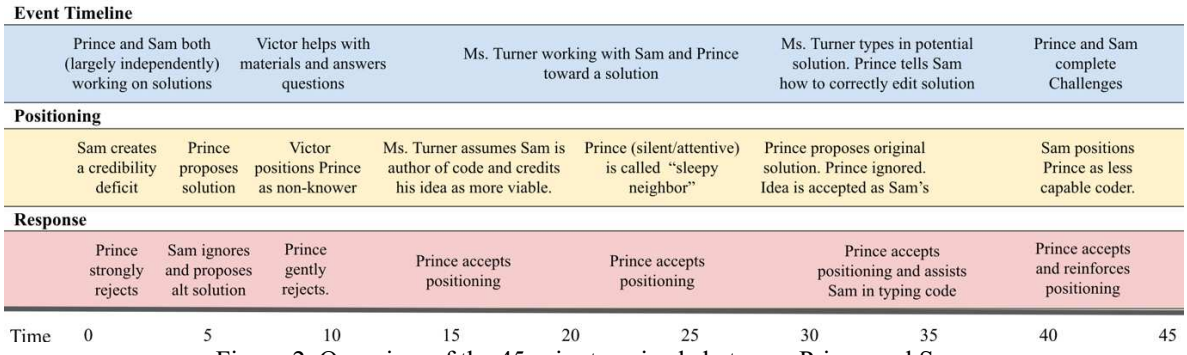


Figure 2. Overview of the 45-minute episode between Prince and Sam.

## Phase 1: Positioning rejected

From the outset of their interaction, Sam positioned Prince as non-essential to the task. This happened first, subtly, when Sam ignored Prince's attempt to help him open the model, and subsequently, by Sam's initial attempt solve the White Square problem independently. These moves suggest that Sam anticipated Prince's ideas not being worthwhile (or, at the very least, that Sam did not need any assistance to solve the problem, despite being asked to work in pairs). This positioning was made more explicit when Prince was given access to the computer and made his first bid to solve the problem, an interaction in which Sam more explicitly claimed Prince's contributions as unworthy. This is seen in the transcript below, which occurred approximately 5 minutes into the video.

1 Prince (P): Are we gonna make a square right here or right here (*pointing mouse to top right and bottom right corners of the NetLogo interface)*
2 Sam (S): In the middle
3 P: In the middle...
4 S: Yeah
5 P: We already have this (*clicks on white strip in the middle of the screen*)
6 S: I know and now we need to just go chop, chop, take away, take away...
7 P: Oh, it's a big *white* square
8 S: Yeah, and then try to change the size of the square.
9 P: So... we gotta do something with the pycor.
10 S: You think???
11 P: No sir, I did not think. That was all muscle memory. So... we just go down... (*begins typing new line of code*)
12 S: Screw everything up

In turns 1-8 Prince explored the model for the first time. In turn 9, Prince made a bid for how to address the bug, focusing on an aspect of the code that is currently missing (the code in its initial state reads: "ask patches with [pxcor > -5 and pxcor < 5] [set pcolor white]"). Prince's proposal was an unusual one for students to offer at the onset of working on this problem (c.f. Gresalfi, Brady, Knowe, & Steinberg, 2020), but is a necessary path towards a solution. It was also not a solution that Sam had explicitly tried in his earlier testing of the model. However, in turn 10 Sam responded to Prince's proposal with a dismissive "You think?" In this move, Sam positioned Prince's contribution as obvious and uninteresting, offering the first assertion of Prince's *credibility deficit.* However, Prince rejected this positioning in turn 11 almost without pause, claiming that he didn't even *have* to think. Still, as he began to add a new line of code to address the y-coordinates, Sam quietly muttered "screw everything up" suggesting a lack of trust for Prince to derive the correct solution.

As Prince began to type, Sam began to work independently on his own idea, seen in turns 15-19. His lack of attention to Prince further positions Prince's ideas as unworthy in Sam's eyes. Although Prince appeared to be aware of Sam's movements and his lack of attention (for example, Prince leaned back when Sam reached in front of him but did not look away from the screen where he was typing), he did not object to or engage in any way with Sam's utterances, again serving as a rejection of Sam's positioning of his ideas as unworthy.

15 P: Oh, I got something... ask patches, ask patches...
16 S: (*talking over Prince*) I wish we had something we could write this down on. We never got one of those dry-erase things to write on.
17 Victor (V): Yeah you do, he has it (*alluding to Prince having a dry-erase board*). You have to share.
18 S: Oh okay (*reaches over the computer to grab Prince's dry-erase board*)

| | | |
|---|---|---|
| 19 | S: | I know what we need to do. We just need to make... if we find... |
| 20 | P: | Hey what's our um... |
| 21 | S: | Look, look! Look! Look! |
| 22 | P: | No, sir! |
| 23 | S: | No! Look what we need / to do, look! |
| 24 | P: | /No, nonononono, no, no! (*makes slashing motion with his hand)* |
| 25 | S: | Make zero-zero |
| 26 | P: | No, we- yeah, we have to find the zero-zero, cause then I'mma just turn the rest of it blue. What color blue is this? |

In turn 19, Sam attempted to shift Prince's attention away from his own solution and towards Sam's new idea, again making a bid to position Prince's ideas as uninteresting. However, once again Prince forcefully rejected this positioning, with a strong "No sir," and a repeated "no no no no."

## Phase 2: Positioning uncontested

The initial interactions between Sam and Prince suggest that Prince had a credibility deficit with respect to Sam, seen in Sam's repeated positioning of Prince's ideas as obvious and unworthy of attention. However, Prince consistently rejected this positioning. Still, as the episode went on, others entered the interactional space and contributed to Prince's positioning as having a credibility deficit. For example, about seven minutes into the interaction, Prince asked for assistance from Victor, the class TA. Prince was trying to determine the coordinates of the NetLogo canvas, with the goal of typing a command for the y-coordinates. However, the TA failed to listen, and in so doing positioned Prince as confused, once again creating a credibility deficit.

| | | |
|---|---|---|
| 1 | P: | How do we put, um, the graph on it? |
| 2 | Victor (V): | Do what? |
| 3 | P: | Put a graph. |
| 4 | V: | Hit setup. Go to code… your code. There's a problem in your code. It's fussing at you for something. |
| 5 | P: | Oh I didn't, I didn't finish, like I was looking for- |
| 6 | V: | (*Cutting off Prince*) Oh well then it won't do anything. |
| 7 | P: | I know, I was looking for the um/ the grid |
| 8 | S: | / We need to do this! We need to write, we need to write, dude. We need to write… |
| 9 | V: | Oh, oh, the grid. You can't turn the grid on. (*Prince looking at the screen and nodding)* |
| 10 | S: | (*Starts repeatedly poking Prince on the shoulder)* |
| 11 | V: | But you can look at the code and figure it out. |
| 12 | S: | We need to write the coordinates. (*Prince nods slightly at Sam, still attending to Victor)* |
| 13 | V: | Alright, hold on (*Takes control of laptop, clicks back to code*) |
| 14 | P: | (*Following along with Victor, eyes on the laptop screen*) |

By interrupting and not listening to Prince's strategy or what he is trying to accomplish, Victor appeared to approach the question from Prince with an assumption that he was confused, seen in particular in turn 4. This positions Prince again as having a credibility deficit. In turn 7 Prince gently rejected Victor's bid, stating that he knew his code was unfinished and that unfinished code wouldn't run, but he was focused on something else for the moment. At no point in the interaction was Prince asked what he was doing or trying to do, but instead Victor immediately assumed that Prince was confused and in need of explanation.

Prince ultimately completed and tested his proposed solution, which would have fixed the bug. However, he made a minor coding error. Instead of telling Netlogo to color blue all pixels with y-coordinates *greater* than five, he wrote to color in all y-coordinates *less* than five, resulting in the bottom two-thirds of the screen being colored blue, and a small white strip at the top of the screen. Seeing this failure, Prince looked at Sam and said "I tried," and while Sam looked back at him, adds "hey buddy, you failed too." Sam sat back up, grabbed the laptop and pulled it towards himself, saying "alright, watch me. Watch me." Prince asked "what are you gonna do," but Sam didn't respond and instead began typing.

As an additional example of continued positioning, Ms. Turner, the lead teacher, came to check on the boys' progress around 15 minutes into the episode. In this moment Prince made one last bid to share his idea, and Ms. Turner seemed interested, and even impressed. However, her own apparent lack of faith in Prince's ideas, along with repeated interruptions from Sam, served to re-route Ms. Turner from Prince's code, and Prince sat back to watch as the teacher and Sam began to physically talk and work over Prince.

| | | |
|---|---|---|
| 2 | Ms. Turner (T): | Where are you guys? Still on Paint a Square? |
| 3 | P: | mmmhmm. I made, um, (*unintelligible. Clicks "interface" and motions toward white rectangle in the top middle on screen*). |
| 4 | T: | Oh you did that! Okay. |
| 5 | P: | I know, like, so it's "ask patches". (*S clicking "make square" button repeatedly*) Duh, duh (*motions with his hand in an "L" shape*) |
| 6 | S: | We messed up "setup" didn't we. |
| 7 | P: | It's pycor. It's gonna be pycor less, less than, less than 5. |
| 8 | T: | Okay. Try that! Try that. He's got pxcor greater than -5. You want. Are you adding it here are you making another line? |
| 9 | P: | (*looks at teacher and opens mouth as if to answer*) |
| 10 | S: | I know what I did was wrong. But we should do this. Ask patch O 3. Well, whatever one it is O O. Ask neighbors, but also have it turn white too. That would make a square. |
| 11 | T: | Let's see it! (*directed at S. P nods)* |
| 12 | S: | I don't know how to make the one in the middle white too. Oh! After I do it, make O O white. Okay so that's how it's supposed to work. I think. (*looks to teacher. Turns computer to face himself more.*) |
| 13 | P: | (*Watching the screen, listening to Sam*) |

In this interaction, Prince's idea was once again positioned as less interesting, and even as not belonging to him. In turn 4 Ms. Turner responds to Prince's code with a retort that appears surprised, saying "Oh you did that! Okay." This surprise suggests that she did not anticipate that Prince might have written advanced code, further positioning him as having a credibility deficit. Prince does not appear to notice her surprise and continues to explain his idea. However, in turn 8, the teacher stated, "He's got pxcor greater than negative five," attributing Prince's code to Sam. Before Prince could respond, Sam interrupted, pulling the teacher's attention away. This shift in attention away from Prince's idea was completely uncontested, a contrast with Prince's earlier responses, where being positioned as having less worthwhile ideas was something that he actively rejected.

## Phase 3: Positioning accepted

As a final example, towards the end of the episode, Sam, gets frustrated with his code, not completely understanding what to do. He pushes the laptop back to Prince for the first time in around 30 minutes. After Prince explains an alternate approach, Sam asserts that he can do it faster.

| | | |
|---|---|---|
| 1 | S: | Is it make another square somewhere else? Or is it move that square? |
| 2 | P: | You wanna just… make another square? It didn't say it has to be a big square, it just has- it says make another square. |
| 3 | S: | Shut up! |
| 4 | P: | It just says make another square, so you can put, um… do the same code |
| 5 | S: | Let me show you |
| 6 | P: | No, do this code with a different, um, number. |
| 7 | S: | This number? |
| 8 | P: | Different number. Do that code, nonono, yeah yeah, but just put it with a different number |
| 9 | P: | But do the same thing you just did right there, but with a different number |
| 10 | S: | Nine, nine |
| 11 | P: | No no no, keep that, keep that right there, go right here and then change… copy and paste |
| 12 | S: | I hate when you're trying to tell me... you do it! |
| 13 | P: | Okay (*S: Growls*) |
| 14 | P: | So, copy… |
| 15 | S: | We jus- are we just gonna make another tiny square somewhere else? |
| 16 | P: | We're gonna do that and then we're gonna ask neighbors |
| 17 | S: | okay, so basically just make another tiny patch somewhere else? |
| 18 | P: | Yeah |
| 19 | S: | I could do it faster |
| 20 | P: | I know, I told you to do it |
| 21 | S: | Why? ... Nine-nine... |

Despite the fact that turns 2-11 involved Prince proposing a solution that he was attempting to explain to Sam, Prince again was positioned as a less capable coder. Sam's frustration, which led him to turn the computer over to Prince, was immediately followed with his continued efforts to understand the proposed solutions. Once that had been accomplished, Sam made an immediate bid for his own greater competence, saying in turn 19 "I could do it faster." In previous interactions with Sam, Prince was more likely to defend himself from a positioning of being a less capable coder. In this moment, however, he conceded to Sam and affirmed him as the faster coder by saying "I know" in response on line 20.

Overall, Prince spent a total of 5 minutes on the laptop. Upon relinquishing it to Sam, Sam controlled the laptop and the thinking for the next 30 minutes, and the teacher will eventually write a solution for them. The group never returned to Prince's original idea, which would have resulted in the desired white square had an inequality symbol not been mixed up. This was a collective loss of knowledge not only for Sam and Prince, but for the rest of the class, as Prince had a unique solution.

## Broader storylines: Resources tacitly accessed in interaction

The *Code Your Art* camp, in general, was a collaborative and creative environment where students were frequently sharing ideas and creating new things. However, the debugging activities were different in that there was a pre-defined goal for all students. Previous research on pair programming suggests that a focus on speed can create inequitable outcomes between group members (Lewis & Shah, 2015), and this activity's structure invited a familiar classroom storyline of competing to be the student who is first to get the right answer. There were many times when both boys, especially Sam, appeared to be working *against* each other, insofar as they compared their relative success and emphasized failing as something to be embarrassed about. This supported a competitive dynamic that became a resource for positioning; if we are competing, someone must by definition be better than someone else. This also connects with a broader narrative that failure in STEM is indicative of broader incompetence. This could possibly account for why Prince was quick to give up, as it is better to be caught not trying than to be caught making a mistake.

A key element of epistemic injustice is identity. Though there was never explicit mention of race in this episode, there were moments when it seemed that Prince's race was made visible. For example, when Prince first took control of the laptop, Sam reached out and squeezed Prince's hair. The hair touch draws upon a broader storyline of the exotification of Black people and Black features, such as Black hair. It appeared that Prince was further racialized by the teacher, during a period in which Prince put his head down. His teacher encouraged him to "make a rap about it," assuming that rap was the way to engage a Black student in coding, even though Prince had expressed a very high engagement with the debugging activity before being consistently undermined. These interactions suggest to us that race, and specifically, the idea that "Black students aren't good at STEM," was recruited as a storyline in these interactions. This storyline created tacit expectations of Prince, and then was used to make sense of Prince's behavior, specifically if he had a question or was simply quiet.

## Discussion, conclusion, and implications

In this paper we used positioning theory to understand how and why Prince's participation appeared to change over time, ultimately resulting in what, to us, seems a clear case of testimonial injustice. The first-order positioning of Prince from the teacher, teaching assistant, and Sam all seem to assume that his ideas are unworthy of serious attention. These moments of established credibility deficit were initially challenged by Prince, but it took few repetitions for him to become increasingly silent and accepting of the position that was given to him. Though Prince's self-removal from the activity can be seen as an act of self-preservation, it also highlights his own apparent acceptance, or at least agreement, that his ideas are less valuable. Finally, these episodes of epistemic injustice resulted in real intellectual harm. Prince's idea to paint the top and the bottom of the strip blue, leaving a white square in the middle was an important contribution that, uniquely among other solutions, coordinated mathematics with programming. The idea would have worked, had it not been for a small coding error. However, the result was taken as a confirmation from both Sam and Prince that Prince's idea was not worthwhile. This ended the opportunity to investigate Prince's idea fully and resulted in a literal loss of knowledge about coding. We relate these moments of positioning of Prince in relation to his ability as a computer programmer to his racial identity through what seemed to be racially motivated comments. In this way, the broader storylines that were drawn on as resources in the interactions helped make the repeated assumption that the Black student in the pair was less likely to have a good idea, an assumption that was seemingly leveraged by everyone in the interaction.

Although we argue that Prince's race played a crucial role in his positioning, we also note that, consistent with the findings of Lewis & Shah (2015), the storyline of "competition" also offered an important resource that contributed to this interaction. This could have been mediated by explicit instruction about how students should

work together, which did not happen before students began this activity. We know that creating group work without defined roles for each person, or without teaching groups how to work together is often ineffective (Cohen, 1994), and in fact, this lack of structure enabled all participants to recruit and use storylines that ultimately did harm. Still, we see this episode as representative of greater systemic trends in which Black students and their disciplinary contributions are regularly sidelined and ignored due to assumed creditability deficit based on their racial identity. The persistence of episodes like the one outlined here perpetuates the acceptance of Black learners' positioning as less capable and ultimately contributes to Black students' disengagement in disciplinary practices and in STEM fields more generally.

## References


Anderson, K. T. (2009). Applying positioning theory to the analysis of classroom interactions: Mediating micro-identities, macro-kinds, and ideologies of knowing. Linguistics and Education, 20(4), 291-310.

Bills, T., & Hunter, R. (2015). The role of cultural capital in creating equity for pasifika learners in mathematics. *Mathematics Education Research Group of Australasia*.

Cohen, E. G. (1994). Restructuring the classroom: Conditions for productive small groups. *Review of educational research*, *64*(1), 1-35.

Dumas, M. J. (2014). 'Losing an arm': Schooling as a site of black suffering. *Race Ethnicity and Education*, *17*(1), 1-29.

Fricker, M. (2007). *Epistemic injustice: Power and the ethics of knowing*. Oxford University Press.

Gresalfi, M.S., Brady, C., Knowe, M., & Steinberg, S. (2020). Engaging in a New Practice: What Are Students Doing When They Are "Doing" Debugging? In M.S. Gresalfi & L.S. Horn, (Eds.), *The Interdisciplinarity of the Learning Sciences, 14th International Conference of the Learning Sciences (ICLS) 2020, Volume 3. (pp. 199-206).* Nashville, TN: International Society of the Learning Sciences.

Hand, V., Penuel, W. R., & Gutiérrez, K. D. (2012). (Re) framing educational possibility: Attending to power and equity in shaping access to and within learning opportunities. Human Development, 55(5-6), 250-268.

Van Langenhove, L., & Harré, R. (1999). *Positioning theory: Moral contexts of intentional action*. Maiden, Mass: Blackwell.

Lave, J., & Wenger, E. (1991). *Situated learning: Legitimate peripheral participation*. Cambridge University Press.

Lewis, C. M., & Shah, N. (2015, August). How equity and inequity can emerge in pair programming. In *Proceedings of the eleventh annual international conference on international computing education research* (pp. 41-50).

Leyva, L. A. (2017). Unpacking the male superiority myth and masculinization of mathematics at the intersections: A review of research on gender in mathematics education. *Journal for Research in Mathematics Education*, *48*(4), 397-433.

Martin, D. B. (2019). Equity, inclusion, and antiblackness in mathematics education. *Race Ethnicity and Education*, *22*(4), 459-478.

Miller, E., Manz, E., Russ, R., Stroupe, D., & Berland, L. (2018). Addressing the epistemic elephant in the room: Epistemic agency and the next generation science standards. *Journal of Research in Science Teaching*, *55*(7), 1053-1075.

Nasir, N. I. S., & Cooks, J. (2009). Becoming a hurdler: How learning settings afford identities. *Anthropology & Education Quarterly*, *40*(1), 41-61.

Rittberg, C. J., Tanswell, F. S., & Van Bendegem, J. P. (2018). Epistemic injustice in mathematics. *Synthese*, 1-30.

Ryoo, J. J., Tanksley, T., Estrada, C., & Margolis, J. (2020). Take space, make space: how students use computer science to disrupt and resist marginalization in schools. Computer Science Education, 1-25.

Tisue, S., & Wilensky, U. (2004, May). Netlogo: A simple environment for modeling complexity. In *International conference on complex systems* (Vol. 21, pp. 16-21).


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