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"All Students are Brilliant": A Confession of Injustice and a Call to Action

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This colorful graphic signals that this contribution is a featured part of the "Race and Physics Teaching" special collection. See the editorial from the September 2017 issue of *TPT* for more details.

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The two of us (AR and LAE), in our teaching, research, and work with teachers, advocate for responsive teaching—an approach that seeks out and builds on the productive "seeds of science" in what our students say and do[1-3] and assumes that "all students...are brilliant."[4] This pedagogical approach requires a commitment to listening to and intellectually empathizing with students' scientific ideas.

Among other reasons, we care about responsive teaching for reasons of social justice: data that tracks participation in physics suggests an unjust distribution of access, resources, and power, and traditional pedagogies have done little to ameliorate this.[5-7] We believe that responsive teaching, by making students' own ideas, experiences, and narratives about scientific phenomena the raw material of curriculum,[2,8,9] has the potential to broaden participation.[10]

And yet (of course) we encounter stories that show us how challenging it can be to hear and build on students' ideas, and how much we (the authors) have to learn when it comes to creating inclusive, responsive classroom spaces. Take, for example, the story of Leona, a 7-year-old Black girl. Leona tells her class the following story during "sharing time":

> "Today it's Friday the 13th, an' it's bad luck day, an' my grandmother's birthday is on bad luck day. An' my mother's bakin' a cake, an' I went up my grandmother's house while my mother's bakin' a cake, an' my mother was bakin' a cheese cake. My grandmother was bakin' a whipped cream cupcakes. An' we both went over my mother's house, an' then my grandmother had made a chocolate cake, an' then we went over my aunt's house, an' she had make a cake. An' everybody had made a cake for nana. So we came out with six cakes. Last night, my grandmother snuck out, an' she ate all the cake, an' we hadda make more (she knew we was makin' cakes). An' we was sleepin' an' she went in the room an' gobbled em up. An' we hadda bake a whole bunch more." (Ref. 11, pp. 29–30)

When compared to the story told by a White child (also cited in Ref. 11)—with its introduction of characters and clear sequence of events, culminating in a moment of tension and resolution—Leona's story seems (to us) almost incoherent. Leona's teacher (like us) also finds her stories hard to follow, frequently cuts Leona's stories short, and describes Leona as a student who often rambles. She takes steps in class to set rules around "sharing time"—e.g., students will talk about "one thing" that is "important"—as a way of limiting Leona's (and her peers') lengthy "filibusters." And yet the author who writes about Leona's story (not all of which is excerpted above) shows us how it is, in fact, intricately "organized, through syntactic parallelism and lexical and syntactic repetition."

Unable to understand the linguistic strengths of Leona's story, her teacher had difficulty following it, or even seeing a story at all. And so, rather than helping her class notice and value Leona's (and other Black children's) contributions, the teacher's "questions were often mistimed, stopping the child mid-clause." The questions themselves were "thematically inappropriate," attending to minutiae and not to the theme of her story. These questions "seemed to throw the children off balance, interrupting [their] train of thought." In the cases where such children were uninterrupted by poorly chosen questions, they were often cut short by the teacher, who "jokingly referred to [the stories] as filibusters on occasion."[12]

We recap this work because it was jarring and humbling to us as teachers. Though we organize our professional lives around noticing and attending to the productivity and sensibility of student thinking, we, like Leona's teacher, did not notice the intricate complexities within her story when we first read it, instead seeing it as disjointed, disorganized talk. We can imagine that, had Leona been in our class, we too would have cut her off, asked thematically inappropriate questions, and even been reluctant to call on her raised hand. In fact, we can look back at our own classroom practice and recognize that some of the students whom we regularly thought were "off topic" or "off track" may have instead been drawing on different resources for talking—resources that we now see we could have recognized and valued.

Leona's story, as told by the researchers who visited her class, highlights an (often invisible) form of injustice, and in it we can see how we have acted in unjust ways in our own classrooms and disciplines. In particular, Leona's story makes visible that the linguistic structures that are prioritized in science and in science classrooms are cultured; they reflect one way of ordering our talk. Other forms of discourse—such as "topic-associative discourse" common in African American speech,[13-18] which draws on "dramatic performance in reporting," extensive "contextual framing," and "stage setting in presenting,"[19] and in which "[r]elated explanations unfold in overlapping, intersecting loops, one emerging out of and building on others"[20]—can also order students' productive sense-making and communication about the physical world. Recognizing and affirming these discourses is one way in which we can disrupt systems of unfair advantage in STEM classrooms.

In the next section, we briefly consider two additional classroom examples, this time from math and science.[21] When we encountered these examples, we experienced the same sense of humility that we did with Leona's story: we originally struggled to see the sensibility in these students' talk, and were deeply moved as the narrative unfolded and the researcher unpacked the continuities between what the students were doing and what we consider to be rigorous justification of ideas. We use the awareness we gained from these stories—Leona's and the ones in the following section—to better understand what is going on in a short episode from an introductory physics course. Then we issue a call to teachers and researchers at the close of the paper. Throughout, we position ourselves as co-learners; we are sharing our unfolding journey toward recognizing our own privilege and inviting others to join us in working toward appreciating the "wonderful ideas"[22] that all of our students are bringing to their learning of physics.

Examples from mathematics and science

The paper "Can the Intellectual Affordances of Working Class Storytelling Be Leveraged in School?"[23] leads with an example from a third-grade mathematics class in which the teacher asks her students, "Here is a number pattern: 2, 5, 8. What comes next? How did you find out?" The author of the paper contrasts two students' answers to this question; the first came from James, "a working-class European American boy," who answered,

> "9, 10, 11[.] Because I know the answer. Because me and my sister plays school a lot. My sister teach me this when I play school."

Stephany, "a middle-class European American girl," on the other hand, responded,

> "The answer is 11 because you are counting by 3's. The first number of the pattern is 2. And the second number is 5. There are three numbers from 2 to 5. The third number is eight. And there are three numbers between 5 + 8. And then that means that you just have to go up 3 numbers from 8 and the answer is eleven."

As with Leona, our first reaction to James' response was that *he was not answering the question.* Maybe he was not clear about what the teacher was asking him to do? As with Leona's story, this story helped us to see that our sense of the question *and* our sense of what counts as a legitimate answer are products of our embeddedness in a culture that recognizes certain ways of talking (and particular slants on experience) as more valid than others. For example, the author highlights that James and Stephany are both marshaling evidence for their answers: James is "explicating the experiences" that "substantiate" his intellectual expertise, whereas Stephany is "explicating the mental processes" that she engaged in to reach her answer. The author writes:

> "Why is it that Stephany *seems* smarter than James when both had the correct answer? Stephany's answer is 'obviously' a good and smart explanation because we (like her teacher) have been thoroughly socialized to speak with and through these cultural tools. And because the speech genres middle-class children learn at home are far closer to the ones valued in school, the middle-class children spontaneously produce them without (seemingly) having to be taught. The school genre of 'explication of one's reasoning' carries with it a slant on what counts as relevant experience and what elements of mental experience need to be explicated. It's not natural or smart, in and of itself, and it's certainly not the only way it could be done. That helps explain why it is not obvious to newcomers to the school game what it is that needs to be accounted for (one's right to a knowledge claim or the process of figuring out some intellectual puzzle)."

The author goes on to show us that James' explication of his experiences—the *narrative practice* that underlies his answer—is *continuous with* scientific practices. She highlights that James is relying on his everyday experiences as evidence and as a tool for sense-making about abstract concepts. She illustrates how this narrative practice serves students in making progress in thinking about scientific phenomena with an excerpt from an interview with Teresa, "a working-class African American girl," as she discusses the role of the Earth's axis in its rotation. Originally Teresa defines the axis "as a pole that helps the earth turn around on it." However, when asked a follow-up question about the tilt of the Earth's axis, she starts to reconcile formal representations of the Earth's axis with her own experience:

> "The axis is tilting, it's tilting this way, and—I think it's this way—and the earth turns. (pause) No it's this way, [she motions with her hands in the opposite directions] I think I saw it in a book this way. It turns around on its axis, but it's tilted."

The author writes,

> "Then Teresa pauses, and with an impish, just-between-you-and-me kind of grin says, 'But the earth isn't tilted, because if it was tilted, we would all be sitting like this [tilts her torso over] or something, so it's not really tilted.' And then in utter seriousness, she says, 'The earth isn't tilted, but the pole is and you can't see it.'"

It is not as difficult for us to recognize "science" in this excerpt from Teresa's interview; the structure of her talk is more similar to our own. And yet we can also recognize that what Teresa is doing is the same as what James was doing—she is telling the interviewer how she knows that the pole is imaginary, by explicating her *experiences*. These experiences help her to sense-make about the pole as an imaginary entity, just as James' experiences help him to identify the next number in a pattern. Though these may not be the responses that the teacher anticipated, we can imagine ways to build on these productive seeds of scientific (and mathematical) thinking.

An example from introductory physics

These examples—of Leona, James, Stephany, and Teresa—deepen our awareness of a particular form of injustice, that of unconsciously prioritizing a particular set of linguistic structures and mischaracterizing students who are using a different discourse style as "off topic" or "missing the point." This awareness has helped us to see examples of physics teaching and learning—from our classrooms and the classrooms of others—differently. In this section, we briefly unpack one such example.

In a video of collaborative group work in an introductory physics course, a group of students has just drawn a pie chart representation[24,25] for the energy of a ball as it bounces.[26] In their drawing, the size of the "pie" shows the total amount of energy in the ball, and the colors depict the fraction of the energy that is kinetic (blue) and potential (brown)—see Fig. 1. The video begins with one Black student, Quinn,[27] rejecting his instructor's efforts to represent the bouncing ball differently. As he explains his group's representation, he does so in a way that aligns with depictions of "topic-associative discourse" described above. In particular, he dramatically reports his group's model in ways that use extensive "contextual framing" and "stage setting in presenting."[19] Early in the dialogue, he exclaims, "And then it [the ball] reaches the ground. Stop! It's blue! It's all blue pie! And as it hits, it loses something, it's reducing its blue pie-ness...There's blueberry everywhere because the elasticity's not complete." Importantly, his explanation emphasizes contextual features—like the size of the pie pan (12 inch) and the flavor of the pie (blueberry)—alongside (and at times more than) the features of the energy story. The instructor, however, does not interrupt and in fact takes up Quinn's language, entering the world of his story, animatedly asking, "So then there's blueberry everywhere?" As the conversation unfolds, more of Quinn's group members engage around the narrative of the pie, and we can see canonical understanding and scientific discourse emerging from his explanation: "The blue pie [kinetic energy] is due to motion, and it is increasingly getting faster as it moves down," and "we lose blueberry [kinetic energy] in sound and we lose blueberry in heat."

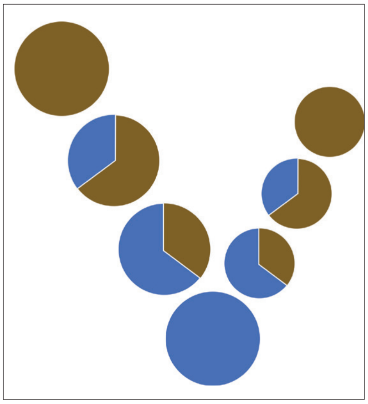

Fig. 1. Reproduction of group's drawing, modified with permission from Periscope materials.[26]

When we first encountered this video episode a few years ago, we did not see its significance as an example of Quinn engaging in topic-associative discourse. In fact, had we been Quinn's instructor, we can easily imagine ourselves asking him questions to focus his attention on the features of the story we considered relevant and/or to structure his discourse into a more "linear" storyline. Now, with new eyes informed by Leona and James, we hope we would respond more like Quinn's instructor, entering his story-world and taking up his own discourse structure as we seek to understand and build on his thinking.

A call for teachers and researchers

The examples of Leona and James have made one aspect of our privilege visible to us. We both grew up in White middle-class homes where the speech genres we learned from our parents were close to those called for by our teachers, and these narrative practices were rewarded and reinforced in school. That we could not initially see the richness of Leona's and James' explanations makes sense—it is not through any deliberate antagonism—but it is nonetheless deeply problematic. Racism need not be a personal ideology; it may instead manifest as a "*system* of advantage based on race."[23]

So what can we do? We want to issue a call to *teachers* to join us in becoming aware of the multiplicity of ways that we can talk about physics—including historically recognized discourse structures *and* other culturally rich discourse structures, such as topic-associative discourse or explication from experience. This awareness has helped us to *see* better; we are starting to appreciate the richness of examples like the "blueberry pie" episode above, to lament missed opportunities in our own past instruction, and to think about how we might respond in ways that honor and take up the discourse styles of all of our students.

We feel that *responsive teaching*, discussed in the introduction as an instructional approach that seeks to understand what our students *mean* by what they say and do, and then seeks to build on the productive "seeds" therein, has incredible potential for this work. Responsive teaching, at heart, celebrates "the having of wonderful ideas."[22] Teachers who embody this approach truly believe that students talk and act the ways they do for *good reason*—that whatever ideas and practices they are bringing to bear in a particular instructional moment have been sensible for them up to this point and can be productive moving forward.[2,28,29] Further, responsive teaching seeks out continuities between "what is going on right now"[30] and *science*, broadly conceived.[1,10,31,32] And finally, within responsive teaching, there is an expectation of and openness to emergence—if the teacher is truly listening to and seeking to build on her students' ideas, the content of the class will emerge, such that what is learned cannot be fully anticipated in advance (which need not mean it is unscientific).[8,9] In all of these ways, responsive teaching has the potential to invite—and celebrate—a diversity of ways of talking and thinking about science.

However, we argue that responsive teaching, as currently construed, is not enough: it calls on instructors to attend to the scientific substance of students' ideas, but we still find ourselves unequipped to do so across the many ways of seeing, arguing, and talking that students bring to bear. Though responsive teaching has helped us see students' intuitive ideas as continuous with science,[28,33-36] we (the authors) know that it is inevitable that the lenses through which we seek to recognize and cultivate the "seeds" of science in student thinking[29] are shaped by our own culture, both home and professional. We are still learning how to leverage responses like Leona's or James's even if we can recognize now that these responses are sophisticated in ways we do not immediately see. We can look back at our instructional histories as responsive teachers and see ways in which we attended to specific ways of talking, and likely missed the scientific ideas of students whose discourse practices were less like our own.

This inspires us to also issue a call to *researchers*. The physics and science education research literatures provide us with rich examples that show both (1) how students' intuitive ideas, practices, and epistemologies can be framed as "seeds" of sophisticated or canonical ways of thinking, and (2) how instruction can build on these "seeds." These cases (e.g., Refs. 1, 2, 9, 37-40) provide us with ideas of what this might look like in our own instruction. There are fewer, if any, examples within physics that showcase and build on students' *cultural* ways of knowing, talking, and thinking. We need more research—particularly descriptive case study research—that can help us to attend to and understand the sophistication of these ways of knowing, as others have done with Leona, James, and Teresa.

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(or non-dominant) groups. Second, our own experience as physics teachers was deeply impacted by these examples from elementary school; as we show later in this article, the insights from Leona's story—and then from the stories we share in the next section—helped us to see and appreciate examples from introductory physics. We anticipate that the same may be true for other physics teachers, and we share these examples in that spirit.
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