Reframing Educational Outcomes: Moving beyond Achievement Gaps

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ABSTRACT

The term "achievement gap" has a negative and racialized history, and using the term reinforces a deficit mindset that is ingrained in U.S. educational systems. In this essay, we review the literature that demonstrates why "achievement gap" reflects deficit thinking. We explain why biology education researchers should avoid using the phrase and also caution that changing vocabulary alone will not suffice. Instead, we suggest that researchers explicitly apply frameworks that are supportive, name racially systemic inequities and embrace student identity. We review four such frameworks—opportunity gaps, educational debt, community cultural wealth, and ethics of care—and reinterpret salient examples from biology education research as an example of each framework. Although not exhaustive, these descriptions form a starting place for biology education researchers to explicitly name systems-level and asset-based frameworks as they work to end educational inequities.

INTRODUCTION

Inequities plague educational systems in the United States, from pre-K through graduate school. Many of these inequities exist along racial, gender, and socioeconomic lines (Kozol, 2005; Sadker *et al.*, 2009), and they impact the educational outcomes of students. For decades, education research has focused on comparisons of these educational outcomes, particularly with respect to test scores of students across racial and ethnic identities. The persistent differences in these test scores or other outcomes are often referred to as "achievement gaps," which in turn serve as the basis for numerous educational policy and structural changes (Carey, 2014).

A recent essay in *CBE—Life Sciences Education* (*LSE*) questioned narrowly defining "success" in educational settings (Weatherton and Schussler, 2021). The authors posit that success must be defined and contextualized, and they asked the community to recognize the racial undercurrents associated with defining success as limited to high test scores and grade point averages (GPAs; Weatherton and Schussler, 2021). In this essay, we make a complementary point. We contend that the term "achievement gap" is misaligned with the intent and focus of recent biology education research. We base this realization on the fact that the term "achievement gap" can have a deeper meaning than documenting a difference among otherwise equal groups (Kendi, 2019; Gouvea, 2021). It triggers deficit thinking (Quinn, 2020); unnecessarily centers middle and upper class, White, male students as the norm (Milner, 2012); and downplays the impact of structural inequities (Ladson-Billings, 2006; Carter and Welner, 2013).

This essay unpacks the negative consequences of using the term "achievement gap" when comparing student learning across different racial groups. We advocate for abandoning the term. Similarly, we suggest that, in addition to changing our terminology, biology education researchers can explicitly apply theoretical frameworks that are more appropriate for interrogating inequities among educational outcomes across students from different demographics. We emphasize that the idea that a simple "find and

Selection of research frameworks used to interrogate educational outcomes within and across demographics				
Research framework	Deficit models	Opportunity gaps	Educational debt	Community cultural wealth	Ethics of care
This framework...				
connects learning to	Deficiencies	Systemic discrimination		Personal, cultural, or other assets	
centers students from the	Dominant group	Historically or currently marginalized groups			
focuses on	Achievement gaps	Supports / Barriers	Debts owed	Lived experiences / Relationships	
assigns solutions to	Culture	Society		Culture	
	Institution				
	Instructor			Instructor	
	Student			Student	

FIGURE 1. **Research frameworks highlighted in the essay.** The column in gray summarizes deficit-based frameworks that focus on achievement gaps. The middle column (in gold) includes examples of systems-based frameworks that acknowledge that student learning is associated with society-wide habits. The rightmost columns (in peach) include examples of asset-based models that associate student learning with students' strengths. The columns are not mutually exclusive, in that studies can draw from multiple frameworks simultaneously or sequentially.

replace," swapping out the term "achievement gap" for other phrases, is not sufficient.

In the heart of this essay, we review some of these systems-level and asset-based frameworks for research that explores differences in academic performance (Figure 1): opportunity gaps (Carter and Welner, 2013), educational debt (Ladson-Billings, 2006), community cultural wealth (Yosso, 2005), and ethics of care (Noddings, 1988). Within each of these frameworks, we review examples of biology education literature that we believe rely on them, explicitly or implicitly. We conclude by reiterating the need for education researchers to name explicitly the systems-level and asset-based frameworks used in future research.

We will use the phrase "students from historically or currently marginalized groups" to describe the students who have been and still are furthest from the center of educational justice. However, when discussing work of other researchers, we will use the terminology they use in their papers. Our conceptualization of this phrase matches, as near as we can tell, Asai's phrase "PEERs—persons excluded for their ethnicity or race" (Asai, 2020, p. 754). We also choose to capitalize "White" to acknowledge that people in this category have a visible racial identity (Painter, 2020).

Positionality

Our positionalities—our unique life experiences and identities—mediate our understanding of the world (Takacs, 2003). What we see as salient in our research situation arises from our own life experiences. Choices in our research, including the types of data we collect and how we clean the data and prepare it for analysis, adopt analytical tools, and make sense of these analyses are important decision points that affect study results

and our findings (Huntington-Klein *et al.*, 2021). We recognize that it is impossible to be free of bias (Noble, 2018; Obermeyer *et al.*, 2019). Therefore, we put forth our positionality to acknowledge the lenses through which we make decisions as researchers and to forefront the impact of our identities on our research. Still, the breadth of our experiences cannot be described fully in a few sentences.

The four authors of this essay have unique and complementary life experiences that contribute to the sense-making presented in this essay. S.Y.S. has been teaching since 2003 and teaching in higher education since 2012. She is a South Asian immigrant to the United States, and a cisgender woman. E.J.T. has taught middle school, high school, and college science since 2006. She is a cisgender White woman. J.K.A. is a cisgender Black mixed-race man who comes from a family of relatively recent immigrants with different educational paths. He has worked in formal and informal education since 2000. R.M.P. is a cisgender Jewish, White woman, and she has been teaching college since 2006. We represent a team of people who explicitly acknowledge that our experiences influence the lenses through which we work. Our guiding principles are 1) progress over perfection, 2) continual reflection and self-improvement, and 3) deep care for students. These principles guide our research and teaching, impacting our interactions with colleagues (faculty and staff) as well as students. Ultimately, these principles motivate us to make ourselves aware of, reflect on, and learn from our mistakes.

Simply Changing Vocabulary Does Not Suffice

The term "achievement gap" is used in research that examines differences in achievement—commonly defined as differences in test scores—across students from different demographic

groups (Coleman *et al.*, 1966). Some studies replace "achievement gap" with "score gap" (e.g., Jencks and Phillips, 2006), because it defines the type of achievement under consideration; others use "opportunity gap," because it emphasizes differences in opportunities students have had throughout their educational history (e.g., Carter and Welner, 2013; more on opportunity gaps later). The shift for which we advocate, however, does not reside only with terminology. Instead, we call for a deeper shift of using research frameworks that acknowledge and respect students' histories and empower them now.

The underlying framework in research that uses "achievement gap" or even "score gap" may not be immediately apparent. Take for example two studies that both use the seemingly benign term, "score gap." A close read indicates that one study attributed the difference in test scores between Black and White students to deficient "culture and child-rearing practices" (Farkas, 2004, p. 18). Thus, even though the researcher uses what can be considered to be more neutral terminology, the phrase in this context represents deficit thinking and blame. On the other hand, another study uses the term "score gap" to explore differences that have been historically studied through cultures of poverty, genetic, and familial backgrounds (Jencks and Phillips, 2006). While these researchers discuss the Black–White score gap, they present evidence that examines this phenomenon with nuanced constructs, such as stereotype threat (Steele, 2011) and resources available. These authors also mention ways to reduce score gaps, such as smaller class sizes and high teacher expectations (Jencks and Phillips, 2006).

Some researchers who use the phrase "achievement gap" explicitly avoid deficit thinking and instead embrace an asset-based framework. Jordt *et al.* (2017) address systemic racism, just as Jencks and Phillips (2006) do. Specifically, Jordt *et al.* (2017) identified an intervention that affirmed student values that might also be a potential tool for increasing underrepresented minority (URM) student exam scores in college-level introductory science courses. The researchers found that this intervention produced a 4.2% increase in exam performance for male URM students and a 2.2% increase for female URM students. Thus, while they use "achievement gap" throughout the paper to refer to racial and gender differences in exam scores, the study focused on ways to support URM student success.

In pursuit of improved language and clarity of intent, the term "achievement gap" should be replaced to reflect the research framework used to interrogate educational outcomes within and across demographic groups.

DEFICIT THINKING

Deficit thinking describes a mindset, or research framework, in which differences in outcomes between members of different groups, generally a politically and economically dominant group and an oppressed group, are attributed to a quality that is lacking in the biology, culture, or mindset of the oppressed group (Valencia, 1997). Deficit thinking has pervaded public and academic discourse about the education of students from different races and ethnicities in the United States for centuries (Menchaca, 1997).

Tenacious deficit-based explanations blame students from historically or currently marginalized groups for lower educational a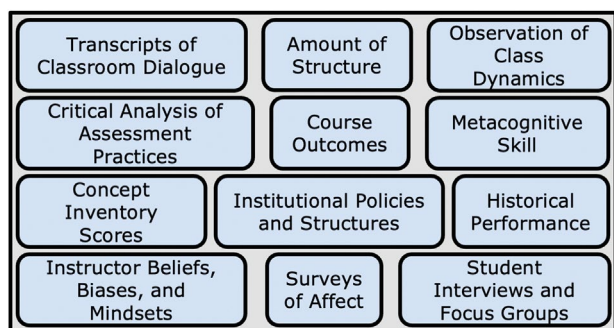ttainment. These falsities include biological inferiority due to brain size or structure (Menchaca, 1997), negative cultural attributes such as inferior language acquisition (Dudley-Marling, 2007), and accumulated deficits due to a "culture of poverty" (Pearl, 1997; Gorski, 2016). More recently, lower achievement has been attributed to a lack of "grit" (Ris, 2015) or the propensity for a "fixed" mindset (Gorski, 2016; Tewell, 2020). While ideas around grit and mindset have demonstrable value in certain circumstances (e.g., Hacisalihoglu *et al.*, 2020), they fall short as primary explanations for differences in educational outcomes, because they focus attention on perceived deficits of students while providing little information about structural influences on failure and success, including how we define those constructs (Harper, 2010; Gorski, 2016). In other words, deficit models often posit students as the people responsible for improving their own educational outcomes (Figure 1).

Deficit thinking, regardless of intent, blames individuals, their families, their schools, or their greater communities for the consequences of societal inequities (Yosso, 2006; Figure 1). This blame ignores the historic and structural drivers of inequity in our society, placing demands on members of underserved groups to adapt to unfair systems (Valencia, 1997). A well-documented example of structural inequity is the consistent underresourcing of public schools that serve primarily students of color and children from lower socioeconomic backgrounds (Darling-Hammond, 2013; Rothstein, 2013). Because learning is heavily influenced by factors outside the school environment, such as food security, trauma, and health (Rothstein, 2013), schools themselves reflect gross disparities in resourcing based on historic discrimination (Darling-Hammond, 2013). Deficit thinking focuses on student or cultural characteristics to explain performance differences and tends to overlook or minimize the impacts of systemic disparities. Deficit thinking also strengthens the narrative around student groups in terms of shortcomings, reinforces negative stereotypes, and ignores successes or drivers of success in those same groups (Harper, 2015).

Achievement Gaps

The term "achievement gap" has historically described the difference in scores attained by students from racial and ethnic minority groups compared with White students on standardized tests or course exams (Coleman *et al.*, 1966). As students from other historically or currently marginalized groups, such as female or first-generation students, are increasingly centered in research, the term is now used more broadly to compare any student population to White, middle and upper class, men (Harper, 2010; Milner, 2012). Using White men as the basis for comparison comes at the expense of students from other groups (Harper, 2010; Milner, 2012). Basing comparisons on the cultural perspectives of a single dominant group leads to "differences" being interpreted as "deficits," which risks dehumanizing people in the marginalized groups (Dinishak, 2016). Furthermore, centering White, wealthy, male performance means that even students from groups that tend to have higher test scores, like Asian-American students, risk dehumanization as "model minorities" or "just good at math" (Shah, 2019).

Many researchers have highlighted the fact that the term "achievement gap" is a part of broader deficit-thinking models and rooted in racial hierarchy (Ladson-Billings, 2006;

Transcripts of Classroom Dialogue	Amount of Structure	Observation of Class Dynamics
Critical Analysis of Assessment Practices	Course Outcomes	Metacognitive Skill
Concept Inventory Scores	Institutional Policies and Structures	Historical Performance
Instructor Beliefs, Biases, and Mindsets	Surveys of Affect	Student Interviews and Focus Groups

FIGURE 2. A selection of potential data sources that could inform researchers about within- and between-group differences in educational outcomes. This list does not encompass the full range of possible data sources, nor does it imply a hierarchy to the data. Instead, it reflects some of the diversity of quantitative and qualitative data that are directly linked to student outcomes and that are used under multiple research frameworks.

Gutiérrez, 2008; Martin, 2009; Milner, 2012; Kendi, 2019). Focusing on achievement gaps emphasizes between-group differences over within-group differences (Young *et al.*, 2017), reifies sociopolitical and historical groupings of people (Martin, 2009), and minimizes attention to structural inequalities in education (Ladson-Billings, 2006; Alliance to Reclaim Our Schools, 2018). Gutiérrez (2008) names this obsession with achievement gaps as a "gap-gazing fetish" that draws attention away from finding solutions that promote equitable learning (Gutiérrez, 2008). Under a deficit-thinking model, achievement gaps are viewed as the primary problem, rather than a symptom of the problem (Gutiérrez, 2008), and for decades they have been attributed to different characteristics of the demographics being compared (Valencia, 1997). As such, proposed solutions tend to be couched in terms of remediation for students (Figure 1).

Ignoring the social context of students' education necessarily limits inferences that can be drawn about their success. Limiting measures of educational success, also conceptualized as achievement, to performance on exams or overall college GPA, often leaves out consideration of other potential data sources (Weatherton and Schussler, 2021; Figure 2). This narrow perspective tends to perpetuate the systems of power and privilege that are already in place (Gutiérrez, 2008). The biology education research community can instead broaden its sense of success to recognize the underlying historical and current contexts and the intersections of identities (e.g., racial, gender, socioeconomic) that contribute to those differences (Weatherton and Schussler, 2021).

In biology education research, many papers still use the language of "achievement gap," even in instances when researchers explicitly or implicitly use other nondeficit frameworks. While some may argue that this language merely describes a pattern, its origin and history is explicitly and inextricably linked to deficit-thinking models (Gutiérrez, 2008; Milner, 2012). Thus, we join others in the choice to abandon the term "achievement gap" in favor of language—and frameworks—that align better to the goals of our research and to avoid the limitations and harm that can arise through its use.

Example: Focusing on Achievement Gaps Can Reinforce Racial Stereotypes

Messages of perpetual underachievement can inadvertently reinforce negative stereotypes. For example, Quinn (2020) demonstrated that, when participants watched a 2-minute video of a newscast using the term "achievement gap," they disproportionately underpredicted the graduation rate of Black students relative to White students, even more so than participants in a control group who watched a counter-stereotypical video. They also scored significantly higher on an instrument measuring bias. Because bias is dynamic and affected by the environment, Quinn concludes that the video discussing the achievement gap likely heightened the bias of the participants (Quinn, 2020).

Education researchers, just like the participants in Quinn's (2020) study, inadvertently carry implicit bias against students from the different groups they study, and those biases can shift depending on context. Quinn (2020) demonstrates that just using the term "achievement gap" can reinforce the pervasive racial hierarchy that places Black students at the bottom. Researchers, without intending to, can be complicit in a system of White privilege and power if the language and frameworks underlying their study design, data collection, and/or data interpretation are aligned with bias and stereotype. If the goal is to dismantle inequities in our educational systems and research on those systems, the biology education research community must consider the historical and social weight of its literature to address racism head on, as progressive articles have been doing (e.g., Eddy and Hogan, 2014; Canning *et al.*, 2019; Theobald *et al.*, 2020).

SYSTEMS-LEVEL FRAMEWORKS

To move away from the achievement gap discourse—because of the history of the term, the perceived blame toward individual students, as well as the deficit thinking the term may imbue and provoke—we highlight some of the other frameworks for understanding student outcomes. We conclude discussion of each framework with an example from education research that can be reinterpreted within it, keeping in mind that multiple frameworks can be applied to different studies. We acknowledge two caveats about these reinterpretations: first, we are adding another layer of interpretation to the original studies, and we cannot claim that the original authors agree with these interpretations; second, each example could be interpreted through multiple frameworks, especially because these frameworks overlap (Figure 1).

In this section, we begin at the systems level by examining opportunity gaps and educational debt. Rather than blaming students or their cultures for deficits in performance, these systems-level perspectives name white supremacy and the concomitant policies that maintain power imbalances as the cause of disparate student experiences.

Opportunity Gaps

The framework of opportunity gaps shifts the onus of differential student performance away from individual deficiencies and assigns solutions to actions that address systemic racism (Milner, 2012; Figure 1). Specifically, opportunity gaps embody the difference in performance between students from historically and currently marginalized groups and middle and upper class,

White, male students, with primary emphasis on opportunities that students have or have not had, rather than on their current performance (i.e., achievement) in a class (Milner, 2012). Compared with deficit models, the focus shifts from assigning responsibility for the gap from the individual to society (Figure 1).

Some researchers explore opportunity gaps by discussing the structural challenges that students from historically and currently marginalized groups have been facing (e.g., Rothstein, 2013). For example, poor funding in K–12 schools leads to inconsistent, poorly qualified, and poorly compensated teachers; few and outdated textbooks (Darling-Hammond, 2013); limited field trips; a lack of extracurricular resources (Rothstein, 2013); and inadequately supplied and cleaned bathrooms (Darling-Hammond, 2013). Additional structural challenges that occur outside school buildings, but impact learning, include poor health and lack of medical care, food and housing insecurity, lead poisoning and iron deficiency, asthma, and depression (Rothstein, 2013).

While the literature about opportunity gaps focuses more on K–12 than higher education (Carter and Welner, 2013), college instructors can exacerbate opportunity gaps by biasing who has privilege (i.e., opportunities) in their classrooms. For example, some biology education literature focuses on how instructors' implicit biases impact our students, such as by unconsciously elevating the status of males in the classroom (Eddy *et al.*, 2014; Grunspan *et al.*, 2016).

Example: CUREs Can Prevent Opportunity Gaps. Course-based undergraduate research experiences (CUREs) are one way to prevent opportunity gaps (e.g., Bangera and Brownell, 2014; CUREnet, n.d.). Specifically, we interpret the suggestions that Bangera and Brownell (2014) make about building CUREs as a way to recognize that some students have the opportunity to participate in undergraduate research experiences while others do not. For example, students who access extracurricular research opportunities are likely relatively comfortable talking to faculty and, in many cases, have the financial resources to pursue unpaid laboratory positions (Bangera and Brownell, 2014). More broadly, when research experiences occur outside the curriculum, they privilege students who know how to pursue and gain access to them. However, CUREs institutionalize the opportunity to conduct research, so that every student benefits from conducting research while pursuing an undergraduate degree.

Educational Debt

Ladson-Billings (2006) submits that American society has an educational debt, rather than an educational deficit. This framework shifts the work of finding solutions to educational inequities away from individuals and onto systems (Figure 1). The metaphor is economic: A deficit refers to current mismanagement of funds, but a debt is the systematic accumulation of mismanagement over time. Therefore, differences in student performances are framed by a history that reflects amoral, systemic, sociopolitical, and economic inequities. Ladson-Billing (2006) suggests that focusing on debts highlights injustices that Black, Latina/o, and recent immigrant students have incurred: Focusing on student achievement in the absence of a discussion of past injustices does not redress the ways in which students and their parents have been denied access to educational

opportunities, nor does it redress the ways in which structural and institutional racism dictate differences in performance. This approach begins by acknowledging the structural and institutional barriers to achievement in order to dismantle existing inequities. This reframing helps set the scope of the problem and identify a more accurate and just lens through which we make sense of the problem (Cho *et al.*, 2013).

Example: NSF Supports Historically Black Colleges and Universities. One program that aims to repay educational debt is the NSF's Historically Black Colleges and Universities Undergraduate Program (National Science Foundation, 2020). This grant program supports HBCUs in ways intended to have far-reaching consequences; among the multiple strands are opportunities to begin research projects and to fund specific, short-term goals to improve science, technology, engineering, and mathematics (STEM) education. Another strand establishes broadening participation research centers. Financial resources aimed specifically at historically Black colleges and universities, and other minority-serving institutions acknowledge and address the stresses that marginalized students experience at primarily White campuses. Supporting HBCUs in turn supports students. As former NSF program officer Claudia Rankins reports:

> From my own (yet to be published) research, a participant described the HBCU where he studied physics as providing a "dome of security and safety." In contrast, he recounted that when he attended a predominantly White institution, he constantly needed to be guarded and employ "his body sense," an act that made him tense, defensive, and unable to listen. (Rankins, 2019, p. 50)

Example: Institutions Can Repay Educational Debt. Institutions can repay educational debt by ensuring that their students have the resources and support structures necessary to succeed. The Biology Scholars Program at the University of California, Berkeley, is a prime example (Matsui *et al.*, 2003; Estrada *et al.*, 2019). This program, begun in 1992 (Matsui *et al.*, 2003) and still going strong (Berkeley Biology Scholars Program, n.d.), creates physical and psychological spaces that support learning: a study space and study groups, paid research experiences, and thoughtful mentoring. The students recruited to the program are from first-generation, low-socioeconomic status backgrounds and from groups that are historically underrepresented. When the students enter college, they have lower GPAs and Scholastic Aptitude Test scores than their counterparts with the same demographic profile who are not in the program. And yet, when they graduate, students in the Biology Scholars Program have higher GPAs and higher retention in biology majors than their counterparts (Matsui *et al.*, 2003), perhaps because of the extended social support they receive from peers (Estrada *et al.*, 2021). Moreover, students in this program report lower levels of stress and a greater sense of well-being (Estrada *et al.*, 2019).

ASSET-BASED FRAMEWORKS

In this section, we continue to explore frameworks that move away from the achievement gap discourse, now focusing on models that build from students' strengths. We have chosen two frameworks whose implications seem particularly relevant to

and coincident with anti-racist research in biology education: community cultural wealth (Yosso, 2005) and ethics of care (Noddings, 1988). As before, we reinterpret articles from the education literature to illustrate these frameworks, and we once again include the caveats that we extend beyond the authors' original interpretations and that other frameworks could also be used to reinterpret the examples.

Community Cultural Wealth

One asset-based way to frame student outcomes is to begin with the strengths that people from different demographic groups hold (Yosso, 2005). Rather than focusing on racism, this approach focuses on community cultural wealth. The premise is that everyone can contribute a wealth of knowledge and approaches from their own cultures (Yosso, 2005).

Community cultural wealth begins with critical race theory (CRT; Yosso, 2005). CRT illuminates the impact of race and racism embedded in all aspects of life within U.S. society (Omi and Winant, 2014). CRT acknowledges that racism is interconnected with the founding of the United States. Race is viewed in tandem with intersecting identities that oppose dominant ones, and the constructs of CRT emerge by attending to the experiences of people from communities of color (Yosso, 2005). Therefore, the experiences of students of color are central to transformative education that addresses the overrepresentation of White philosophies. CRT calls on research to validate and center these perspectives to develop a critical understanding about racism.

Community cultural wealth builds on these ideas by viewing communities of color as a source of students' strength (Yosso, 2005). The purpose of schooling is to build on the strengths that students have when they arrive, rather than to treat students as voids that need to be filled: students' cultural wealth must be acknowledged, affirmed, and amplified through their education. This approach is consistent with those working to decolonize scientific knowledge (e.g., Howard and Kern, 2019).

Example: Community Cultural Wealth Can Improve Mentoring. Thompson and Jensen-Ryan (2018) offer advice to mentors about how to use cultural wealth to mentor undergraduate students in research. They identify the forms of scientific cultural capital that research mentors typically value, finding that these aspects of a scientific identity are closely associated with majority culture. They challenge mentors to broaden the forms of recognizable capital. For example, members of the faculty can actively recruit students into their labs from programs aimed to promote the diversity of scientists, rather than insisting that students approach them with their interest to work in the lab (Thompson and Jensen-Ryan, 2018). They can recognize that undergraduate students may not express an interest in a research career–especially initially—but that research experience is still formative. They can recognize that students who are strong mentors to their peers are valuable members of a research team and that this skill is a form of scientific capital. They can value the diverse backgrounds of students in their labs, rather than insisting that they come from families that have prioritized scientific thinking and research. In sum, the gaps that Thompson and Jensen-Ryan (2018) identify are in research mentors' attitudes, rather than in student performance.

Assets can also be developed in the classroom. We interpret Parnes *et al.*'s (2020) analysis of the Connected Scholars program as stemming from community cultural wealth. The Connected Scholars program normalized help-seeking and increased the help network available to first-generation college students, 90% of whom were racial or ethnic minorities, in a 6-week summer program that bridged students from high school to college. First-generation college students were provided explicit instruction on how to sustain these two types of support. The Connected Scholars intervention promoted help-seeking behaviors and seemed to mediate higher GPAs. Additionally, students in the intervention reported through a survey that they had better relationships with their instructors than students in the control group (Parnes *et al.*, 2020). In other words, cultural wealth can be amplified in college for first-generation students (see also the Biology Scholars Program, discussed in the *Opportunity Gaps* section; Matsui *et al.*, 2003; Estrada *et al.*, 2019).

Ethics of Care

As a framework, ethics of care complements community cultural wealth, in that both are asset-based. A key difference is that community cultural wealth focuses on the assets that students bring, and ethics of care focuses on the assets that an instructor brings to create a classroom of respect and confidence in students.

A foundation of biology education research is that instructors want their students to learn, and it is buttressed by literature concerning students' emotional well-being. For example, the field considers how students with disabilities experience active learning (Gin *et al.*, 2020) and how group work promotes collaboration and learning (Wilson *et al.*, 2018). Studies like these echo the philosophy of ethics of care developed by Noddings (1988).

The premises of teaching through the ethics of care are that everyone—including students and instructors—has both an innate desire to learn and the capacity to nurture (Pang *et al.*, 2000). In teaching, these premises form the basis for student–instructor relationships. Nieto and Bode (2012) caution against the oversimplification that caring means being nice: the ethics of care encompasses niceness, in addition to articulating high standards of performance. Instructors must also support and respect students as they meet those standards, especially when students did not recognize that they could meet those goals at the outset. This framework is about nurturing students to accomplish more than they thought possible.

Combining an inclusive culture, for example, through positive instructor talk (Seidel *et al.*, 2015; Harrison *et al.*, 2019; Seah *et al.*, 2021), growth mindset (Canning *et al.*, 2019), or increased course structure (Eddy and Hogan, 2014), with evidence-based practices for teaching content (Freeman *et al.*, 2014; Theobald *et al.*, 2020) has garnered recent attention as a way to create a powerful ethic of care in classrooms. For example, instructor talk, that is, what instructors say in class other than the content they are teaching, addresses student affect. Seidel *et al.* (2015) and Harrison *et al.* (2019) analyzed classroom transcripts to identify different categories of instructor talk. While further research can probe the impacts of instructor talk on student outcomes, the idea is consistent with the principles of ethics of care: for example, one category of talk describes

the instructor–student relationship as one of respect, fostered through statements such as "People are bringing different pieces of experience and knowledge into this question and I want to kind of value the different kinds of experience and knowledge that you bring in" (Seidel *et al.*, 2015, p. 6). Instructor talk also generates a classroom culture of support and validation for marginalized students and overall builds classroom community (Ladson-Billings, 2013).

Example: Departments Can Implement Care. Gutiérrez (2000) presents an example of an entire department applying ethics of care to support how African-American students learn math. This study is an ethnography of a particularly successful STEM magnet program in a public high school with a population that is majority African American. In her analysis of the math department, Gutiérrez avoids the phrase "achievement gap," while also recognizing that people outside the school assume a deficit model when considering the students. Instead, she illustrates how researchers can use an asset-based lens to build from knowledge about differences in performance (Gutiérrez, 2000).

Gutierrez (2000) examines pedagogy that supports African-American students. She documents how a culture of excellence is developed within a school setting that promotes student achievement. This culture is complex, in that there are multiple layers of support that provide students with repertoires for advancement (Gutiérrez, 2000)—the emphasis is on how teachers create an environment where students are both challenged through the curriculum and supported along the way. The teachers in this study have a dynamic conception of their students, and they demonstrate a unified commitment to support the broadest array of students at their school. The institution itself, represented in part through the departmental chair, has values that empower teachers to support students, proactive commitment from teachers to find innovative practices to serve students, and a supportive chairperson.

The math department exhibited a student-centered approach that epitomizes ethics of care. The teachers in the math department rotated through all of the courses and were therefore familiar with the entire curriculum. This knowledge helped them support one another, sharing successful strategies and working to improve the courses. It set up an environment in which they prioritized making decisions collectively. This collaboration led to a sense of togetherness among teachers and a sense of investment in individual students' successes. As a result, the teachers decided to remove less-challenging courses from the curriculum and replaced them with more advanced courses—against the recommendations of the school district. The chair of the department worked with the faculty to support student learning, consider course assignments, and choose topics for and frequency of faculty meetings. The chair also attended to teachers' emotional needs, for example, by talking to teachers every day, working with teachers to determine the best strategies for evaluating teaching practices, and enacting a teaching philosophy that valued problem solving over achieving correct answers.

The support that the teachers provided each other coincided with strong support for students. For example, students attended the magnet program because they were interested in science; they notably did not have to take entrance exams or maintain a certain GPA. If students struggled with a subject, they received tutoring. The teachers also invited graduates of the program to come back and visit, keeping the students motivated by showing them success.

Example: Biology Instructors Can Adopt an Ethics of Care. In much of the research on differential performance in our field, researchers focus on identifying strategies that help students, regardless of their histories, in their learning success. This asset-based approach acknowledges that students start at different places, but also that instructors can implement strategies that support all students in a trajectory toward common learning goals. This argument is often posited in terms of inclusive teaching (e.g., Dewsbury and Brame, 2019).

Some papers that measure the effect of inclusive teaching practices may use "gap" language, perhaps as a historical artifact of our discipline. These papers emphasize the just mission to "close the gap"—or, in anti-deficit language, for all students to learn the material and perform well on assessments. For example, Theobald *et al.* (2020) conducted a meta-analysis of undergraduate STEM classes, drawing on 26 studies of courses reporting failure rates (44,606 students) and 15 studies (9238 students) that reported exam scores. Within these samples, they compared instruction in lecture format with instruction using active-learning strategies. The analysis compared the success of students from minoritized groups using these two teaching strategies and found conclusive evidence of the efficacy of active teaching for underrepresented student success in STEM courses. The powerful implication of this study is that college STEM instructors can mitigate some of the effects of oppression that students have experienced in their lifetime.

In another study demonstrating the philosophy of ethics of care, Canning *et al.* (2019) found narrower racial disparities in performance in courses taught by instructors who had a growth mindset about their students' ability to learn, compared with instructors who viewed level of achievement as fixed. In fact, they found that the instructor mindset had a bigger impact on student performance than other faculty characteristics (Canning *et al.*, 2019). While they focused on the negative consequences of instructors' fixed mindset, the corollary is that a growth mindset can reflect an ethics of care that both motivates students and generates a positive classroom environment.

The successful instructors will also work to recognize their implicit biases and to ensure that they support a growth mindset for all students, regardless of demographic. This is particularly relevant, because implicit biases have "more to do with associations we've absorbed through history and culture than with explicit racial animus" (Eberhardt, 2019, p. 160). Realizing how our own socialization may have conditioned us to automatically produce harmful but hidden narratives warrants our attention (Eberhardt, 2019).

MOVING FORWARD

Ladson-Billings (2006) reframed the performance of students from historically and currently marginalized groups from achievement gap to educational debt; this reframing has contributed to a movement to critically examine the term. At the same time, however, the term "achievement gap" has become a catchall used by researchers untethered from its deeper historical context.

Researchers choose words to describe their research that reflect their personal worldviews and research frameworks; in turn, these worldviews and frameworks influence future researchers. Every discipline grapples with terminology, and phrases that were common historically may fall out of use. In some instances, the terms themselves no longer suffice, so a simple "search and replace" may be all that is required to address the issue. The term "achievement gap," however, is tied to specific frameworks that need to be acknowledged and redressed; it affects how research is designed, how results are interpreted, and what conclusions are drawn. Simply replacing "achievement gap" would not address the undermining nature of deficit-based research frameworks.

Researchers who used the term "achievement gap" may not have intended to use a deficit-thinking framework in their study. In fact, as we have demonstrated with our examples, some powerful articles exist in biology education research that used the term and also implicitly used one of the systems-level or asset-based frameworks we identified.

In these examples, we have reinterpreted the results of primary research with the frameworks we identified. This leads to two points of caution. The first is that we are adding another layer of interpretation, one that the original authors may not have intended. The second is that each example could be interpreted through multiple frameworks, especially because these frameworks overlap (Figure 1). For example, Bangera and Brownell (2014) identify barriers to participating in independent undergraduate research experiences. Course-based undergraduate research experiences (CUREs) offer research opportunities to students who previously could not access them. As discussed earlier, we posited CUREs as an example of a way to reduce opportunity gaps. However, we could also have interpreted the act of implementing a CURE as repaying an educational debt by repairing a form of bias typical within the academy (Figure 1).

Addressing educational inequities requires that biology education researchers quantify differences in performance across demographic groups (Figure 2) and must be done with the utmost care. Disaggregating data is necessary, as is analyzing those data with a just framework that dismantles racial hierarchies and carefully considers the sources of data used to understand those inequities. The frameworks we choose affect our analysis; we must avoid the common trap of assuming that quantitative data and data analysis are free from bias. To illustrate the degree of subjectivity that enters data analysis, Huntington-Klein *et al.* (2021) found that when seven different researchers received copies of the same data set, each reported different levels of statistical significance, including one researcher who found an effect that was opposite to what the others found. Moving away from analyses based on the phrase "achievement gap" will avoid unintentionally reinforcing the racial bias and better reflect the intention of disaggregating data to quantify differences in performance across demographic groups to actively dismantle persistent educational inequities.

In addition to disaggregating and diversifying data on outcomes (Figure 2), the biology education research community must consider how definitions of success may center White,

TABLE 1. A list of questions that individuals or groups could use to adopt frameworks that achieve a more equitable and just educational system

Research

What qualities do I believe are important for success in research? How do those align with the filters I use to accept trainees or identify collaborators?

Are there ways in which this research question, design, or analysis could be harmful to students or collaborators?

How do I integrate trainees' and collaborators' goals for research into the design of my research lab or program?

What cultural perspectives are centered in my approach to and beliefs about success in research?

How does my research contribute to a more just world?

Teaching and mentoring

What assumptions do I make about my trainees, particularly those who have experienced and continue to experience different levels of success?

What stories do I tell, or language do I use, when describing trainees and their performance? How does my definition of excellence lift some voices over others? For example, do my letters of recommendation use gendered language or a narrow definition of success?

How do my students perceive their own success in my class? How might that differ from my perspective? How does the design of my courses reflect my beliefs in equity, justice, or inclusion?

What data do I collect on how others perceive my sense of justice? How do I respond to those data?

Administration and service

Who benefits or is harmed from the policies I support? How do I know?

Is this policy in place due to historical or equity considerations?

What unwritten policies exist that need to be interrogated and revised?

What invisible filters might prevent or dissuade someone from accessing resources for students?

How does investment of time or resources in our institution align with professed devotion to equity and justice?

Are researchers and policy makers working on issues of justice appropriately compensated and recognized in the promotion and tenure process?

Personal

What are some areas of growth in my understanding of systemic inequities in education? How will I engage with these issues?

How can I tell when I have unintentionally inflicted harm?

How do I process my own failures and successes? How does that compare with my view of the failures and successes of others?

What am I actively doing to recognize people's strengths?

middle-class ways of knowing and performing (Weatherton and Schussler, 2021). In their recent essay, Weatherton and Schussler (2021) reported that, in articles published in *LSE* between the years 2015 and 2020, the word "success," when defined, largely meant high GPAs and exam scores. This narrow definition of success prioritizes scientific content, whereas there are additional admirable goals by which success could be measured (Figure 2; see also Weatherton and Schussler, 2021 and references therein). Moreover, the scientific skills that are valued are Eurocentric, rather embodying a diversity of scientific approaches (Howard and Kern, 2019). In addition to the limitations of narrowly defining success as exam performance, it should be noted that tests themselves are not always fair or equitable across all student populations (Martinková *et al.*, 2017); success measured in this way should be interpreted with caution, particularly when comparing students across different courses, institutions, or identities.

As we discussed earlier, instructors' and researchers' deep beliefs about educational success and achievement necessarily impact their actions. For this reason, we propose that interrogating the frameworks we use is necessary and that such interrogation should acknowledge harm that may have been inflicted. While writing this essay, for example, our understandings of the frameworks underlying our own research, teaching, and other engagements have grown. Much like the research studies we discuss, our intentions, actions, and frameworks can be and have been out of alignment. For example, our own actions with respect to departmental policies, course designs, and program structures have not always reflected the principles to which we subscribe. Although this essay focuses on frameworks in research, we provide a list of some questions that we have asked of ourselves and that could catalyze reflection in all areas of our professional work (Table 1).

In conclusion, we have presented four ways to frame differences in academic performance across students from different demographic groups that firmly reject deficit-based thinking (Figure 1). The notions of opportunity gaps and educational debt demonstrate how systems thinking can recognize socio-environmental barriers to student learning. Asset-based frameworks that include community cultural wealth and ethics of care can help identify actions that institutions, instructors, and students can take to meet learning goals. We hope that researchers in the field move forward by 1) avoiding, or at least minimizing, deficit thinking; 2) explicitly stating asset-based and systems-level frameworks that celebrate students' accomplishments and move toward justice; and 3) using language consistent with their frameworks.

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