

Exploring physics teacher identity: Pathways toward equitable instruction among teachers

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Physics teacher identity encompasses teachers' beliefs and views toward being a physics teacher. Physics teacher identity is influenced by teachers' perspectives on physics teaching and learning. Previous studies on teacher identity in general suggest that the construct is complex and malleable. Studies further suggest that it influences instructional methods, student engagement, and classroom environment. However, within physics education, there has yet to be an examination of how physics teacher identity influences "equitable" teaching approaches. This qualitative study sought to identify various dimensions of physics teacher identity and its implications for physics education research. We interviewed secondary and postsecondary physics teachers ($n = 10$) from different regions of the country with varying years of experience. We searched for consistent themes regarding the influence of physics teacher identity on equitable instruction using a conceptual framework that examines conceptions of self, others, knowledge, and pedagogy. Findings showed that teachers held a variety of conceptions of self and others, while many struggled to describe their conceptions of knowledge and pedagogy. Our findings are significant for physics teachers, educators, and researchers aiming to employ equitable teaching strategies. Ultimately, this study fostered a deeper understanding of the relationship between physics teacher identity and equitable instruction.

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I. INTRODUCTION

"Physics isn't for people like us." This is what an African American student told the first author during a high school physics lesson. Compelled to understand his viewpoint, I asked him to elaborate. He pointed out the glaring absence of African American role models in the discipline. In response to his statement, I told him that I, and many other African Americans, could pursue a career in physics or any other science, technology, engineering, and mathematics

(STEM)-related field. In my later reflection on this exchange, I realized my unique position as a physics teacher of color could help challenge this narrative. I understood his perspective. When I was his age, I observed the same absence of African Americans in physics. So, imagining that I was speaking to my younger self, I went further. I told him not to be intimidated by what appeared to be a challenging career path. I encouraged him to pursue a career in physics, which he eventually did.

In my work as a physics education researcher, interactions like the one above were not uncommon. As a physics instructor, I prioritized providing my students with an equitable learning experience in physics that I did not have as a student. Over time, I wondered how my experiences as a physics student shaped my view of myself and consequently shaped my practice and my students'

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classroom experiences. This wondering has led me to a more formal study of how physics teachers conceptualize equitable instruction and the experiences that shape these conceptualizations. My interest in this study area has been magnified as I have spoken with physics teachers about their beliefs around equity and how to actualize it in the classroom. During these discussions, physics teachers struggle to express how equitable instruction should be actualized in the classroom.

One reason physics teachers may struggle to articulate how to actualize equity in the physics classroom is that the natural sciences, especially physics, are often regarded as inherently equitable and meritocratic. More research is needed to consider physics teacher identity as a construct that might influence equitable instruction. A simple “physics teacher identity” search yields fewer than five articles in peer-reviewed journals. Research on “science teacher identity” is only slightly more expansive. Our work intends to better understand physics teachers’ identity, which can, in turn, help physics education researchers and physics teachers push toward more equity-aligned pedagogies. Our research question is: *How do physics teachers in a cohort understand their identities in relation to equitable instruction, including their conceptions of self, others, knowledge, and pedagogy?*

In this study, we do not begin with a fixed or prescriptive definition of equity. Instead, we examine how different physics teachers conceptualize equity in their own words and practices. Our goal is to understand how teachers interpret the concept of teaching equitably in the context of physics instruction. The fundamental question guiding our analysis is: What does equity mean to these teachers, and how are their views of equity informed by their conceptions of self, their students, disciplinary knowledge, and pedagogy? Rather than evaluating these views against an external standard, we aim to understand the internal dynamics of each teacher’s stance on equity. In doing so, we highlight both the variation and the patterns that emerge in how equity is taken up and made meaningful in physics classrooms.

II. LITERATURE REVIEW

A. Science teacher identity

There is a relatively small body of work that specifically addresses physics teacher identity. So, when reviewing relevant literature, we examined the broader concept of “science teacher identity.”

The present study defines teacher identity as *the beliefs, values, and commitments a person holds toward teaching*. Teacher identity can be viewed as a continual process of interpreting and reinterpreting who one considers oneself to be in the context of teaching [1–3]. Teacher identity encompasses both personal and professional aspects of a teacher [4]. The professional aspects of a teacher’s identity

are influenced by others’ recognition of an individual’s role as a teacher. This suggests that a teacher’s identity is shaped by self-definition and how others perceive them in a social context [5].

Understanding teacher identity is important because it influences teachers’ experience, classroom practice, and student engagement. One’s teaching identity has been found to affect a wide range of factors, including teachers’ pedagogical choices [1], their willingness to pursue and remain in the profession [6], relationships and interactions with students [3], professional growth [7], and curriculum development [1].

Science teacher identity encompasses the knowledge, emotions, and motivations of teachers related to science teaching [3]. Teacher preparation experiences shape this identity and inform instructional practices. In recent years, a growing body of research has emerged regarding the various factors that influence science identity formation among science teachers, as well as the classroom experiences and instructional practices that promote positive science teacher identity development [8–11]. For instance, studies have found that personal characteristics and practices employed during teacher education were the most critical factors affecting teacher identity development. This suggests that the structure and experiences offered during a teacher’s training are vital in shaping how beginning teachers perceive themselves as science teachers. For example, Luehmann [12] found that when preservice teachers engaged in collaborative activities during their preparation, they began to develop more agentic and inquiry-oriented teacher identities. Beauchamp and Thomas [4] found that when teachers integrated their pedagogical beliefs with their self-concept, it strengthened the development of a coherent and robust professional identity.

In a review of the use of the science teacher identity construct in science education literature, Avraamidou identified several limitations: (i) the lack of a coherent and well-defined conceptualization of science teacher identity, (ii) the disconnect between theoretical frameworks and reform recommendations, and (iii) the need to understand how science identities are enacted in the classroom [3]. In the present study, we aim to address a notable void in the literature concerning teacher identity: the lack of exploration into how teacher’s identity impacts equity in their instruction. Our study aims to bridge this gap by examining the relationship between the identity of physics teachers and equitable teaching practices.

Finally, we want to clarify the distinction between the physics teacher and student identity. Physics teacher identity focuses on how a teacher sees themselves as a teacher, and physics student identity is how one sees themselves as a physics learner. These identities are related to how we as scholars research them, but they are distinct constructs shaped by different experiences. A physics student’s identity can be a precursor to their teaching

identity, but it does not fully define it. Physics student identity can be a foundation for physics teacher identity, but the transition involves additional experiences, pedagogical development, and shifts in professional self-perception.

B. Equitable instruction

The *Cultural Studies of Science Education* journal featured a special issue on equity in science teacher education, providing an excellent theoretical exploration of how equity has been addressed in our collective work. Drawing on some of the articles published in this special issue [13–15], we characterize equitable instruction as *students having the support and resources they need to thrive as whole humans in school—including academically, socially, and emotionally*. This characterization is also rooted in Ladson-Billings’ conceptualization of culturally relevant pedagogy [16]. Specifically, we understand equitable instruction as reflecting three criteria of culturally relevant pedagogy: academic success, cultural competence, and sociopolitical consciousness [16,17]. Ladson-Billings’ [16] treatment of culturally relevant pedagogy aligns well with the present study’s focus on identity, emphasizing the role of teachers’ conceptions regarding self, others, social relations, and knowledge.

C. Science teacher identity and equitable instruction

Both teacher identity and equitable instruction constructs are multivariate [3,18]. The approach to teaching equitably differs among teachers in terms of providing students with equal outcomes, resources, opportunities, system changes, and participation.

In recent years, some scholarship has examined the intersection between equitable instruction and science teacher identity [3,19–23]. Chen and Mensah’s [19] case study on teaching contexts that influence teachers’ science teacher identity development found that preservice teachers’ personal identities and histories, coursework, student-teacher experiences, and opportunities to authentically teach all mediated the development of their science teacher identity.

Mockler *et al.* [23] theorized teacher identity as ongoing, dynamic, and shifting. They argue that teacher identity formation is influenced by personal, professional, and political dimensions of teachers’ lives that intersect each other in an active way. This body of work suggests a tight relationship between professional identity formation, the personal experiences of teachers, and the social consciousness of science teachers. In this way, the literature suggests that there may be a link between science teacher identity and the approach toward equitable instruction; however, there is a dearth of empirical research on the topic. This study aims to investigate the relationship between equitable instruction and science teachers’ identities.

D. Summary

In summary, identity, particularly in the context of teaching, is multivariate and influenced by an interplay of personal, professional, and situational dimensions. Teacher identity is a useful research frame because it treats teachers as whole persons in and across social contexts who continually reconstruct their views of themselves in relation to others, workplace characteristics, professional purposes, and teaching cultures. It is also a pedagogical tool that teacher educators and professional development specialists can use to make various holistic, situated frameworks visible.

More research is emerging regarding the formation of science teacher identity and equitable instruction approaches used in science classrooms. However, there is a gap in the literature regarding how science teacher identity development affects the implementation of equitable instruction among physics teachers. The current work addresses this gap by exploring how physics teacher identity formation can motivate equitable instruction among physics teachers.

III. CONCEPTUAL FRAMEWORK

This study’s conceptual framework examines the relationship between two major constructs. These are physics teacher identity and equitable instruction. The model of physics teacher identity used in this study comprises four distinct domains: teachers’ conceptions of *self*, *others*, *knowledge*, and *pedagogy*. Our notion of conception is based on Thompson’s [24] work, wherein conception refers to a “general mental structure, encompassing beliefs, meanings, concepts, mental images, preferences, and the like.” The idea that equitable instruction is an inevitable consequence of teachers’ conceptions is virtually a truism in extant research [24]. This point is evidenced in our efforts to produce equitable instruction by impacting teachers’ ideas about self, others, knowledge, and pedagogy. This conceptual framework is primarily informed by Ladson-Billings’ work on culturally relevant pedagogy [17]. Here, she identifies specific conceptions held by successful teachers of African American students. She organizes these conceptions into three domains: (i) conception of self and others, (ii) social relations, and (iii) conceptions of knowledge. Our conceptual framework differs from Ladson-Billings’ in two ways. First, we disaggregate the first domain so that self and others are separate categories. Second, we replace the second domain, social relations, with pedagogy. These two modifications are intended to facilitate our data collection. We expect secondary and postsecondary physics teachers to be different from the teachers in Ladson-Billings’ original study in that they will be less likely to think much about social relationships with students and more likely to think about their work in terms of pedagogy. We also expect the notions

of self and others to be less of a unified or singular idea and more likely to be conceptualized separately. These differences are partly due to the age of the students taught by our teachers and the unique perspective brought by teachers steeped in physics knowledge. Below, we provide a comprehensive description of each conception.

Another difference between our model and the Ladson-Billings model is that we have a more open-ended approach toward equitable instruction. In contrast, Ladson-Billings gives specific criteria for her conceptions that teachers should have to be culturally relevant.

- *Conceptions of self*—Teachers’ “conceptions of self” refers to the beliefs and perceptions that teachers hold about themselves as teachers. These conceptions significantly shape how teachers approach their roles, interact with students, and make instructional decisions. We are particularly interested in conceptions of self that speak to their ability to teach for equity. Examples of this conception would be: “I see myself as a supportive physics teacher.”
- *Conceptions of others*—Teachers’ “conceptions of others” refer to how teachers perceive and understand their students, colleagues, parents, and other stakeholders within the educational context. Examples of this conception would be: “My students are very capable of succeeding” or “My students need to improve more in order to do well in physics.”
- *Conceptions of knowledge*—Teachers’ “conceptions of knowledge” refer to teachers’ understandings and views about the nature of knowledge and how it is acquired, constructed, and applied in the context of teaching and learning. Examples of this conception would be: “I view physics knowledge as objective.” or “I find some of the physics theories questionable.”
- *Conceptions of pedagogy*—Teachers’ “conceptions of pedagogy” refer to their beliefs, theories, and understanding of how teaching and learning should take place in the classroom. Examples of this conception would be: “I believe teaching for equity involves activities where students work together in class,” or “My way of teaching equitably is allowing students to develop physics problems.”

A. Positionality

As context, we share our positionality regarding how we come to this work in terms of identity, motivation, history, and perspectives. The authors of this study operate with the understanding that the researchers’ own experiences influence the conduct of a study, from the framing of a research question to the analysis and interpretation of data. Given the current study’s focus on equity, it is important to us that we explicitly state our positionality in order to give transparency in how our perspectives have shaped the study [25]. The first author, Mathis, holds an undergraduate and a master’s degree in physics and a doctorate in science

education. During his educational experience, he experienced instances of racism that have influenced his physics identity and sense of belonging in the community. The first author’s former experience as an African-American male physics teacher gives him a critical perspective on issues of equity within physics teaching.

The second author, Mutegi, is an African American male and a tenured professor of science education. In his personal life, he is expressly committed to working for the social uplift of African people throughout the Diaspora. This commitment is also seen in his professional work as he explores ways that systemic racism works to influence people of African descent in various domains of science teaching and learning. This includes teacher content knowledge [17], structural forces in K-12 schools [26], structural forces in academia [27,28], and pedagogical innovation [29,30]. A significant portion of his work also aims to produce curricular materials for science learners of African descent [31].

The third author is a Black male from the southeastern United States. He is from an economically disadvantaged family. He has professional backgrounds in physics, engineering education, and career and technical/workforce education. He has studied issues related to STEM teacher identity in informal STEM learning settings, the impact of student participation in high school STEM-themed career academies, as well as inequities in access to academically rigorous programs in schools, particularly for ethnically and racially diverse students, as well as students who come from economically disadvantaged backgrounds.

The fourth author of the paper is an Indian female who came from an upper-class family. Due to her privilege, she determined that she has a larger platform than most women of color and must use it to help prevent discrimination within her community and the science field that she hopes one day to work in. As a result of her race and gender, she has faced discrimination, and due to this, she notices many issues with equity. She has grown up in a diverse environment, which has allowed her to recognize the importance of equity in creating a sense of community and belonging.

The fifth author comes from a middle-class family in a predominantly white city in the Northwest, where she witnessed discrimination and systemic oppression of people of color in all aspects of life, as well as the impact of others’ implicit biases about women on her. These experiences shape her positionality as someone who can use her privilege to promote equity in physics education and oppose the systemic oppression and discrimination of people of color to pursue justice and ensure everyone has equal opportunity to discover the joy of physics.

IV. METHODS

A. Data collection

Data collection consisted of semistructured interviews with 10 physics teachers selected from a pool of

250 physics teachers who expressed interest in participating in a study on physics teacher identity. The interested pool of teachers was identified through an open invitation sent to a LISTSERV associated with a national organization of physics teachers. During the selection process, we aimed for a diverse sample based on their years of teaching and gender. Half the participants were secondary physics teachers, and the other half were postsecondary physics instructors. We acknowledge that secondary and postsecondary teachers, in many cases, have different levels of exposure to professional development in terms of training around equitable instruction. However, our goal was to examine broad themes in identity formation across various education levels.

We considered diversity in terms of years of teaching experience and setting (secondary vs postsecondary); however, we did not report gender or racial/ethnic demographics because our sample lacked diversity in those areas. Given this limitation, we focused on variations in teaching experience and institutional context instead of demographics. Our interview protocol included questions that asked participants to describe their teaching identity across aspects of self, others, knowledge, and pedagogy. The interview protocol was semistructured. While the protocol fixed the topic of discussion, the open-ended questions served as an invitation for participants to speak at length on those topics. Interviews ranged from 45 to 60 min. They were conducted via an online teleconference (Zoom) and transcribed verbatim. All recordings and transcriptions were saved using interviewee pseudonyms on a password-protected computer to protect participants' confidentiality. Pseudonyms were used in all subsequent analyses

and writing. Table I provides a demographic summary of each participant.

B. Data analysis

A qualitative case study design was employed to investigate aspects of physics teacher identity among both secondary and university physics instructors. Our rationale for using a case study is based on the novelty of the physics teacher identity framework related to equity, positioning this as a groundbreaking empirical study. We illustrated in the literature review that, according to numerous studies, several aspects of what many consider equitable teaching practices require clarification and understanding. Our interview protocol (Table II) explored the participants' perceptions of self, others, knowledge, and pedagogy in the context of teacher identity. The software Vosaic was used to assist in organizing the data emerging from the transcriptions.

We analyzed transcripts of interviews using a deductive approach [32]. Teachers' statements that reflected their conceptions of self, others, knowledge, and pedagogy were identified and categorized into themes corresponding to each of these conceptions. For interrater reliability, interviews were coded by three different researchers.

While our study provides a multifaceted understanding of teacher identity and equity, the interview protocol regarding validation and variability in interview depth, particularly for some teachers who needed to explain all their conceptions, represents a limitation. These findings should thus be viewed as an initial exploration rather than generalizable conclusions about physics teachers' identity toward equitable instruction.

TABLE I. Demographic information of the participants.

Participant	Description
Rania	Secondary physics teacher in the Eastern United States, with over 5 years of experience.
Shari	Secondary physics teacher in the Eastern United States, with over 5 years of experience.
Natalie	University physics instructor in the Eastern United States with over 15 years of experience
Leonard	University physics instructor in the Western United States, with over 30 years of experience
Layla	Secondary physics teacher in the Southern United States, with over 10 years of experience
Adonis	University physics instructor in the Western United States with over 15 years of teaching experience
Ruby	Two-year college physics instructor in the Western United States, with over 5 years of experience
Sheldon	Secondary Physics teacher, in the Western United States, with over 10 years of experience
Pearl	Secondary physics teacher in the Eastern United States, with over 10 years of experience
Bill	University physics instructor in the Southeastern United States, with under 5 years of experience

V. FINDINGS

Our research focused on aspects of teacher identity related to equitable instruction among a cohort of physics teachers, particularly their conceptions of self, others, pedagogy, and knowledge. We categorized the teachers' conceptions across these four domains and explained how these conceptions varied. While many insights could be derived from our data, we have organized our findings into three types. These are (i) *articulations of identity*, (ii) *approaches to equity*, and (iii) *the relationship between identity and equity*. In this section, we use this organization to highlight a few overarching insights.

A. Articulations of identity

Although all teachers were interviewed using the same protocol, responses varied substantially and revealed a broad range in how teachers articulated these four aspects of identity. One way that we illustrate this variability in responses is through the use of concept maps. These concept maps capture how teachers articulate identity, specifically conceptions of self, others, knowledge, and

TABLE II. Interview protocol questions.

<i>Conceptions of self [Goal: Understand how physics teachers view themselves within their ability to teach equitably.]</i>
1. If you could describe your teaching identity, what would it be?
2. How do you define equitable teaching? [if their definition is not aligned with ours, we give them our definition of equity and ask the following questions]
*****We define equitable instruction as students having the support and resources they need to thrive as whole humans in school—including academically, socially, and emotionally.
a. How do you feel about our definition? If you disagree, why? If you agree, why? [if their definition is aligned with ours, then ask the following questions]
b. Do you want to teach for equity? Why or why not?
c. Do you believe in your ability to teach for equity? Why or why not?
d. Do you think teaching for equity is obtainable? Why or why not?
e. Do you believe your personal view of self impacts your teaching? Why or why not?
<i>Conceptions of others [Goal: Does the teacher think all students can achieve academic success or that some students will inevitably not succeed?]</i>
1. How do students do in your class?
a. Why do you think some students struggle/fail? [Who fails? Ties to deficit perspectives—the culture of poverty?]
b. Out of the students who fail, do you think they have the ability to achieve academic success? Why?
c. What would need to change in order for your students to succeed? [Teacher answers with deficit lying on student vs on self/system/community.]
<i>Conceptions of knowledge [Goal: Understand if teachers have a critical stance on how physics knowledge was developed and if they want to encourage students to have a critical stance (which recognizes the social/cultural influence of knowledge development).]</i>
1. Do you think physics knowledge is objective and free from bias? If yes, how? If no, how is it not?
2. Can you think of any physics concepts that are questionable in correctness? Do you push your students to push the boundaries of physics knowledge?
<i>Conceptions of pedagogy [Goal: How they view themselves as a teacher (in terms of pedagogical knowledge/skills). What would teaching for equity look like?]</i>
1. What is the best approach for teaching equitable instruction? Why?
a. [Probe for cultural connections] What do you look for in creating cultural connections to physics ideas?
2. How do you ensure all students participate in your classroom?
a. What is your view of equitable student participation in your classroom?

pedagogy. Figure 1 provides Adonis’ concept map. This concept map reveals that, in his interview, Adonis shared thoughtful insights about his conception of self, others, pedagogy, and knowledge. Adonis’ concept map represents a robust articulation of identity; it was the most robust of the ten concept maps created by the teachers interviewed.

Figure 2 provides Sheldon’s concept map. It shows that in his interview, Sheldon shared only thoughtful insights related to conceptions of self. He emphasized the importance of relationships, including student-teacher connections, subject connections, and the overall student experience. However, in his interview, he did not articulate any other aspects of identity—neither conceptions of others, conceptions of knowledge, nor conceptions of pedagogy. Sheldon’s concept map and the conceptions it represents provide an example of an articulation of identity less robust than Adonis’s.

Figure 3 provides Bill’s concept map. This indicates that in his interview, Bill shared only thoughtful insights related to his conceptions of self. Here, he emphasized the importance of continuous self-improvement. This concept

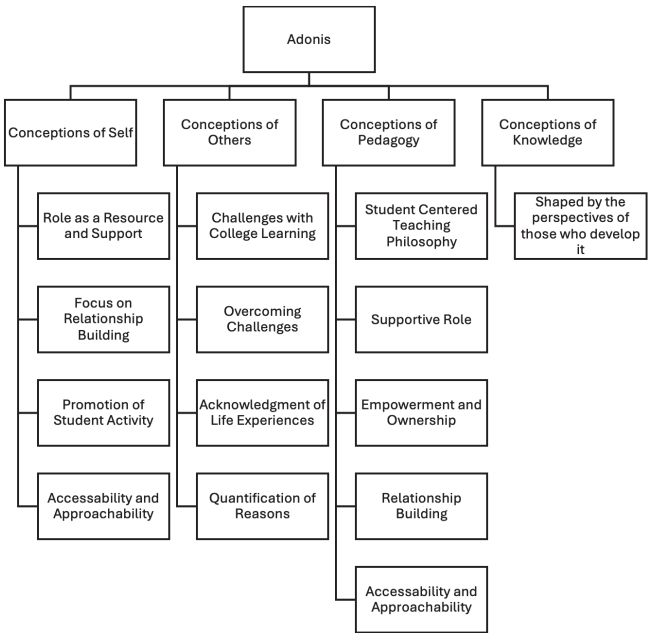


FIG. 1. Adonis’ concept map.

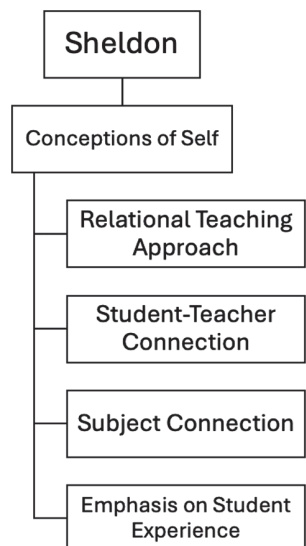


FIG. 2. Sheldon's concept map.

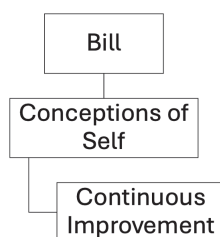


FIG. 3. Bill's concept map.

map and the conceptions it represents were the least robust of the ten teachers interviewed.

We have shared concept maps for three of the ten teachers in our sample to illustrate the range of their conceptions of identity. Other than Adonis, none of the teachers spoke meaningfully about all four conceptions, and only one other teacher shared thoughtful insight on three. As we will see in the next section, teachers with more robust conceptions tend to manifest traits of equitable instruction to a greater degree.

B. Approaches to equity

Examining teachers' conceptions reveals diverse approaches to what they perceive as equitable instructional practices.

1. Student-centered approaches

Several teachers emphasized a student-centered approach, building supportive, nurturing relationships with their students. Adonis, Shari, Ruby, Leonard, and Thomas viewed their roles as facilitators and guides, prioritizing the holistic development of students beyond academic achievement. Adonis, for instance, described his role as "more of a teacher than a professor, more of an instructor than faculty,"

emphasizing the importance of creating a welcoming environment. He said,

So, I'm here as their resource and aid to help them in a system [to] get through this ... I try to develop relationships and keep an open, welcoming atmosphere so that when they're confused, struggling, angry, even, they feel comfortable approaching me and asking for help or questions or concerns.

Shari echoed this sentiment, stating,

"I care much more about the beliefs and values that my students leave my class with than the skills and abilities they leave with." She emphasized that her success as a teacher is measured by the confidence and enthusiasm her students develop: "At the end of the school year, to me, I define success as students leaving thinking, 'I can do this, I'm excited to do more of it.'"

Adonis and Shari's statements align with Ladson-Billings' framework of culturally relevant pedagogy [16], specifically emphasizing building relationships and affirming students' cultural knowledge. They demonstrated what Ladson-Billings termed "cultural competence," fostering environments where students' lived experiences are valued in the learning process.

Similarly, Ruby focused on her role in fostering students' growth, comparing her approach to nurturing a garden:

I care about them as humans growing as opposed to thinking of myself as some sort of test giver ... I try to foster growth in the students instead of weeding them out. I'm trying to have each little seedling grow.

Leonard described his role as a co-learner or guide:

I view myself on a journey along with the students. A tour guide, maybe. I don't know all of physics, but I know enough that I can help students find their way along that journey.

This collaborative mindset highlights his belief in learning alongside students rather than adopting a purely authoritative role.

2. Awareness of student challenges

Many teachers demonstrated a keen awareness of students' challenges, recognizing that external factors often hinder their academic success. Adonis, Pearl, Leonard, Natalie, and Sheldon acknowledged that students' struggles frequently stem from life experiences, lack of college readiness, or insufficient support systems.

Adonis, for example, pointed out that students' difficulties are not due to a lack of intelligence but rather due to life circumstances:

Honestly, most of them that don't do well, it's because they haven't learned how to play college, not because they're dumb or incapable of understanding the content ... they have life experiences that kept them from being able to do what the course required to pass.

Natalie expanded on this, emphasizing the impact of external factors on student success:

"The strongest factor in whether or not my students are successful is what's going on outside of class. They have so many other things taking up their space that it's hard for them to persist." She added, "If they were given the space and time they need to have grit, then they would all have it."

Pearl also observed that students' struggles often result from a lack of experience with agency and critical skills, such as organization and time management:

Generally, the students who struggle the most are the ones with the least experience with more agency in the classroom and the least experience with executive functioning skills.

All of the teachers' statements show their recognition of external barriers and show a more systemic understanding of inequities [33].

3. Commitment to equity and inclusivity

Several teachers, including Shari, Natalie, and Thomas, demonstrated a strong commitment to equity and inclusivity. These teachers were particularly concerned with addressing the sociopolitical contexts of education and the biases present in the historical narratives of physics.

Shari, for instance, highlighted the need to challenge the dominance of "dead white European men" in physics history:

If you look at all the people after whom we've named our equations and laws, they're all dead white European men, and that's a problem. It's not because they're the only ones who did any physics work; it's because they're the only ones we celebrate.

Shari emphasized the importance of helping her students recognize this sociopolitical context: "It's important for my students to realize the sociopolitical context of their physics

classes in a way that I never got as a student." Thomas similarly expressed his desire to address biases in the subject matter and ensure his students understand the influence of power and privilege in developing knowledge. He stated,

I don't think physics is free from bias, because we are all biased human beings by nature, and that knowledge base comes from people who might look at things differently. That will open up a different way of thinking for you.

Shari and Thomas's insights exemplify teachers working toward pushing against an objective approach to knowledge [34], broadening what constitutes scientific knowledge and who is recognized as a knowledge producer.

4. Evolving conceptions of knowledge

Several teachers, including Adonis, Pearl, Natalie, and Thomas, reflected on the objectivity of physics, acknowledging that while the field strives for objectivity, it is not free from bias. They recognized that knowledge is shaped by the perspectives of those who develop and teach it. Adonis expressed this idea by stating,

I think all knowledge has bias to some extent. You can say facts are facts, and that's very true, but how you frame those facts—that context, who discovered those facts—that's where bias comes in.

He emphasized that his goal was to help students recognize that physics, like all knowledge, is shaped by human experiences and perspectives. Pearl offered a similar perspective:

Physics concepts, when applied, are fairly concrete and objective, but they are still shaped by assumptions. It's subjective to some degree because the conclusions we draw depend on the assumptions we make at the start.

On the other hand, Bill and Leonard took a more objective view of physics. Leonard emphasized the empirical nature of the discipline, stating:

Do I think physics knowledge is objective, as in that it reflects the world out there? Yes, I think it is objective. There is a real world out there, and physics tries to describe that world in objective ways.

5. Creative pedagogical approaches

Teachers like Thomas and Natalie advocated for creative and nontraditional teaching methods that engage students and cater to diverse learning styles. Thomas, for example,

described his approach to teaching as deliberately unconventional:

I don't like to do things in a traditional way all the time. I try to come up with creative ways to engage my students, ways that show me their knowledge without just sitting in front of them and lecturing all day long.

Natalie shared a similar focus on creative pedagogy, noting that she constantly reevaluates her teaching methods:

Every time I teach a course, I start with a blank slate, rethinking everything from scratch. I never finish a semester feeling like I got it right, because there are always some students I can't seem to reach.

C. Relationship between identity and equity

Having organized the presentation of findings into the two key constructs (identity and equity), we began to notice an interesting phenomenon. Teachers with more robust articulations of identity also appeared to have deeper and more comprehensive understandings of equity.

We sought to assess our suspicion by (i) measuring the robustness of identity (as determined by the number of nodes in each participant's concept map) and (ii) measuring the comprehensiveness of teachers' understanding of equity (as determined by the number of equity approaches identified by each participant). An equity approach can be defined as a specific teaching practice or pedagogical strategy that supports students' access, engagement, and potential success in physics while addressing structural barriers, cultural assets, and sociopolitical contexts. We measured the robustness of teacher identity toward equity through "nodes," which are identity markers found within the teacher interview transcripts. Identity markers are moments where teachers spoke to their conceptions of self, others, knowledge, and pedagogy. Table III below shows the numbers for the equity approaches, the total nodes in the identity concept map, and the primary nodes in the identity concept map. Participants are also sorted into four groups (A–D) based on the number of equity approaches identified. The data suggest an association between the number of equity approaches and the number of identity-related nodes, though this relationship is not perfectly linear, particularly between groups B and C. The nonperfectly linear relationships between groups B and C are probably due to the small sample size of participants ($n = 10$).

We do not aim to argue that robust articulations of identity lead to more equitable teaching. Our data were not intended to assess that relationship. However, we do suggest that this relationship be explored in future studies.

TABLE III. Nodes for different equity approaches.

	Identity	
	Equity	total nodes
		primary nodes
Group A		
Adonis	3	17
Natalie	3	12
Thomas	3	8
Mean nodes/person group A		12.3
Group B		
Leonard	2	7
Shari	2	4
Pearl	2	8
Mean nodes/person group B		6.3
Group C		
Sheldon	1	5
Ruby	1	4
Rania	1	11
Mean nodes/person group C		6.7
Group D		
Bill	0	2
Mean nodes/person group D		2.0

VI. CONCLUSION

The data from this study show a multifaceted understanding of teacher identity and equitable instruction among participating physics teachers. Each teacher's approach to teaching was informed by their conceptions of self, others, knowledge, or pedagogy, resulting in diverse approaches for fostering equitable learning environments. All teachers held various conceptions, but some did not elaborate on each conception in their interviews.

For conceptions of self, a recurring theme was that many teachers were committed to building meaningful relationships with students. Whether they see themselves as facilitators, guides, or co-learners, these teachers prioritize student-centered approaches, emphasizing the importance of creating supportive and nurturing environments where students feel empowered to learn. This relational aspect of teaching, which includes fostering student agency and encouraging personal growth, is critical in how these teachers address equity in their classrooms [16].

For conceptions of others, a recurring theme was teachers' awareness of students' challenges resulting from external factors, such as socioeconomic status and personal life circumstances. Rather than viewing students through a deficit lens, many teachers acknowledged these challenges and adapted their teaching to provide additional support and create inclusive spaces. This awareness reflects a broader recognition of the need to address the full range of students' experiences, not just their academic performance.

The teachers' conceptions of knowledge further highlight the complexity of their approaches. While some view

physics as a fundamentally objective discipline, others recognize the influence of biases in how physics knowledge is framed and taught. This tension between objectivity and subjectivity underscores the teachers' efforts to engage students critically with the content, encouraging them to question the sociopolitical contexts of science.

For conceptions of pedagogy, the teachers' dedication to continuous improvement, as seen in individuals like Natalie and Bill, illustrates their ongoing efforts to refine their teaching practices. This commitment to self-reflection and change is imperative for advancing equitable instruction, as it allows teachers to be responsive to their students' evolving needs.

There were instances where teachers' views of aspects of their identity aligned with multiple conceptions. For example, in both questions about conceptions of self and pedagogy, Adonis stated that he values building relationships with students. This demonstrates that these conceptions can be interwoven rather than distinct, distinguishable ideas in teachers' minds.

Our findings suggest that teachers' identities may influence how they take up and enact equitable teaching practices. Their varied conceptions of self, others, knowledge, and pedagogy reflect a shared commitment to fostering inclusive and supportive learning environments.

We recognize that listing multiple equity practices does not always equate to their consistent implementation. Our

findings suggest that teachers with more robust conceptions around equitable instruction tend to articulate a wider range of strategies for equitable instruction. These findings also suggest that equitable instruction in physics is not a one-size-fits-all approach, but rather an individualized and teacher-specific approach shaped by each teacher's unique perspectives and experiences. Future research could investigate how these diverse conceptions influence student outcomes and how teacher identity evolves in various contexts.

Also, our conceptual framework intentionally focuses on teachers' conceptions of equity as they relate to their views of self, students, knowledge, and pedagogy. We did not approach equity from a predetermined lens that prioritizes race, gender, or class, as we aimed to understand how teachers themselves define and take up equity in their teaching contexts. While we recognize that intersectional dimensions, such as race, gender, and social position, are deeply important in broader equity work, our study was designed to surface the variability in how equity is conceived and enacted by physics teachers, regardless of whether or how those social categories were addressed in their reflections. This decision allowed us to respect the integrity of participants' perspectives while also highlighting the diverse meanings that "equity" can carry within science instruction.

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