

A Look Physics Teacher Identity Around Equitable Instruction: The Tour Guide, Coach, and Gardener

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Studies show that a physics teacher's identity impacts how they teach. For teachers interested in pursuing diversity, equity, and inclusion practices in physics instruction, their identity likely informs how they conceptualize equitable instruction. We highlight three teacher identity cases from a data set of 25 interviews of secondary and university physics teachers to examine how they conceptualized equitable instruction through four domains: their conceptions of self, others, knowledge, and pedagogy. Selected teachers had distinct conceptualizations around enacting equitable instruction that we described across three metaphors: a tour guide, a coach, and a gardener. This study urges researchers to be more attentive to the varying dynamics of physics teacher identity and its impact on teacher practice.

Keywords: physics teacher identity, equity, teacher conceptions

I. INTRODUCTION

A teacher's identity influences practice and how they embrace reform efforts [1, 2]. This is why identity has been researched with the goal of helping teachers maximize effectiveness [2, 3, 4]. An examination of the literature on teacher identity [2, 5, 6,7] shows several consistent themes: (1) teacher identity is socially constructed; (2) teacher identity is dynamic; and (3) teacher identity is complex and multivariate, consisting of intersecting sub-identities. These sub-identities of teachers include: how they position themselves with a group; how they view what they teach; how they interact with students; how they feel about others; and how others feel about them. Also, other identity markers such as race, gender, and sexuality impact how teachers view themselves and their interactions with others. Within physics education, research on teacher identity is scant. Teacher identity has been primarily researched in social science disciplines, with a small amount in STEM disciplines. This paper will describe a study on the physics teacher identity of three teachers to understand the differences and dynamics of their conceptions of self, others, knowledge, and pedagogy. We expect our study to initiate the expansion of research on physics on teacher identity by introducing a new analytical lens on physics teacher identity toward equitable instruction.

II. ANALYTICAL FRAMEWORK

A. Physics Teacher Identity

Physics teacher identity refers to how one sees oneself as a physics teacher [8]. Teacher identity is important because it provides a lens to examine teachers' perspectives on "how to be, how to act, and how they view their place in society" [9]. Teacher identity is developed based on many factors, such as experiences, values, and interests. Identity is dynamic and can shift over time based on the influences of many internal and external factors [10].

In an analysis of focus group interviews of physics teachers who participated in a professional development workshop on equitable instruction [11], we found teachers had various perspectives on how equitable instruction is actualized. Taking inspiration both from this analysis and the culturally relevant theoretical framework [12, 16, 17, 18], we developed a new framework for physics teacher identity towards equitable instruction that consists of four domains: conceptions of *self*, *others*, *knowledge*, and *pedagogy*.

Conceptions of self focus on how physics teachers view themselves and their ability to teach for equity. A teacher's conception of self on equitable instruction can consist of their self-efficacy; pedagogical discontentment; their belief in the ability to: connect, motivate, inspire, and relate to

students; and their ability to reconcile their experiences with their beliefs towards their teaching.

Conceptions of others focus on physics teachers' view of their students. This includes teachers' views about students' abilities, including those related to cognitive processing of physics ideas, doing scientific and/or academic tasks, and epistemic strengths.

Conceptions of knowledge focus on physics teachers' views of canonical (content) knowledge. This can be examined in teachers' belief in objectivity in physics or their ability and/or willingness to problematize physics theories and ideas.

Conceptions of pedagogy focus on how teachers view their ability to teach for equity. This includes views of how equitable instruction is actualized through teachers' moves, student engagement, lesson planning, assessment design, and integrating content and scientific practices.

III. RESEARCH QUESTIONS

Conceptions about equitable instruction vary among teachers. The goal of our study is to unpack these different conceptions of how physics teachers develop equitable instruction. To do so, we answer two research questions: What are the different conceptions of physics teacher identity across self, others, pedagogy, and knowledge? How do teachers' definitions of equity intersect with their physics teacher identity?

IV. METHODS

A. Data Collection

A group of physics teachers (n=25) was selected for interviews based on demographics, years of experience, and gender. The teachers were interviewed through a semi-structured interview protocol that asked about their conceptions of self, others, knowledge, and pedagogy. Some interview questions were: "If you could describe your teaching identity, what would it be?; Why do you think some students struggle/fail?; Do you think physics knowledge is objective and free from bias?; What is the best approach for teaching equitable instruction? Why?" We selected these teachers based on educational role, race, gender, years of profession, and school demographics. The interviews were held online where they averaged around 60 minutes in length.

B. Data Analysis

We reviewed the data to identify similarities and differences across teachers. Using a multiple case study approach [13], we identified three teachers who exemplified different identity patterns to better conceptualize different constellations of physics teacher identity and their relationship to teaching for equity. Each

teacher was given a pseudonym: Leonard, Layla, and Ruby. We coded and analyzed videos using online software (Vosaic). Nvivo was used to analyze transcripts of teachers through thematic coding over several cycles. In our first coding cycle, we identified common conceptions and grouped them around self, others, knowledge, and pedagogy. This allowed us to identify common patterns across identities, which we applied to a second coding cycle that conceptualized different groupings of identity. Through the second coding cycle, we identified the different types of identity markers at a smaller grain across teachers' conceptions of self, others, knowledge, and pedagogy. For example, a teacher's conception of self could be one who values self-improvement. We later mapped these onto the metaphors of tour guide, coach, and gardener.

III. FINDINGS

After analyzing interview data, we found that teacher responses aligned with three metaphors for teaching identities: *tour guide*, *coach*, and *gardener*. Although we recognize that these groupings are not completely disparate, they reveal a pattern of types of identity along with definitions of equity. In the sections below, we introduce each teacher's case and their self-identified metaphor to better characterize different constellations of teacher identity.

A. Leonard the Tour Guide

Leonard is a white male university physics instructor with 15 years of teaching experience. He describes himself as a *"tour guide who is on a journey with students, helping them navigate a path to expand their physics knowledge."* Through this metaphor, Leonard sees himself as a teacher who helps visitors (students) navigate a terrain (physics knowledge). However, Leonard also shared that he is not perfect, and although he thought equitable teaching was an obtainable goal, he did not believe he had mastered it yet.

Leonard's tour guide analogy aligns with his conceptions of pedagogy. When asked to describe his teaching approach, Leonard described it as more lecture oriented, focused on explaining physics concepts and showing students skills for problem-solving. However, Leonard also shared teaching strategies that were more student-centered. When asked about teaching for equity, Leonard responded that he used strategies such as getting students to talk to each other through think-pair-share, working in groups to do quizzes and problem sets, and having class discussions around physics topics. Although Leonard's pedagogy was diverse, it largely aligned with a traditional didactic, teacher-as-knower stance, which positions students as blank slates [14].

Leonard believed all physics knowledge was correct and made of facts, adding: *"The stuff I teach is correct physics as far as humanity knows it today."* This corresponds with a traditional tour guide stance that shares facts which are

posited as truth rather than positioning knowledge as subjective or biased.

Leonard stated that he wants his students to succeed, *"however, they have a responsibility for their own learning."* Leonard explained further:

Students have responsibility for their own education. An unwilling student that's not motivated [to learn], that's on them, and it [the responsibility] should not be removed from them and given to the institution or the teacher.

When looking at this response through a tour guide metaphor, we can similarly find that tourists are responsible for what they take away from their guide's presentation.

Within the context of schooling, Leonard's response also speaks to his definition of equity. When Leonard was initially asked if he wanted to teach for equity, he responded in the affirmative, adding that it can be done in many ways if there is active learning and participation among students.

When he was later asked: "What is equitable student participation?" Leonard appeared confused, stating, *"[I'm] not sure how to interpret that question. I don't know what equitable student participation is."* Leonard further reflected: *"I think we should have opportunities for every student to participate if that's what you mean by equitable, fine. But that's not equitable participation; that's equitable opportunities."* Leonard said he expected all students to *"be vocal in class"* and that *"every student gets a chance to answer questions."* This stance was reiterated when Leonard agreed with the interviewer's definition of equity, *"students having the support and resources they need to thrive as whole humans in school—including academically, socially, and emotionally,"* however he added that he is for *"equal opportunity and participation, but that does not mean equal outcomes."* Much like a tour, the opportunity is the same for each visitor.

B. Layla the Coach

Layla is a white female high school physics teacher with ten years of teaching experience. Layla metaphorically described her teaching identity as a coach. She stated she wants to support and *"coach"* [students] through the learning process.

Her identity as a coach mapped onto how she thought of her students and of teaching. Layla stated that she wants students to feel comfortable within the classroom. She described pushing her students to embrace *"productive struggle"* in understanding physics. When thinking about pedagogy, Layla discussed readjusting the classroom to meet the individual needs of her students. She reflected:

I think that there are certain groups of people that in a science classroom can come [in] and automatically feel like they [...] play an important role in the science world. And then some people that feel like they have not been told that they play an important role. And so I

think part of equitable teaching is making sure that everybody feels like they have an important role to play, and so maybe not just support it in their learning of the material, but also support it in their identity as a scientist.

Later in the interview, Layla stated, “I’m not trying to convince everyone to be a scientist, but I want them in the science classroom to feel like they are a scientist.” Layla’s statements on wanting students to “feel” as if they are a scientist indicate a teaching focus on strengthening students’ perceptions of their capability of doing physics. In addition, Layla stated that she adjusts her teaching to the needs of the students, both individually and as a group, because students have different needs for learning. As a coach, Layla described wanting to foster improvement in each student and continually looking for better tactics to do so.

Regarding the discipline of physics, Layla described physics knowledge as a model to represent how the world works. Notably, she recognized the limitations of models due to human error and bias. Layla also viewed physics knowledge as a tool to understand and apply phenomena.

Layla described equity as related to respecting students and setting them up for success:

I definitely think [equity is] attainable in the sense that we can be at a place where we’re like: We are now honoring our students and supporting them and giving them the resources they need. For sure, but I think they’ll always be something you can do better.

Layla’s coach metaphor permeated her conceptions of self, other, and pedagogy. In addition, unlike Leonard, she recognized the sociocultural influence of knowledge and considered students’ individual needs when discussing equity.

C. Ruby the Gardener

Ruby is a white female physics teacher at a two-year college with 21 years of teaching experience. In describing her teaching identity, Ruby referred to herself as a gardener:

I care about [my students] as humans growing, as opposed to thinking of myself as some sort of test-giver...I try to foster growth in the students. I’m thinking of a garden: instead of weeding out students, I’m trying to have each little seedling grow.

In her conception of others, Ruby aligned with the gardener metaphor by recognizing that her students are diverse, each with their own experiences and perspectives. Ruby shared that many of these outside experiences cannot be controlled by the teacher and, therefore, can make it impossible to teach thoroughly for equity without changing those external systemic issues.

The garden metaphor also applies to Ruby’s conceptions of pedagogy. Ruby recognized that learning is not just about imparting knowledge but also about cultivating an environment that supports student growth and development.

She stated that she preferred student learning to be a community effort and not an individual task.

The importance of perspectives emerged in Ruby’s conception of knowledge, where she posited physics knowledge as biased and cultural:

Culture comes in [to] almost every aspect [of physics knowledge]: our own internal bias, confirmation bias, all of the biases that we have when we’re interpreting data. [...] Who gets to ask the research question? Who gets to focus the research? Who gets the money to ask their own research question? Who gets hired in the first place? Who even gets an interview?

Similar to Layla, Ruby understands the role of bias and its impacts on research and knowledge. However, she adds more complexity and criticality when describing the role of bias in physics knowledge creation. Ruby continues:

There is another set of barriers that are specifically aligned with the dominant culture, the white culture, and even the naming of our laws. Why are we naming them after people and not naming them for what they are [about]? [...] It’s because the people in power are the white males, and so every single physics law is after a white male. It’s amazing how illogical that is, even though you know there were Muslim men who actually discovered things before the white males that have their names on things. Even Ibn Sahl, for example [...] that should not be Snell’s Law, it should be Ibn Sahl. So it’s all Eurocentric, and every step of the way is biased. ..Oh, yeah, is it subjective? Absolutely.

Here Ruby explicitly names whiteness and provides a critical perspective that considers power asymmetries in regard to physics contributions. She names examples where white, European men’s names have been attached to concepts with non-European roots. This differs significantly from Leonard’s conception of objectivity in physics and a meritocratic definition of equity, as well as from Layla’s definition of bias as tied to human error and a more individualistic description of equity. Ruby’s statement indicates that she views the bias within physics as impacting what students learn. She acknowledges how the traditional physics canon is deemed credible and does not consider the different perspectives or contributions of individuals from non-Eurocentric communities.

Similar to her conceptions of knowledge, Ruby viewed issues of equity as systemic and larger than the classroom. She shared that outside factors, such as socioeconomic status, family background, and access to resources, can significantly impact a student’s ability to learn and succeed. Despite these challenges, Ruby shared a desire to provide a supportive and inclusive learning environment that helps all students to achieve their full potential. As such, Ruby sought to create a learning environment that meets students where they are and provides them with the resources and support they need to succeed. Ruby’s conceptions of her own role as a teacher, her students, teaching, and knowledge map to her gardener metaphor, in that she sees

the role outside factors play in education and knowledge creation. This metaphor includes an acknowledgment of the larger institutional and systemic factors at play in teaching and physics knowledge.

IV. DISCUSSION & CONCLUSION

Three metaphors emerged from our study to help us articulate some of the nuances of physics teacher identity across self, others, pedagogy, and knowledge. In addition, considering teachers' definitions of equity alongside these metaphors helps us consider the relationships among them.

A. Productivity of the Metaphors

The metaphors from the study help us better understand the interconnections across conceptions of identity. For example, implicit in each metaphor is a representation of one's perspective of self as a teacher: Leonard's tour guide metaphor aligned with taking students on a journey of learning; Layla's coach metaphor positions her as helping students in their learning; and Ruby's gardener metaphor situates her as wanting to support students in their growth.

These metaphors map onto pedagogical stances, with the tour guide representing a lecture-centric identity that positions the teacher as all-knowing. In contrast, the coach and gardener metaphors map to a student-centered practice, where teachers support student learning through scaffolding and feedback (coach) or providing the resources needed to thrive (gardener). The gardener metaphor also considers the classroom context, critiquing how cultural and systemic norms operate.

When viewing the three metaphors through teachers' conceptions of knowledge, we can also identify three different paradigms. Leonard believed physics knowledge was objective, aligning with a post-positivist lens. Layla recognized the utility of physics in modeling the world. She also noted how physics is created by humans and is rife with bias and limitations, aligning with a constructivist paradigm. Ruby discussed how physics knowledge was created in biased and Eurocentric systems, aligning with a constructivist and sociocultural paradigm along with a critical examination of power dynamics.

The metaphors help us understand how the different aspects of identity intersect. Leonard's tour guide metaphor conceptualizes a traditional stance that positions students as blank slates and teachers as knowers, with lectures as a central practice. In this stance, students are responsible for their own learning and success, and physics knowledge is positioned as an objective fact. Layla's coach metaphor conjures a constructivist and student-centered practice, where students are recognized as knowers with individual strengths, and physics models are tools that may include implicit bias. Ruby's garden metaphor recognizes the role external environments and systems have on education, critically looking at the role of power dynamics in how knowledge is created and taught. Although we recognize

that no teacher, even the three cases presented here, fit neatly into one category, the metaphors provide useful tools to critically examine the constellations of physics teachers' identity across different domains.

B. Defining Equity Across Metaphors

Teachers' understandings of equity significantly impact how they identify and describe their teaching. Leonard's definition of equity was closely aligned with equality. For example, Leonard stated that students fail to succeed as a result of their own poor work ethic, disregarding how systems of oppression play a role in dis/advantage and aligning with the myth of meritocracy [15].

Layla defined equity as providing students with the resources they need to be successful. In addition, she was aware of students' diverse identities and wanted to make sure students felt represented in the classroom. Layla's definition aligned with her metaphor of coach, where she believed in meeting students where they are and helping them improve. Unlike Leonard, she positioned student failure in her class as due to external factors, such as the need for more time with students. This belief aligned with other evidence of her self-reflective nature and her desire to improve.

Lastly, Ruby's definition of equity recognized how each student has unique strengths and needs and how outside factors play a role in teaching equitably. Unlike the other teachers, Ruby discussed systemic aspects of inequity. With a systematic perspective, Ruby acknowledged that she would never be able to become a completely equitable teacher but would strive to constantly improve. This perspective acknowledged outside factors, similar to Layla's concern with time, as playing significant roles in student success.

Although we recognize the power of using these metaphors to label teachers' identities and the relationship between identities and conceptions of equity, we also found identities to be fluid and non-binary. For example, besides didactic teaching examples, Leonard also shared student-centered practices, such as group work. We share these metaphors and their correlating definitions of equity to better conceptualize physics teachers' identities. We do not assume physics teachers' identities are static or neatly aligned into any one of the metaphors. Our intention is that these metaphors and teachers' varying definitions of equity provide helpful conceptual tools to frame future work in this space.

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