You Don’t Look Like a Physicist

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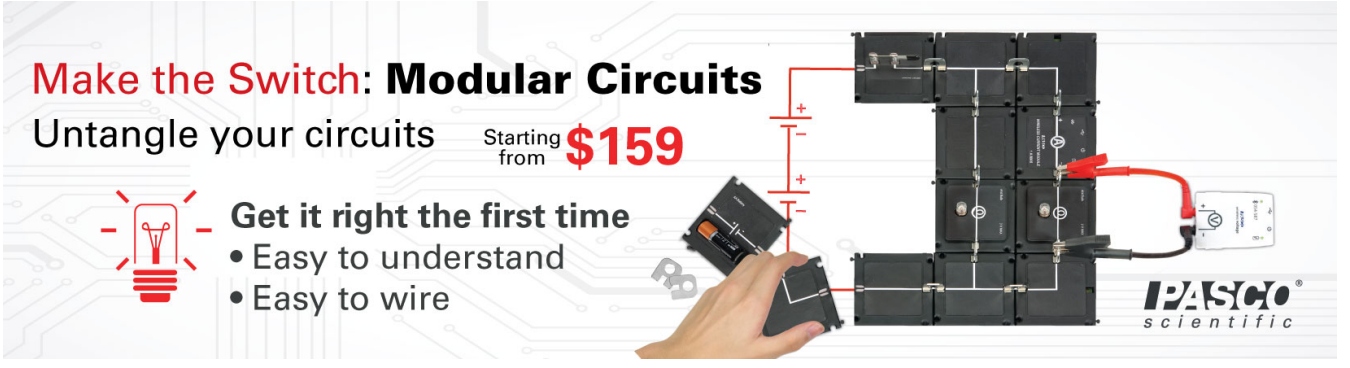

You Don't Look Like a Physicist

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

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"You don't look like a physicist!" "Sorry, this bus only goes to the university, Sir." "Where are you going, sir?" "So, you are a university professor? But a substitute one, aren't you?" "OK, you're a professor, but do you do research?" As a person of color teaching physics in Brazil, those are some comments that I usually hear. They are consequences of stereotypes, prejudices, and discrimination, which are related but different ideas.[1] Stereotypes indicate expectations and beliefs about an individual or a group, prejudice denotes feelings, and discrimination expresses behaviors. People are likely to be astonished whenever a Black person says that he or she is a physicist. This paper aims to raise awareness of the underrepresentation of Black physics professors and researchers in Brazil and how the lack of quality high school physics education impacts Black and poor students in Brazil. Finally, some considerations on how physics education can assist minority students in overcoming social barriers that contribute to their underrepresentation are presented.

Underrepresentation in Brazilian universities and research

• ***Underrepresentation among faculty.*** Black people (here "Black" refers to people who define themselves as Black or Brown) are still underrepresented in science and science education in Brazil, with physics being one of the fields of lowest participation. Although Black people in Brazil are not easy to map onto a U.S. racial category, we can give U.S. data on the U.S. racial category of Black people as a comparison. Brazil is even worse than the United States for racial underrepresentation at universities if we compare faculty members. For instance, in a 2013 study of faculty in the United States, "3% were Black males, 3% were Black females, 2% were Hispanic males, 2% were Hispanic females."[2] So U.S. Black faculty are an even higher percentage of total faculty than in Brazil, which is less than 2%,[3] with a lower representation in the total population (~13% in United States vs. 50.8% in Brazil).[4,5]

This holds true even when looking at individual institutions. A recent survey by Federal University of Juiz de Fora found that among the approximately 1000 faculty members, only 20 (or 2%) are Black.[6] Another Brazilian university, University of Brasilia, has 65 self-declared Black faculty among its 3670 faculty members (less than 2%).[3] Thus, it is not surprising that the number of Black faculty does not reach 2% of the national average in Brazil.[3]

• ***Underrepresentation in physics.*** There are no specific data of Black faculty in physics departments in Brazil, but, for instance, when I look around in the Physics Institute at Universidade Federal do Rio de Janeiro (UFRJ), it is clear that the broad majority of professors, maybe as high as 80%, are White and Asian men. The remainder of professors are mainly White women (a little less than 20%), with only a few men that are not White or Asian, and no Black or indigenous women, according to their phenotype. I have personally heard of no more than three Black women physicists in Brazil, though I am not aware of any sources that are tracking this information in higher education, either for students or faculty. For the sake of comparison, according to the National Science Foundation's *Women, Minorities and Persons with Disabilities in Science and Engineering* report,[7] 4.2% of physicists self-identified as Black as of 2012 in the United States, though less than 13% of the U.S. population were Black in 2010.[8]

• ***Underrepresentation in research.*** A study on the distributions of Black and White researchers in the Brazilian scientific system was carried out from the survey data on the payrolls of all fellows of the National Council for Scientific and Technological Development (CNPq), between March 2014 and January 2015.[9] This survey revealed disparities related to funding access for Black people, but did not provide specific data on Black physicists. Despite Brazilian federal policies developed in the last decades to increase diversity in higher education, data still point to the low participation of Black researchers in national science, as seen in Figs. 1 and 2. A quarter (25.6%) of registered fellows (students and researchers) in CNPq's research grant system self-identified as Black, from a total of 91,103 fellowships in all fields and levels throughout the country in January 2015. Figure 2 shows the distribution of CNPq fellowships to support studies of Brazilian fellows abroad. Although not shown in Figs. 1 and 2, participation is particularly low for Black women and it becomes

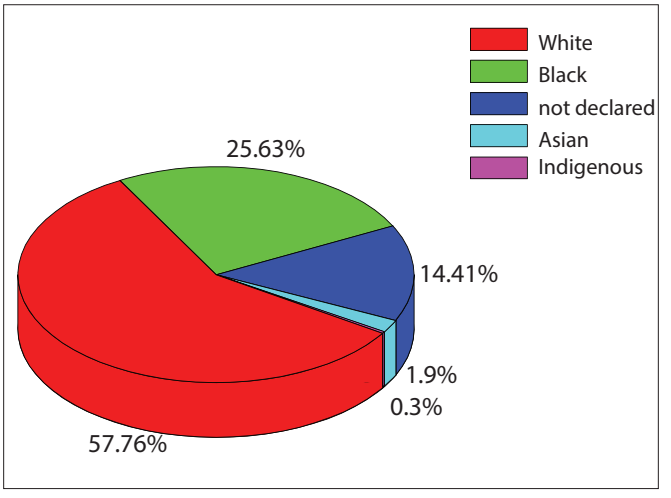

Fig. 1. Distribution of all CNPq fellowship recipients (students and researchers) according to their race/ethnicity.[9]

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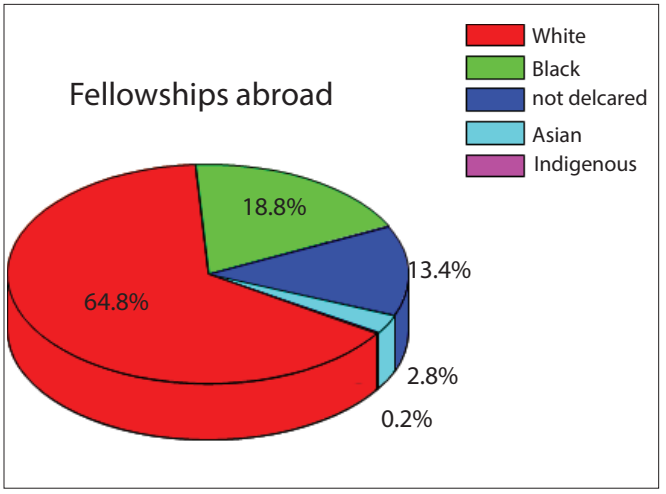

Fig. 2. Distribution of CNPq fellowship abroad (students and researchers) according to race /color.[9]

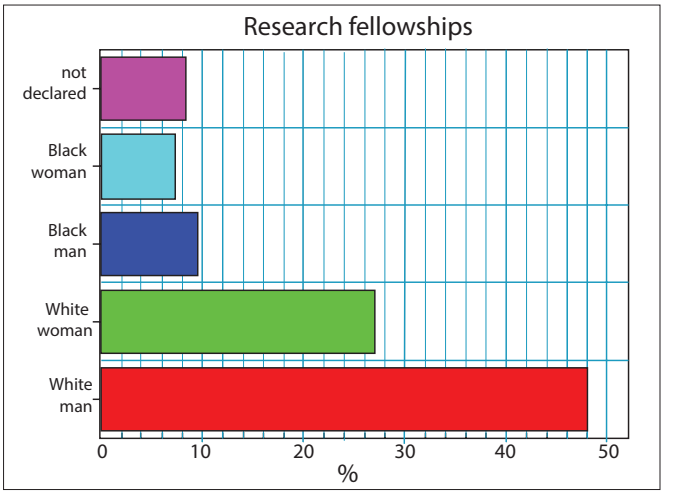

Fig. 3. Distribution of CNPq productivity research fellowships, awarded in January 2015, according to race and gender. The productivity research fellowships are the highest level of grants awarded by CNPq.

even lower when considering fellowships requiring higher levels of training, as discussed below.

The report shows that, when looking exclusively at fellowships awarded to the most productive scientists, the disparity is even bigger. Among the productivity researcher fellowships awarded in January 2015, more than 75% of the recipients were White (see Fig. 3). Additionally, according to Ref. 9, more than 64% of these fellowships were granted to men, bringing to light the gender disparities at the top of Brazilian science. White women correspond to, at least, 60% of CNPq's women fellows, while Black women are less than 27% and 13% did not declare their race. Among men who declared race, White men received more than four times as many productivity research fellowships as Black men. The involvement of Black researchers decreases as the level of training rises from fellows in both sexes. In total, 7% of researchers in the top productivity grant rank are Black women, and 9.5% of these researchers are Black men.

Relational issues facing Black students

Nasir[10] presents a framework to investigate racialized identities by means of the existing resources in contexts and cultures in which students learn. One of its components is the *ideational resources*,[10] which are a set of thoughts about oneself and one's relationship with a social group, and beliefs about what is appraised. Structural racism and group stereotypes give rise to stereotype threat, which accounts for the behavior of individuals in a manner that compromises their performance and supports the stereotype. Stereotype threat, i.e., the psychological threat a subject feels when faced with a performance that might reinforce the stereotype,[1] may help explain the low academic accomplishment among Black Brazilians. This susceptibility causes the subject to underachieve in high-stakes testing environments. For instance, in Brazil, as well as in the United States, Black students are usually perceived as being low skilled in physics and math, resulting in low levels of performance among these students due to this stereotype.[11]

There are often parallels with race and gender in stereotype threat research and thus it is likely that the race of the test proctor matters. It has been shown, for instance, that female students taking a math test achieved better scores when under the guardianship of a female test proctor who is presented as being highly skilled in math. Black students in Brazil will rarely have a Black proctor and thus will rarely be able to benefit from this effect. Women also reached better results when taking a math test under stereotype threat conditions after reading a newspaper article reporting an intelligent girl who excelled in math.[12] The frustration of being stereotyped in social interactions at universities can lead to students not getting the same access to critical resources necessary to succeed.[13] Physics culture is specifically unwelcoming for Black women, obliging them to struggle perpetually with the implications of race and gender identities.[7]

Additionally, the concepts of "whiteness,"[13] an ideology tied to social status, i.e., a system socially and politically constructed of privilege to people identified as White, that reveals itself in education through ideas of "colorblindness," may also be responsible for the low performance of Black students. In sociology, colorblindness is an expression for the neglect of social bias associated to racial characteristics. Colorblindness operates as misjudged privilege, due to one's lack of ability to acknowledge structural barriers that Black students face. Black students, especially Black women in physics, relentlessly face moments where their aptitudes are challenged, causing them to feel the need to prove their intelligence.

Access to physics education

Ensuring racial and socioeconomic equity is crucial in affording equal opportunities in our society. In Brazilian high schools, although it is a mandatory part of the curriculum, quality physics classes tend to be accessible only to middle- and upper-class students, due to the lack of quali-

fied physics teachers. There are strong ties between race and socioeconomic class in Brazil; this means that Black students are disproportionately affected by this fact. As a consequence, they stay behind as an untapped supply in fulfilling the scientific and technological positions available in society. Even for non-majors in physics, physics is a gatekeeper[14] because success on the physics university entrance exam is required to enter high demand courses, even with high grades in other subjects.

It has been observed that physics is one of the critical areas where the number of high school physics teacher graduates (14,247 during the years 2002 and 2010) in Brazil[15] is far below the estimated demand (55,231) for the same time period, especially if we consider that these graduates will not necessarily work as teachers. One aspect not considered yet is how the number of physics graduates are distributed among the different schools compared with the demand for teachers.

This lack of availability of physics courses for secondary students affects deeply the *relational resources*, i.e., the means in which a positive rapport with people in the field is able to boost one's relationship with that subject.[10] For example, some students attribute their interest in physics to their high school teachers. In addition, my personal experience and perception have shown that having a physicist or a physics teacher in one's family affects positively the choice of pursuing a career in physics, an analogy with a bosonic system, i.e., the aggregation of individuals in the same state, which is a characteristic of particles obeying Bose–Einstein statistics.

Some defenders of meritocracy claim that the higher the social and economic development of the students, the lesser the effect of social origin on their trajectories and results in education.[16] However, it has been acknowledged that the educational system is not an equal opportunity producer.[17,18] More recently, studies have shown that even taking into account social class and income, racial inequality plays a fundamental role in the Brazilian educational system.[19]

Implications for physics teaching: What teachers and physics education researchers can do

Some physics education literature devoted to elementary school teachers and secondary and/or college students have focused on their reasoning abilities (see for instance Refs. 20 and 21), but neglected their social background and/or racial or ethnic background. Physics is a tool for appreciating the world around us, and, as far as the underrepresented students are concerned, physics education can assist them in overcoming social forces that subsidize their devaluation. Research shows that practices which point teachers' consideration to identity and empowerment within STEM (science, technology, engineering, and math) classrooms can address this gap in school performance by establishing positive outcomes for students.[22]

Contact with role models can contribute to the reduction of stereotype threat.[1] Role models who work hard, conveying the idea that struggling and persistence are part of one's routine, are the most successful ones. The go-getter who succeeds through determination and tenacity is more positive to the student. On the other hand, role models who are seen as geniuses and who accomplish by endowment instead of endurance are less inspiring and not effective. Low-esteem high school or college students can be encouraged, for instance, to watch videos where a Black physicist or teacher plays a role. Also, videos in which Black physicists and teachers acknowledge having professional and scholastic drawbacks can be very effective.[1]

The physical environment and infrastructure are also important keys to student achievement. Some people deny the importance of role models in their lives—*relational resources*—and describe themselves as "Called by the Universe." However, digging deeper we may find that they were exposed to *material resources*,[10] i.e., the ways in which the physical environment (science museums, physics laboratories, etc.) and artifacts (physics toys, games) support our connection with a subject.

In addition, fostering friendly and collaborative environments and discouraging competitive ones are positive practices for low-esteem students. Finally, providing both academic and non-academic support may help students to succeed in STEM fields.[22]

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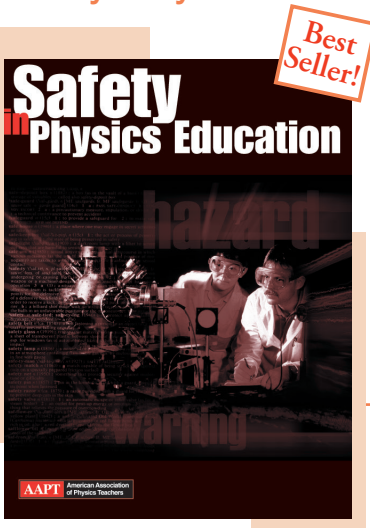

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