Addressing Racism in Human Genetics and Genomics Education

Julia Svoboda Gouvea*
Tufts University, Medford, MA, 02155

ABSTRACT

This installment of *Current Insights* summarizes recent research and scholarship in genetics and genomics education in order to stimulate critical discussions of the impact of genetics and genomics education on scientific racism. While it has been uncommon for genetics instruction to address issues of race explicitly, researchers suggest that a more humane, anti-racist approach to genetics and genomics education is needed and have begun to describe what it might look like. The articles in this set draw attention to the ongoing need for instructional design, careful research, and critical scholarship addressing racism in human genetics and genomics education.

INTRODUCTION

The science of human genetics has a fraught history. As many of us are aware, false beliefs about genetic differences among humans have long been used to justify racialized oppression, undermining both scientific progress and social justice (Norton *et al.*, 2019; Visintainer, 2022). Despite advances in our scientific understanding of the human genome and of human populations, problematic ideas about human genetics remain pervasive. As Visintainer (2022) explains in a recent essay, racialized conceptions of the genetic basis of intelligence continue to feed white supremacist ideology today. At the same time, opportunities for science students and science teachers to understand why these ideas are false and dangerous continue to be limited in science education. Worse, there is evidence that science education may foster problematic beliefs by teaching genetics without critical attention to how the science intersects with ideas about race and racism (e.g., Morning, 2008; Donovan, 2014).

In this *Current Insights*, I discuss three recently published articles to highlight the pressing need for critical scholarship and anti-racist research at the intersection of human genetics and education. In the first paper, Donovan and colleagues (2021) present *humane genomics literacy* as an anti-racist learning objective for biology education. The next two papers illustrate well-intentioned work that falls short of this goal—Zimmerman *et al.* (2022), by engaging students with personal genomic data without providing them with tools to understand how these data are linked with historical and ongoing racialized oppression, and Archila *et al.* (2022), by presenting ideas about the genetic basis of race as a legitimate scientific “controversy.” In what follows, I briefly summarize each article, and use Donovan and colleagues’ concept of *humane genomics literacy* to critically examine how the work does or does not further the aim of refuting and reducing scientific racism.

THE NEED FOR HUMANE GENOMICS LITERACY

Donovan, B. M., Weindling, M., Salazar, B., Duncan, A., Stuhlsatz, M., & Keck, P. (2021). Genomics literacy matters: Supporting the development of genomics literacy through genetics education could reduce the prevalence of genetic essentialism. *Journal of Research in Science Teaching, 58*(4), 520–550. https://doi.org/10.1002/tea.21670

CBE Life Sci Educ December 1, 2022 21:fe5
DOI:10.1187/cbe.22-09-0188

This feature is designed to point *CBE—Life Sciences Education* readers to current or noteworthy articles for life science educators and education researchers. We invite readers to suggest current themes or articles of interest in life science education as well as influential papers published in the more distant past or in the broader field of education research to be featured in *Current Insights*.

*Address correspondence to: Julia Svoboda Gouvea (julia.gouvea@tufts.edu).

In this paper, Donovan and colleagues examine the impact of education on genetic essentialism—the false belief that "people of the same race share some set of genes that make them physically, cognitively, and behaviorally uniform, but different from other races" (Donovan *et al.*, 2021, p. 521). The authors propose *genomics literacy* as an antidote to genetic essentialism and distinguish between two conceptions of genomics literacy: standard genomics literacy (SGL) includes basic biological knowledge about the genetic basis of traits and population-level variation. For example, the understanding that skin color is controlled by many genes would be considered an aspect of SGL. Humane genomics literacy (HGL) includes, in addition to SGL concepts, *how to apply* these ideas to dismantle incorrect racist ideas. For example, to use the knowledge that there is more variation within human populations than between populations to counter false ideas about the genetic basis of racial categories.

In this study, the research team designed a 45-minute computer tutorial that presented high school students with data about genetic variation in human populations and race. Students were first presented with hypothetical data that illustrated what population data supporting or refuting discrete racial categories would look like. Then students were presented with data from real human populations (from Rosenberg, 2011) and were asked to craft arguments about the extent to which the real data supported or refuted claims about genetic differences among races. Further, students were asked to critique an essentialist argument made by a fictional character (for more details, see Donovan *et al.*, 2019).

Before the intervention, researchers measured students' baseline SGL and several covariates, including the students' self-identified race and ideas about the nature of intelligence. Using an individually randomized design, students from five different high schools received either the human variation tutorial or a control tutorial about climate variation. Researchers measured the impact of the interventions on students' *perceptions of human variation* and agreement with *genetic essentialist* statements.

Controlling for baseline SGL, the intervention increased students' scores on both measures. Researchers also found an interaction between the intervention and SGL; with higher baseline SGL, the treatment had more effect on students' scores. The authors explain that high SGL may have helped students better read and understand the intervention materials. They also conjecture that students with higher SGL may have experienced less "ego threat" in response to having their beliefs challenged. Donovan and co-authors caution that high SGL alone does not appear counter genetic essentialist beliefs (i.e., many students in the control with high SGL agreed with essentialist statements), suggesting that simply teaching students about genetics, without explicit attention to how it applies to ideas about human race, will be insufficient to reduce potentially problematic beliefs.

While this exploratory study offers a valuable information about the links between genetics knowledge and the efficacy of this short intervention, it also draws attention to the additional work needed to help students develop humane genomics literacy. New curricular designs and research will be needed to understand how to develop students' capacities to critically reason about the relationships between human genomics research and racism.

WHAT YOUTH DO AND DO NOT LEARN FROM PERSONALIZED GENOMICS

Zimmerman, H. T., Weible, J. L., Wright, E. A., Vanderhoof, C., & Jablonski, N. G. (2022). Using youths' personal DNA data in science camps: Fostering genetics learning and socio-emotional attitudes toward science with design-based research. *Science Education, 106*(4), 767–796. https://doi.org/10.1002/sce.21709

Zimmerman and colleagues report on the design and study of a science summer camp for youth (ages 10–14) that featured explorations of their own genomes (using 23andMe) and family histories, among other activities. One of the core conjectures of the research team was that working with one's own genetic data would be engaging for youth. A second conjecture was that completing activities and reflections in a workbook would support content learning and increase engagement.

The summer camp was run twice, once in 2016 at two sites and again the following summer at five sites across the United States. The second iteration of the camps included some changes to the curriculum, assessments, and study structure. Most notably, in the second year, youth at one of the camp sites worked with case study DNA data rather than their own data. Each camp enrolled ~20 participants on average, and camps at different geographic locations attracted students from different communities with different background knowledge and different proportions of self-reported races/ethnicities. Across all camps, researchers collected youths' workbooks and their responses to assessments of genetics content knowledge and affinities for science.

At all sites except the one at which students explored case-study DNA instead of their own, researchers found increases in youths' scores on the genetics knowledge instruments. While scores did increase at this camp, the increase was not significant. The authors use these results to suggest that working with their own DNA led to deeper conceptual engagement for youth. Additionally, youth at all sites reported increased positive affiliation with science after the camp. While this result was not surprising, given that the camp attracted science-interested youth, the authors note that the effect size was larger than that reported for other summer science camps. At none of the camps did engagement in the workbook correlate with knowledge or affiliation gains.

Viewing this work from the perspective of HGL reveals limitations that the authors acknowledge are critical to consider. First, while the camp produced gains in content knowledge (corresponding to SGL), it did not provide youth with opportunities to apply that knowledge to make sense of how genetics concepts connected to race or racism. Thus, youth were unlikely to develop the HGL needed to make sense of how their own genetic information could be used by others to make false claims about them or their communities. Moreover, while the camp engaged students in activities about their families' histories, including information about enslaved ancestors, the authors acknowledge that the curriculum fell short of supporting youth in understanding "the relationship between science, equity, and justice" (p. 792). The research team describes plans to integrate scholarship on culturally relevant pedagogy and race to support students more thoroughly in grappling with the intersection of genomics and racism.

ARGUING ABOUT RACE DOES NOT REDUCE RACIST BELIEFS

Archila, P. A., Molina, J., Danies, G., Truscott de Mejía, A. M., & Restrepo, S. (2022). Using the controversy over human race to introduce students to the identification and the evaluation of arguments. *Science and Education, 31*(4), 861–892. https://doi.org/10.1007/s11191-021-00299-8

Archila and colleagues describe an interest in developing "critical thinkers" who are open-minded, able to reason with evidence, and willing to critically engage with and revise arguments. In this study, the authors aim to explore how identifying and evaluating arguments can stimulate critical thought and exploration of ethical dilemmas. The dilemma they chose to explore with undergraduate students concerns the biological significance of the term "race" in human populations. Referencing the work of Donovan and colleagues, Archila and colleagues link misunderstandings of the biology of race to scientific racism. They propose that, by engaging with arguments about the concept of race in humans, they may be able to stimulate critical thinking in their students, with the ultimate aim of reducing incorrect ideas that are used to support racist views.

The researchers introduced students to the biological basis of race as a "controversy" by presenting them with a fictional dialogue between two scientists (originally published in Beckwith *et al.*, 2017). As summarized by the authors, in the dialogue, "Jon argues that 'race' has no biological basis. Tobi disagrees, arguing that there are distinct biological races that can be separated on the basis of physical characteristics and genetic information" (p. 870). Before the dialogue activity, students answered a question about whether they believed the concept of race applied to humans and why. Then they listened to the dialogue (read aloud by other students) and were instructed to identify (by underlining) the arguments posed by each scientist. Students were asked to evaluate and explain the extent to which the claims were "solid" and then to reanswer the first question about the significance of race in human populations.

The researchers found that engagement in the "two scientists dialogue" did not change students' views about the genetic basis of race in humans. Initially, most students (73 out of 117) agreed that a biological concept of race is applicable to humans. After the intervention, very few (five out of 73) students changed their views, and most students (101 out of 117), regardless of whether they agreed or disagreed with this idea, provided expanded reasoning to support their views, apparently taking up elements of Jon's and Tobi's arguments (e.g., "he [Tobi] highlights the possible benefit of classifying humans into 5 races") (Table 4, p. 877).

While the authors claim that the intervention could be viewed as successful because it engaged students in argumentation, this interpretation is at odds with the goal of humane genomics literacy. After engaging with this dialogue, many students continued to claim that the concept of race was applicable to humans using the incorrect and misleading ideas presented in Tobi's fictional argument. Donovan and colleagues caution that engaging with ideas that emphasize the existence and utility of genetic differences in human populations can reinforce ideas about genetic essentialism that feed racist beliefs. It appears that the dialogue intervention had this sort of negative effect: Students' false and problematic beliefs remained unchanged or were potentially strengthened by this intervention.

It is worth considering how the design of the intervention may have unintentionally led to this outcome. First, presenting the argument as a "dialogue between two scientists" put Jon and Tobi on equal footing as experts, even though many of Tobi's arguments were either false or misleading. For example, Tobi argues that "scientists long ago established that there are 5 distinct races" (Beckwith *et al.*, 2017, p. 531) and that "maybe, races differ in their personalities and their abilities" (Beckwith *et al.*, 2017, p. 532). Second, while Jon raises important questions and concerns, Tobi never acknowledges or engages with them, further portraying the two sides as equivalent. For much of the dialogue, Tobi and Jon appear to be talking past one another, and the dialogue ends without resolution. It is easy to see how students could use either argument to support their initial views, including the view that race may in fact have a defensible and meaningful biological basis. The use of this dialogue by Archila and colleagues illustrates the pitfalls of framing discussions of human genetics and genomics as a simple "controversy." Presenting two equivalent perspectives undermines the goal of critical thinking by allowing false claims, biased interpretations, and historical ignorance to stand as a reasonable viewpoint for a scientific expert.

IMPLICATIONS FOR THE BIOLOGY EDUCATION RESEARCH COMMUNITY

For biology educators and researchers, Donovan and colleagues' distinction between *standard* and *humane* genomics literacy can be used to critically consider the goals and designs of genetics curriculum and instruction. Applying HGL to the intervention designed by Donovan and colleagues reveals its modest success. While engaging with the tutorial decreased students' agreement with essentialist beliefs, it did not (yet) showcase students actively applying genomics concepts to reason about or refute scientific racism. Applied to the study by Zimmerman and colleagues, the concept of HGL points to the limitations of curricular designs that do not create opportunities to explicitly interrogate the links between human genetics and racism. Finally, the intervention used by Archila and colleagues, based on the dialogue designed by Beckwith *et al.* (2017), failed to support HGL, and may have reinforced racist beliefs. Interestingly, both the Donovan and colleagues' and Archila and colleagues' interventions employed the design principle of *contrast* but found opposite effects. The specifics of how they used contrasts helps explain these different outcomes. Donovan and colleagues engaged students with data and scaffolded their ability to interpret how population data do and do not support claims about racial difference (for more details, see Donovan *et al.*, 2019), whereas Archila and colleagues only presented (fictional) scientists' claims and their own interpretations of the data, potentially communicating a false equivalence to students.

As a collection, these studies highlight the challenges of engaging with this "contested terrain," yet as argued by Visintainer (2022), rather than shy away from this challenge, science educators, and biology educators in particular, have a responsibility to continue to work toward effective anti-racist genetics and genomics education.

REFERENCES

Beckwith, J., Bergman, K., Carson, M., Doerr, T., Geller, L., Pierce, R., ... & Zichterman, C. (2017). Using dialogues to explore throughout history, people have used the concept of race to sort human beings into different groups. *Dialoguing to Learn*, *79*(7), 525–537.

Donovan, B. M. (2014). Playing with fire? The impact of the hidden curriculum in school genetics on essentialist conceptions of race. *Journal of Research in Science Teaching*, *51*(4), 462–496. https://doi.org/10.1002/tea.21138

Donovan, B. M., Semmens, R., Keck, P., Brimhall, E., Busch, K. C., Weindling, M., ... & Salazar, B. (2019). Toward a more humane genetics education: Learning about the social and quantitative complexities of human genetic variation research could reduce racial bias in adolescent and adult populations. *Science Education*, *103*(3), 529–560. https://doi.org/10.1002/sce.21506

Morning, A. (2008). Reconstructing race in science and society: Biology textbooks, 1952–2002. *American Journal of Sociology*, *114*(Suppl 1), S106–S137. https://doi.org/10.1086/592206

Norton, H. L., Quillen, E. E., Bigham, A. W., Pearson, L. N., & Dunsworth, H. (2019). Human races are not like dog breeds: Refuting a racist analogy. *Evolution: Education and Outreach*, *12*(1), 1–20. https://doi.org/10.1186/s12052-019-0109-y

Rosenberg, N. A. (2011). A population-genetic perspective on the similarities and differences among worldwide human populations. *Human Biology*, *83*(6), 659–684. https://doi.org/10.3378/027.083.0601.A

Visintainer, T. (2022). Engaging the racist science of human intelligence: Towards a more just science education future. *Journal of Research in Science Teaching*, *59*(8), 1489–1492. https://doi.org/10.1002/tea.21804