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Talking about Race in a Scientific Context*

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ABSTRACT: *There are at least two approaches that assist students in understanding complexity and differing interpretations about human diversity and race. Because differing perspectives emerge from data perceived at different levels, different scales provide a tool for understanding relationships among perspectives and understanding the differential importance of specific factors. Constructivist listening, which assists students in examining their own experiences, feelings and understanding, provides a tool for digesting complex new material and learning emotional literacy. It can be applied to dialogue about race and to classroom situations. These approaches can help students master the conceptual and interpersonal skills needed for successful scientific practice.*

INTRODUCTION

Discussions of human diversity and race on college campuses in the USA are opportunities to discover the impact of widely differing experiences on different people and to consider how these generate or affect divergent views expressed in these communities. This paper focuses on what we who teach natural sciences at the collegiate level can do to assist students to examine what they believe about human diversity. The goals of my approach are two: first, to engage individuals to consider complexity and relationships among contrasting views, and second, to engage both cognitive and affective responses to go beyond polite discourse that acknowledges

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difference but often fails to move its participants toward mutual understanding or sympathy.[1]

Why are these issues important to communicating science and ethical values in science? First, as future professionals and leaders who will influence and implement policy, college science students must be able to understand—not merely acknowledge—a wide array of considerations, including the interests of stakeholders of differing backgrounds and enfranchisement. Education can address cognitive aspects of these issues by providing information and theory about history, social systems, ethics, etc. In addition, effective education must also provide opportunities for students to examine their affective responses, because attitudinal barriers occur even among the well-intentioned,[2] and among those targeted by racism who have unconsciously internalized racist attitudes.[3]

Second, the perception of science as an enterprise affects how well scientific approaches and scientists are trusted by different groups. It affects recruitment of young scientists of diverse backgrounds. More importantly, it influences many people who will not earn their living as scientists, but who are asked to make complex decisions, and who may decide that problem solving approaches based on scientific principles are irrelevant to their lives and decisions.[4,5]

This paper describes applications of two approaches to classroom discussions of human biological diversity and it consequences. Applications of the concept of scale provide a way to examine relationships among different observations. This approach is widely applied in many fields of science and engineering—including my own, ecology[6,7]—to identify the differential relevance of specific factors when interactions with a complex phenomenon occur on different scales. Applications of constructivist listening provide a way for students to assist each other to process feelings related to learning complex, potentially confusing material. This approach also helps students to share their feelings in a non-judgmental setting, to reflect on relationships between their attitudes and experiences and those expressed by others, and to practice listening skills essential to effective leadership and teamwork.

SCALE

Microscopes and telescopes enable us to observe objects and events on vastly different scales from what is visible to us without aid. Events and phenomena occur at microscopic and telescopic spatial scales simultaneously, as do phenomena at geological and atomic time scales, even though we are usually unable to observe them in everyday life. To consider an example of differences of scale that are less extreme, we can compare our observations of ocean waves from an airplane flying at 10 km altitude versus observations from a vantage point on the beach. From the airplane, we can see a regularly textured ocean surface that changes when large ocean swells approach the shoreline and break on the beach. We may be able to see visual contrast between currents and other water but we are unable to resolve individual waves. By contrast, standing on a beach, we observe individual swells arrive successively and break on the beach. From our position on the beach we cannot simultaneously see more than a few swells, but we can infer their regular spacing at sea by their periodic arrival on shore. From the beach it is often difficult to distinguish current flow from other areas.

What appear as the most conspicuous features of a phenomenon depend on the scale on which the phenomenon is perceived.[6,7] Being on the beach does not merely magnify waves. In this example, different features are important when we observe from the beach (large, noisy, individual waves arrive periodically and are sufficiently powerful to knock us off our feet; water is so turbulent and heterogeneous it is difficult to distinguish undertow currents) versus 10 km altitude (a soundless, regular pattern of ocean surface texture, areas of different water color marking current flow).

Many examples occur in the biological sciences. For example, leaf surfaces that appear smooth to our eyes emerge at micrometer scale as the equivalents of high plateaux and deep valleys for microbes living on the leaf surface.[8] In another example, molecular biologists have puzzled over the evolutionary origins of redundancy in the three-letter nucleic acid code for amino acids, the building blocks of proteins. Given 64 possible 3-letter combinations of four nucleotide bases, why do the 64 combinations code for only 20 amino acids? Accounting for duplications when these 64 combinations of 3-bases are read in either direction (in contrast with the modern code, which is read in only one direction), reveals exactly 20 unique combinations,[9] thus generating one plausible hypothesis for the observed redundancy. In an example examining effects of different-sized isolated plots on population processes of vertebrates and plants of differing size and reproductive modes, there was no universal agreement on plot size needed to maintain population persistence. The contrasting results suggest that organisms are differentially sensitive or respond differentially to specific features of their shared habitat.[10]

HUMAN BIOLOGICAL DIVERSITY AT DIFFERENT SCALES

Discussions of human biological diversity have often concerned relationships and presumed hierachies of evolutionary advancement among human groups and their hominid ancestors (for example[11,12]) or predispositions for physiological conditions that compromise individuals' lives (for example[13,14]). Viewing human diversity on different biological scales shows that what is conspicuous to us on a scale of phenotype (observable traits) may obscure far greater diversity on a genotypic scale (genetic code of the individual), or collapse into fewer categories on a social scale where social consequences of phenotypic differences are considered (Table 1, part A, see p. 488).

In addition, considering differing time scales shows that changing environments over time may alter the advantage of one phenotype relative to another, consequently changing the effects of differences on one scale (genotypic) on others (phenotypic and

Table 1. Human Diversity Viewed at Different Scales

Part A. Human Genetic Variation and Its Phenotypic and Social Consequences

Social	Trait	Phenotype	Genotype	Reference
1. obesity, diabetes requiring medical intervention in homozygotes	carbohydrate metabolism & storage	2 phenotypes: normal & affected	missense mutation Trp64Arg; homozygotes are affected; 3 genotypes	(15,19)
2. severe anemia in S homozygotes; malaria resistence in heterozygotes	hemoglobins A, S & C	3 phenotypes normal, sickle trait & sickle cell anemia	6 genotypes	(13)
3. mild anemia in homozygotes; malaria resistance in heterozygotes	hemoglobin E	3 phenotypes	3 genotypes	(13)
4. severe anemia in homozygotes, malaria resistance in heterozygotes	thalassemia	3 phenotypes	multiple loci, multiple alleles[1]	(13)
5. malaria resistance in heterozygotes	deficiency of glucose-6-phosphate dehydrogenase	2 phenotypes normal & deficient	2 genotypes	(13)
6. inability to distinguish red and green	red-green color blindness	2 common phenotypes (normal & affected), but many relatively rare phenotypes	multiple loci, multiple alleles	(20,21)

Table 1: Part B. Human Skin Color Variation and Its Social Consequences

Social	Trait	Phenotypic	Genotypic	Reference
7. "1 drop of blood makes a man of color [black]"	skin color	continuous variation	probable multiple loci & alleles	(22, 36)
8. skin color hierarchy	skin color	continuous variation	probable multiple loci & alleles	(22, 36)
9. "race"	skin color	continuous wide range of variation	probable multiple loci & alleles	(1, 2, 23, 24)
10. "race"	ethnicity	multiple differences in many traits in addition to skin color	probable multiple loci & alleles	(1, 25, 26, 27)

[1] Alleles = genes are alternative substitutes at a genetic locus for a specific trait.

Table 1. Human diversity viewed on different scales.
Part A. Human Genetic Variation and Its Phenotypic and Social Consequences. Phenotypes (observable physical categories) often encompass a far greater number of genotypes (genetic variants) but collapse into a few categories on a social scale.

Part B. Human Skin Color Variation and Its Social Consequences. The social scale encompasses two traits—skin color and ethnicity—which are each equated with "race". The legal foundations of present-day conventions in the USA and much of the Caribbean arise from the Code Noir, or Black Code. This body of law, promulgated about 1685 during the reign of Louis XIV of France, defined varying degrees of African and European heritage, and defined which mixtures were eligible for freedom in Haiti. In the early days of the Code, marriage of a slave to her owner freed the woman and her children. But later, only whites could be free, and a man who was 127 parts white and 1 part black ("one drop of blood") was still a man of color and not entitled to freedom.[23] This mixture represents 7 generations. Thomas Jefferson, in the late eighteenth century, used a less restrictive definition, that i.e., a mixture of 7 to 1 (3 generations) was white.[37] In the USA today, light skinned African Americans may often be considered black, while in Haiti and much of the Caribbean, a hierarchy among the many skin colors operates, with the darkest-skinned African heritage people at the bottom of the hierarchy.[23, 24]

social). For example, diabetes and obesity, often considered metabolic "diseases" with genetic components, may be "thrifty genotypes rendered detrimental by progress" in relatively recent times of carbohydrate surplus.[15-19] Similarly, at longer time and broader geographic scales, the substantial phenotypic and social consequences of genetic "diseases" of the blood such as sickle cell anemia and thalassemia emerge as consequences of natural selection for genetic adaptations evolved by humans of many ethnicities against malarial parasites.[12,13] A discussion of human genetic diversity is less vulnerable to labels of "better and worse" or "advanced and primitive" when it shows that on some scales humans are so nearly identical that physiological data about color vision from one ethnic group may be generalized to all humans, but on other scales, these same traits are enormously diverse among humans.[14,20,21] This diversity leads to the recognition that genetic "diseases" are so widespread among humans since almost everyone is a carrier (heterozygote) of genes for at least one of thousands of such conditions.[12,13] The concept of scale offers students a way to approach this complex topic, and to appreciate cause-effect relationships between entities and events on different levels.

On a given scale, some features of a phenomenon are more prominent than others. Table 1 Part B shows that for the same skin color genotypes and phenotypes, there are at least several ways to view the social consequences of variation in skin color. The term "race" is construed differently by people who experience racism in widely differing ways. To many US-born black people of African heritage, who were systematically stripped of their ethnic languages and cultures by the slave trade,[22] oppression based on "race" is directly connected with skin color.[1,23,24] However, for many white people in North America and Europe, oppression based on "race" is experienced in connection with "ethnicity" rather than with skin color.[1,12,25-27] Many Asians and Latino/as grow up in specific ethnic cultures where racism in the ancestral culture was experienced in relation to ethnicity, but they now experience racism in the USA as related to their skin color.[1]

There are striking similarities between inter-ethnic oppression in one social system and oppression based on skin color in another.[12,26,27] However, these contrasting meanings of "race" correspond to different biological scales because a given skin color category includes many ethnic groups.[12-14,23] Miscommunication may commonly arise in dialogue between white and non-white participants in the USA if their widely differing experiences lead each to think of "race" on a different scale and to misunderstand what aspect of race—skin color or ethnicity—is centrally important to the other. Understanding that both views of race occur simultaneously, that neither is correct to the exclusion of the other, may permit discussion to proceed beyond mutual agreement to disagree towards mutual engagement and understanding.[1]

CONSTRUCTIVIST LISTENING AS A TOOL TO ENHANCE UNDERSTANDING

Constructivist listening is peer listening in pairs or a small group whereby participants take turns to respond to material in both cognitive and affective ways with the goal of constructing one's own understanding.[29] In a supportive context, students (and teachers) reflect and release feelings by talking, laughing, crying, shaking, yawning, etc.,[3,29] "the expressive aspect of affect".[30,31] After processing some feelings in this way, participants can contribute to later discussion based on thinking, rather than on unexamined feelings or undigested confusion.[29,30,32,33] Because affective processes can interfere with access to cognition,[31] release of feelings can assist thinking and may facilitiate reassessment of previously held thinking, attitudes or understanding of unfamiliar information.[3,30,32,34] Students can then think freshly about conflicting viewpoints or evidence, incorporate new data into familiar concepts, and evaluate familiar conceptual frameworks in light of new data, whether these data and frameworks concern science or relationships with people.[29] Students also learn to listen with awareness to acknowledge their own feelings, to respect confidentiality related to feelings,[3,29,33] and to move beyond memorizing to construct their own understanding of cause-effect relationships.

Re-evaluating one's feelings and thinking are useful in a scientific context. In scientific research, I work with the sure knowledge that what is correct today (my observations and interpretations) will almost certainly be corrected, or more frequently recontextualized in a different conceptual framework, at a future time. (For example, Newtonian principles of physics were not made wrong by quantum mechanics, but they were recontextualized because Newtonian physics operate only on some spatial and temporal scales.) Teaching novice scientists to reflect and reassess their previous understanding in light of new data assists them in exposing underlying assumptions, clarifying sources of confusion, and identifying sources of motivation.[29,30,33,34]

APPLICATION IN A LARGE INTRODUCTORY BIOLOGY CLASS

In a large (350+ students) introductory biology course for natural science majors, discussing human genetic diversity is one way to enter a discussion of genetics and evolutionary biology. Because of the negative connotations of variation embodied in terms and phrases such as "genetic disease" and "mutant gene for breast cancer", I have thought it important to engage students' experience with human diversity so that the imposition of values is transparent to them. I ask them to name some "genetic diseases" and "mutations" and to reflect briefly on their experience and attitudes in pairs. Student questions often pinpoint key issues, such as what is "normal" (e.g., whether myopia or nearsightedness ought to qualify as a "genetic disease"). Before discussing differential mortality among newborns of varying birthweight as an example of natural selection, I construct an informal class data set by asking students to raise their hands when their own approximate birthweight is read out. We informally assess an average birthweight for the class. When a birthweight curve and accompanying mortality rates are later shown, students are better prepared to examine the data because they are engaged and understand how the curve was constructed. I discuss in detail the example of human genetic adaptation to malaria/parasites (Table 1, Part A) to show that differential mortality among genotypes depends on environmental presence or absence of malaria.

I believe these efforts to apply constructivist listening approaches help to socialize the class for cooperation and participation, even when students know they will be graded only on performance on their own exams. I believe this approach also reduces the attitude of voyeurism that can occur when a specific human condition (e.g. genetic resistance and susceptibility to malaria) is studied in class. Analyzing genetic variation on different scales exposes differences between studies made on differing scales and helps to identify unanswered questions. Although no systematic survey has been done, my colleagues and I find this approach contributes to more effective student comprehension and appreciation of human genetic diversity.

APPLICATION IN A SMALLER INTERDISCIPLINARY COURSE

An advanced interdisciplinary course of 20-25 students is populated by American Studies majors, and focuses on the interdisciplinary study of Haiti, its history, culture and significance. The faculty challenge is to assist students to understand that racism is central to Haiti's history and current situation.[22,24] I and my colleagues constructed from primary and secondary sources a collage of descriptions of the sugar production enterprise, an essential ingredient in Haiti's colonial economy. Observations on several spatial and temporal scales were juxtaposed. These included excerpts from the agricultural and plant physiology sources, culinary and economic sources, and eyewitness accounts of cane cultivation and harvest in seventeeth century Haiti and contemporary Florida canefields. Student groups were then asked to generate hypotheses about the possible relationships among observations on different scales, to identify aspects of the collage containing evidence for their hypotheses, and to propose what further evidence would shed light on their hypotheses.

To help students process feelings brought up by such material, which included eyewitness accounts of brutal coercion, we used constructivist listening in pairs and small groups. We gave students and ourselves opportunity to discharge feelings about the course material and its implications for the experience of ancestors of students in the class and in the college. This approach not only allowed us to engage in this course material with less pretense about its emotional effects, but also allowed us to move beyond those feelings to construct our individual understandings and questions of this material. My colleagues and I believe that these students, none of whom will be professional scientists, will have a greater appreciation of scientific approaches to problem solving.

CAN EDUCATION THAT ADDRESSES RACISM ALSO CONTRIBUTE TO BETTER SCIENCE EDUCATION?

For experienced scientists, correcting, interpreting and recontextualizing observations and ideas are processes that generate better understanding of a complex problem. By contrast, novice science students often view each problem as having one correct answer to be memorized and a series of wrong ones to be recognized and rejected. Complex phenomena are often viewed as system components to be memorized, even though memorization is a poor substitute for understanding cause-effect relationships in complex systems. Similarly, adopting a stance on racism (politically correct or not) without personal engagement is a poor substitute for understanding how racism (or any other form of oppression) affects different people in a complex society. By integrating into our introductory courses some elements of the skills we value in professional colleagues, we can assist students to construct their own understandings of both race and natural science systems.

Experimenting with such approaches requires that we think differently about our teaching goals,[5] that we teach students that skills transfer to other contexts. Learning components of emotional literacy may seem a luxury that science and engineering students can ill-afford in content-intensive courses. But emotional skills have been suggested as the key factor determining differential success among highly educated professionals.[35] Further, without adequate listening and communication skills, teamwork in science and engineering groups may merely recreate exclusionary interactions among team members of diverse gender, race and class status that are prevalent in wider society.[36] Integrating this kind of education into courses is an excellent chance to teach students awareness and skills that enable them to take initiative in situations where the potential for being excluded exists, and to make such situations more inclusive.[3,29,32] Because much professional work now involves collaboration, education that improves communication skills and cultivates the ability to be thoughtful of others without relinquishing one's independent thinking is an essential complement to technical education.

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