Student discourse about equity in an introductory college physics course

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In a typical introductory college calculus-based physics course for future scientists and engineers, the makeup of the classroom resembles the physics community: few women and even fewer underrepresented minorities. This lack of representation is well known, but is rarely an explicit topic of conversation in physics courses. In an introductory physics course at Seattle Pacific University, we facilitated activities aimed to raise student awareness about demographic disparity between the physics community and the general population. Students had the opportunity to discuss and reflect about what it means to do physics, who does it, and why particular groups of people are not proportionally represented in the field. In this presentation, we share a portion of these activities and our preliminary findings about the impact of and response to these activities.

I. INTRODUCTION

There is a striking and severe underrepresentation of women and people of color in physics. This well documented underrepresentation is a demographic problem that spans from advanced level physics high school classrooms to professors [1, 2]. The skewed distribution of physicists impacts the organization, composition, and social interaction of both the learning of physics and the knowledge that is shared [3]. Using the recent 2016 Supreme Court case *Fisher v. University of Texas (UT)* as a focal point, we designed a series of lessons for an introductory physics class that aimed to raise awareness of these inequities, and empower students to be agents of change. The purpose of this study is to better understand how college students interact with questions of equity in physics and with one another in this context. We share a preliminary analysis of student reflections that illuminate some of the resources students bring to the class.

II. BACKGROUND

A recent call was issued to physics instructors to provide information about how the problem of disproportionate representation is being addressed in

today's classrooms [4]. Research on high school physics preparation identified the use of discussions about women's underrepresentation as having a significant positive effect on females' interest in a physical science career [5]. The authors urge the community to "follow up this work by more deeply probing how and why such discussions [of underrepresentation] might help ...and how they can best be implemented in the classroom" [5]. An overview of a curriculum used in high school physics to engage students in thinking about equity describes a possible inroad for introducing these ideas [6], but not what students experience during the implementation. To our knowledge, this topic is rarely an explicit focus in university physics courses.

University students in introductory physics classrooms base their ideas on prior experiences that shape their understanding about physics, as well as issues of equity. We see those ideas as resources that can be used for approaching this subject productively in the setting of a physics classroom [7].

III. RESEARCH CONTEXT

The instruction and data collection occurred during the second quarter of introductory calculus-based Physics for Science and Engineering at a private

university. This course has integrated lab/lectures, meeting MWF for 80 min and Th for 110 min. Most class time is discussion at round tables in self-selected groups of 4-6 students. Two sections of 32 and 40 students participated. Table 1 shows the university registration data for the classroom demographics.

TABLE 1. Classroom Racial Demographics from University Registrar¹

Race	Number of Students
Asian	10
Black or African American	3
Hispanic of any race	7
Two or more races	5
White	44
Non-Resident Alien	3
Total in both classes	72

IV. SEQUENCE OF CLASSROOM ACTIVITIES

The unit on equity was taught between rotational motion and fluids and used ~165 minutes of class time. Prior to class discussion, students were asked to read about Fisher v. UT, in which Chief Justice Roberts asked, “What unique perspective does a minority student bring to a physics class?” and answer the following questions:

- What is your understanding of the case?
- What might Justice Roberts have meant by his question, “What unique perspective does a minority student bring to a physics class?”
- Why do you think he brought up physics all of a sudden? Would his question mean the same thing if it were another subject such as English?
- How would you answer Justice Roberts’ question?
- What is your reaction to his question?

Students discussed their responses in both small groups, and then as a class. The instructor (Daane) recorded comments and questions on a whiteboard as they arose, but provided no answers. Following discussion, students were asked to “write whatever you are thinking about right now after this discussion.” These reflections are the focus of this study, although

the class continued to discuss this topic during the following class period and completed five additional assignments (not yet analyzed). The reflections provide insight into students’ thinking before they read how physicists responded and prior to discussing the role objectivity plays in the epistemology of physics.

The reflections were anonymized and grouped into emergent categories by subject. Student reflections were usually only one or two sentences. Thus when categorizing the responses, each response was sorted into a single category that best described the topic of the reflection. The first author sorted all reflections, and the second author reviewed for agreement.

V. EXCERPTS OF STUDENT REFLECTION

The student responses varied after the introduction to the Fisher v. UT case. Five students did not complete a reflection. The remaining 67 responses were sorted into five categories (number of students, % of total responses):

- Diversity is generally good in all contexts. (43, 64.2%)
- Physics is objective and fact-based. (13, 19.4%)
- Physics is not objective. (2, 3.0%)
- Equity should not be a topic in physics class. (5, 7.4%)
- Diversity benefits minority students. (4, 6.0%)

Categories B-D became a focus of discussion during the second class meeting. Below, we share examples of student responses using pseudonyms.

A. Diversity is generally good in all contexts.

Many responses described diversity as generally good in any respect and/or focused on the case itself.

I think racial differences in the classroom is important for different views on various subject matters. I also think that racism is stupid and we should all just get along. Why can't colleges accept people with no basis of ethnicity in the holistic process? There are too many opinions... Overall race hate is bad, but diversity is good. – Cole

¹ The University registrar collects the data of “non-resident alien” to record “international student” status.

They collect this data as part of racial demographics, and thus we report it in the same fashion here.

As it stands, I believe that different perspectives are hugely important in a scientific class such as physics. However, I feel these unique perspectives are not contingent upon race and more so on the individual as a human being. Everybody's thought process is different regardless of race. – Alex

Students emphasized that diversity can be measured in many ways, including race, but all diversity should be celebrated. Some students described gender, race, and academic ability as aspects of diversity. Others wrote that all individuals bring unique perspectives, so race was not as important as general diversity.

B. Physics is objective.

Researchers have documented a common belief among students, researchers, and faculty that physics is objective and unbiased [8-9] and consequently that discussions of race and diversity do not belong in the classroom [10]. Several students' reflections aligned strongly with this documented perspective.

I'm thinking about how much race affects an objective subject like physics. I can see clearly its role in subjective topics, but physics feels more fact based to me. As of now, I don't think race is completely irrelevant, but can't see one clear benefit in a physics class resulting directly from race. - Sara

I feel that since Physics is a fact-based class, racial diversity is not as important as academic diversity. I think that students capable of accurately interpreting ideas in physics lend more to the class than what background they came from (this is specifically about physics). - Jeremy

Sara and Jeremy refer to physics as “objective” and based on “fact.” Many students, like Sara and Jeremy, argued that, since everyone's background is different, race does not matter to increase diversity in physics. Views that emphasize the objectivity of physics have been shown to be one way that women are marginalized because objectivity in science is seen as a historically masculine perspective [8]. Having this view surface in

an introductory course suggests that female students may sense that physics is not a place for them.

C. Physics is not objective.

An alternative to viewing physics as objective is the belief that “facts” and “theories” are influenced by backgrounds and cultural references. Noted physicists have recognized this bias. Heisenberg said, “It may be easier to adapt oneself to the quantum-theoretical concept of reality when one has not gone through the naïve materialists way of thinking that still prevailed in Europe in the first decades of this century.” [9]

Only two students wrote a reflection that aligned with the idea that physics is not an objective science.

I think race and experience is crucial to science because science is not numbers and theories, it is the real world we simply derive the theories from our experiences. Without diversity, and new ways of thinking and different backgrounds, we can never really discover anything new and the classroom should be for more than learning, it should be for discovery. – Aaron

Aaron recognizes that we derive “theories from our experiences.” Additional students shared this sentiment in later class discussion. Both classes split evenly when asked to stand on the side of the room that represented their view of physics as objective or subjective.

D. Equity should not be a topic in physics class.

Several students objected to the use of class time for discussing equity in physics.

I think (Honestly) that while diversity is a big issue, we should not dedicate a full class (and maybe part of the next) to it. A lecture that you had us go to, rather than using class time would be better. We paid to learn physics, and while I am not saying we should cover this, I don't think it is the best allotment of class time. - Patrick

I do not understand why we are spending class time to discuss this issue. I am honestly upset by being asked to spend class time, and even homework time designated to physics, to discuss racial issues that

do not apply to what I am paying lots of money to learn. - Ralph

These concerns are valid. How much time should we “spare” to address this issue? Can we afford not to spend any time at all? Research on university students of color suggests otherwise: focusing on “objective” parts of science without connection to the social realms leads to feelings of disenfranchisement [10-11]. This aligns with comments from students in Section E.

E. Diversity benefits minority students.

A few responses noted the direct benefit to those students traditionally underrepresented in physics.

I am glad that this topic was talked about. As a minority student, I have often been the only black student in certain science classes. Often minority students don't take these classes and no one thinks twice about it. I feel it is important to have mixed perspectives even if it is in a science fact-based class. I would hate for anyone to feel like they should not do science because of their races. Thank you for bringing this topic to light. - William

I'm thinking about how race affects one's everyday experience in society. Minorities don't just have a different background they have a different today. We've been arguing if minorities in a physics class (in college) make any contribution. But what about the contribution that physics makes to the lives of those students? - Andree

These reflections note that the presence of minorities in a physics class benefits not only the majority, but

minority students as well. Women of color in science classes [10] express similar views.

VI. CONCLUSION & FUTURE WORK

A majority of these students shared the view that diversity is a positive concept. Others argued that physics is objective. Students also shared opposing perspectives about the relevance and value of the topic of diversity in physics.

We share our results in an effort to begin discussions about the value of explicit instruction of equity in physics classrooms. These data are preliminary, and the categories limited in their applicability due to the limited length and the agreement in coding. However, our hope is that this information will encourage instructors address issues of equity in the classroom. From this initial study, we believe introductory physics instructors can support a more productive and equitable physics community by a) explicitly addressing the subjectivity present in the process of learning and doing physics and b) increasing awareness of the lack of equitable representation in both the classroom and the broader field of physics. Future analysis will examine the effectiveness of subsequent class discussions and readings not included in this analysis.

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