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Design Considerations for Facilitating Equitable Participation in an Ethical Data Science Course for High School Students

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The purpose of this article is to understand how educators may support students from different backgrounds (both relatively privileged and marginalized) to participate equitably and meaningfully in ethical data science discussions. To do this, we draw on the literature regarding STEM identity formation, use Cobb and Yackel's (1996) framework for analyzing social norms for discourse in inquiry-based classrooms, and draw on Hodge and Cobb's Cultural Participation Orientation towards developing an inclusive classroom environment. Finally, we describe the course elements (task structures, participation structures, and discursive moves) from a designed Ethical Data Science course that supported students' equitable participation in ethical data science discussions (Sandoval, 2004).

KEYWORDS: Data Science, ethics, cultural participation, privilege hazard, social norms for discourse

With the onset of globalization and increased neoliberal attitudes in society, world governing entities have increasingly relied on the use of data science and Big Data Analytics (BDA) to process such data in order to make impactful decisions in society (Mayer-Shonberger et al, 2014). Yet, despite the social and economic benefits afforded by the data science industry, there are concerns about its marginalizing effects on non-dominant individuals. Namely, that training algorithms on historical data often reinforce social stereotypes and place individuals in a recurring cycle of misclassification (i.e., feedback loop) (O'Neil, 2016).

Exacerbating these marginalizing effects is the dominant demographic of data scientists and professional mathematicians in the field (i.e. White or Asian,

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male and upper income). This phenomenon, called the *privilege hazard* by D'Ignazio and Klein (2020), occurs when teams of data scientists are composed of people primarily in privileged positions. Although often unintentional, designs created in these contexts reflect the dominant perspectives and experiences of the privileged creators at the expense of non-dominant identities and viewpoints (D'Ignazio et al., 2020; Noble, 2018). Note that when we refer to "privilege" we use Kokka's (2020) conceptualization as a "set of advantages one group has over others, granted because of membership or perceived membership in social categories (e.g., race, class, gender identity, sexual orientation, etc.)" (Kokka, 2020, p. 3). Consequently, one of the biggest threats to society that has come from globalization is the hard coding of discrimination in the processes that are increasingly used by world governing entities (D'Ignazio et al., 2020). Thus, it is imperative that mathematics and data science education be both grounded in ethics and rich with opportunities for students to think critically about the ways in which their mathematical products influence those who may be situated differently in society (Atweh, 2013; Ernest, 2018; Authors., 2021b; Skovsmose, 1994).

Purpose

The context of this study is situated in a Design Research Project whose purpose is to characterize students' ethical reasoning in mathematics and data science in order to develop instructional resources. The Ethical Data Science course was developed through this project, and was implemented over a four-week period in summer of 2022 at a major Urban Research University in the Southeastern U.S. that serves urban intensive, urban emergent, and urban characteristic schools in both its city of residency and surrounding counties (Milner, 2012). The high school students who participated in the course came from a range of urban intensive/emergent/characteristic communities across the state and held a variety of cultural and gendered backgrounds, although predominantly economically and academically privileged. Some of these students attended their home schools while others attended the state school of Mathematics and Science.

Importantly, a course that foregrounds discussions around ethics and privilege has the potential to cause discomfort for students, impacting the ways in which they participate in all elements of the course. For instance, we noticed in the first few days of the course that the females were less likely to participate in discussions that were heavily grounded in the technical and mathematical components of data science. At the same time, White males and Asian students were more likely to participate in the technical discussions and less so in the sociopolitical or ethical grounded discussions. Given that the current demographic of professional mathematicians and data scientists are vastly overrepresented by White and Asian males, while underrepresented by females and people of color, we viewed our students'

cultural and gendered ways of participating in the EDS course as indicative of the current trends in these fields (D'Ignazio et al., 2020). Thus, we argue that in order to reduce the privilege hazard and its negative impact on non-dominant communities, we must prioritize the diversification of the data science industry, beginning by understanding how students with diverse backgrounds participate in these disciplines prior to entering the workforce. As such, the purpose of this study is to understand how designed course structures may support equitable participation among students with diverse and intersecting identities in ethical and sociopolitical data science discussions, where *equitable participation* refers to variability in the students who contribute to class discussions, but more so that these students participate in ways that affirm their identity and sense of belonging. As such, this article contributes to the urban mathematics education literature in that it explicitly addresses issues of power, race, and identity in diverse classrooms (Larnell, 2013) for the purposes of promoting nondominant representation in the data science industry to promote justice in the global economy.

In the sections that follow, we will briefly discuss literature regarding factors that influence identity in the STEM disciplines. Following a description of the Cultural Participation Orientation and methods that ground our study, we will then present evidence of the social norms that became stable in EDS course, accompanied by our conjectures for students' participation in the social norm to explain one's reasoning. Finally, we introduce a new social norm to the literature, called *making space*, and propose several recommendations for promoting meaningful and equitable discourse in high school ethical data science learning contexts.

Factors in STEM Identity Formation

Fragile, Designated, and Relational Identity

According to Solomon et al., (2011), many learners, despite being successful in mathematics, see themselves as "existing only on the margins of the practice, or as lacking stability in it" (p. 565); such *fragile* mathematics and science identities, though not restricted to females, have been shown to appear in girls and women more often (Solomon et al., 2011). Scholars suggest that difficulties for females are closely related to cultural beliefs about gender, wherein common perceptions of what counts as mathematical/scientific knowledge and processes are inimical to womens' traditional roles, and their ways of knowing, thinking, and learning (Ridgeway, 2001).

Women are often cast through dominant social discourses as best suited for caretaking roles in society, which may be tied to Gilligan's (1982, 1993) argument that the moral dispositions of women are more readily concerned with selflessness and care for others. At the same time, Gilligan (1993) argues that men tend to be *separate thinkers* (e.g., those who prefer methodologies associated with logic, rigor, rationality, and absolute truth) while women are more often *connected thinkers* who rely on intuition, creativity, personal processes, and experience. With regard to their preferred ways of learning, Becker (1995) claims that while males more often prefer competitive and pressurized environments, females prefer more cooperative and supportive working environments that often conflict with notions of the traditional mathematics classroom setting. Such designated identities thus contrast with the ideal ways of thinking and behaving in the STEM disciplines, and contribute to the widespread assumption that women are less intellectually capable in these fields than their male peers (Sfard et al., 2005). Importantly, individuals often subscribe to their designated identities unconsciously and without realizing that there are alternatives (Sfard et al., 2005).

An effect of these stereotypes on STEM classrooms is an inhospitable learning environment for females in which teachers, peers, and/or the students themselves do not see females as possessing the necessarily skills, knowledge, or dispositions to become successful scientists and mathematicians (i.e. stereotype threat) (Carli et al., 2016). As a result, students' relational identities are a salient factor in females' participation in STEM environments. That is, despite having similar agentic goals for learning (those which promote self-interest, self-satisfaction, competence and ability), scholars argue that gender shapes differences in STEM goal achievement as evidenced by women's underrepresentation in the STEM disciplines (Moss-Racusin et al. 2012). On the one hand, this gender gap is due to teachers' subordination of feminine ways of thinking and participating, but it is also greatly affected by peer and self-expectations for what counts as acceptable behavior in STEM spaces (Riegle-Crumb et al., 2020). Furthermore, because mathematics and the sciences are often cast as an elite male domain (Castro et al., 2019), women pursuing STEM fields necessarily transgress traditional gender roles and norms, whereas their male counterparts have only to be concerned with demonstrating their knowledge in ways that are tailored to them (Grunspan et al. 2016; Ridgeway et al., 2004). Unsurprisingly, this phenomenon can be seen in postsecondary STEM classrooms which, due to the gendered expectation of faculty and peers, have been described as negative, exclusionary, and "chilly" towards female students (Riegle-Crumb et al., 2020).

Intersectional Identity

There are also differences in motivation within gender classifications that can be ascribed to culture, race, and ethnicity. For instance, despite having similar agentic goals across genders, certain cultures place a greater emphasis on communal goals resulting in "different patterns between goal affordances and commitment to STEM occupations" (Riegle-Crumb et al., 2020, p. 106). As an example, scholars have argued that, generally speaking, the social orientation of Asian cultures promotes a stronger emphasis on community, interdependence, and connections with others (i.e. communal social orientation) (Varnum et al. 2010) while the overrepresentation of Asians in U.S. STEM fields is, at least partially, due to a greater cultural emphasis on the value of STEM fields (Lee and Zhou, 2015). In the U.S., this overrepresentation is generally accepted by dominant groups in society as a result of the so-called "model minority myth" that positions Asian students generally as academically and occupationally successful while also "passive, compliant, and apolitical" (Riegle-Crumb et al., 2020, p. 106; Shah, 2019; Shrake, 2006). At the same time, the ideals of the model minority and the "good at math" stereotype are often pitted against other racial/ethnic minorities (e.g. Black, Latinx, indigenous) resulting in the devaluation of those cultures in STEM spaces (McGee, 2018). However, because Asians are often perceived as foreign and un-assimilating, they are positioned in U.S. society as superior to black and brown individuals in STEM, but subordinate to the ideal White American (McGee, 2018). As a result, students of color in the U.S. experience educational environments as both racialized *and* gendered spaces that differ according to their cultures (Riegle-Crumb et al., 2020) while students of relative privilege (e.g. White or male) may experience racialized or gendered marginalization despite holding one or more privileged identities (e.g. males of color, White females, non-binary gender identifying students). For instance, although Asian and White students are often considered talented in STEM disciplines, White and Asian females and non-binary students are simultaneously subordinated according to their gendered identities, while Black, Latinx, and indigenous females and non-binary students may subordinated according to both their racial and gendered identity. Similarly, Black, Latinx, and indigenous males, despite being viewed as more logical or rational than females, may experience racialized marginalization in STEM classrooms. Furthermore, these students may also encounter forms of marginalization within their own communities where cultural values and traditions related to gender roles may conflict with their educational aspirations (Lee, 2006; Riegle-Crumb et al., 2020).

Impetus for Equitable Participation

The effects of the classroom environment as a racialized and gendered space include different forms of participation among diverse students. Given that students participate in classroom activities according to their identities and

culture, Cobb and Hodge (2019) suggest that the classroom may serve as a space to promote cultural participation among students from different backgrounds. Furthermore, there is sufficient evidence that diversity in educational and professional spaces may promote collective understanding (e.g. Wilson, 1992). Therefore, if the learning goals tied to classroom discussions in a data science course grounded in sociopolitical and ethical contexts are to develop a holistic and collective understanding of the effects of data science on the wellbeing of individuals and groups in society, then it is imperative that a diversity of voices and perspectives are authentically considered. Put differently, a well-rounded understanding of who these methodologies affect, and how they are affected, is needed to safeguard against the privilege hazard in both learning and industry settings to ensure that the needs of marginalized groups are reflected in potential solutions.

Taken together, these research findings helped shape the design of the EDS course. As Sandoval (2004) argues, "the embodiment of the high-level conjecture articulates its reification in features of the learning environment design" (p. 23) that may include tools and materials, task structures, participation structures and discursive practices. Therefore, these course elements were explicitly designed to encourage equitable participation and positive data science identity formation from students with diverse and intersectional identities. We elaborate on each of these designed elements next, beginning with a description of the course structure, tools and materials.

Designing for Equitable Participation

While there have been initiatives in K-12 data science education (e.g., Gould et al., 2016; Heineman et al., 2018; YouCubed, 2020), none to date have consistently incorporated ethics into their coursework. Furthermore, we could find no data-based analyses that document the learning that occurs as students engage in an ethical data science course. To this end, the co-authors initiated a multi-year program of Design-Based Research (Bakker et al., 2014) to develop an introductory ethical data science (EDS) course for high school students.

The EDS course was developed based on the high-level conjecture that students would be more likely to develop their ethical mathematics consciousness if they were immersed in an introductory data science course grounded in ethical and critical contexts. Here, ethical mathematics consciousness (EMC) refers to *the awareness that human beings do mathematics; thus, there are potential ethical dilemmas and implications of mathematical work which may affect entities at the individual, group, societal, and/or environmental level.* Core tenets include sociopolitical, ecological and communicative mathematics awareness, and a willingness and commitment to act on past injustices, share data-based knowledge,

and/or create ethical mathematical designs for the future (i.e. ethical mathematics agency) (Stephan et al., 2021; Register et al., 2021).

In developing these design conjectures, the design team for the larger study conducted three separate task-based, pilot interview sessions: one with middle school students (Reinke et al., 2022), one with high school students (Register et al., 2021; Stephan et al., 2021), and one with preservice teachers in the U.S. and Sweden (Andersson et al., in press), for the purposes of characterizing how students and preservice teachers think ethically in data science contexts. Based on their responses and literature related to ethical dilemmas in the data science discipline, course activities were designed to elicit ethical and critical conversations related to the pros and cons of data science decisions for different groups in society.

With respect to course activities, Sandoval (2004) suggests that learning outcomes are influenced by the learning environment itself and the "changing social infrastructure of the settings" in which these designed environments function (p. 23). As such, we recognized that grounding a data science course in critical and ethical contexts has the potential to cause discomfort in students as well as influence their ways of participating in class discussions. Thus, we explicitly designed the task and participation structures to foster equitable participation and student belonging in the EDS classroom.

Task Structures for Equitable Participation in EDS

Task structures refers to the goals, criteria and standards of the tasks that learners are expected to do (Sandoval, 2014). A majority of the investigations in the EDS course were designed to leverage student discourse in the service of surfacing multiple rationales for making ethical data-based decisions. Thus, the task structures for the course included (1) *decision making*, (2) *pluralistic*, and (3) *qualitative* designs. *Decision making task structures* position students as decision makers who must decide and justify their choices based on both their understanding of the topic and their personal experiences. They must also demonstrate support for and/or challenge the decisions made by their peers. Related to this are *pluralistic task structures* which require that students explore and justify their decisions by arguing pluralistically, considering both the pros and cons of their potential action. Finally, *qualitative task structures* are those in which students are expected to consider the quality or consequences of specific mathematical actions or processes in society, or based upon their personal experiences. Together, these task structures place the onus of responsibility on students to understand the technical aspects of the data science methodology as well as reflect on and anticipate the potential effects of their mathematical products and analyses in society by drawing on their personal, cultural, and gendered experiences.

Participation Structures for EDS

Participant structures refers to how students and teachers are expected to participate in tasks including the roles and responsibilities that they take on (Sandoval, 2014). To support the discursive and reflective nature of the data science process, the task structures were implemented with the following *participation structures*: 1) individual reflections, and 2) structured, problem-based, and open-ended inquiry in individual, small group, and whole group contexts. Here, structured inquiry refers to a sequential process where students conceptualize how to ask questions and investigate real-world issues according to the data investigation process. Problem-based inquiry refers to inquiry-based learning centered around the act of solving a real-word problem, and open-ended inquiry allows students the freedom to explore and develop data-based solutions to an issue of their personal interest. Together, these participation structures serve as a means to scaffold students' inquiry processes in data science contexts by first learning to engage in the data investigation process, apply that process to real-world issues, then investigate an issue of their choosing according to those learned processes.

Discursive Practices and Attention to Identity

Finally, designs must also include the intended *discursive practices*, or ways of talking in the intended learning environment. To this end, the teacher attempted to facilitate discussions that drew upon social norms that are productive for inquiry-mathematics environments (Cobb & Yackel, 1996). These norms include the expectation that students 1) explain and justify their thinking, 2) indicate agreement and/or disagreement, 3) attempt to understand the reasoning of others, and 4) ask clarifying questions when the need arises. Due to the controversial nature of the discussions that surface when examining sociopolitical datasets and engaging in ethical discussions, as well as the diversity of identities present in these discussions, we expected that the negotiation of these norms would look different than in our previous work and that new social norms may emerge. Thus, we conjectured that the teacher would need to make a conscious effort to support students' development of a positive data science identity while also affirming their gendered and cultural identities in the classroom environment. The moves that the teacher intended to foster positive identities included being explicit about, co-establishing, and modeling norms for discourse, and promoting rough draft thinking by encouraging students to share their unfinished and developing ideas while being open to revising those ideas (Jansen, 2020). Given the scope of this paper, we report only on the task structures, participation structures, and select discursive moves made by the teacher that were found to support students' enactment of, and individual beliefs in the importance of equitable participation.

Theoretical Orientation

Generally speaking, scholars concerned with equity work often adopt a Cultural Alignment Orientation towards learning wherein culture is defined as a way of life within a bounded community that is passed down from generation to generation (Hodge et al., 2019). Instructional designs from this perspective attempt to align classroom practices to those from students' home communities (Hodge & Cobb, 2019). This has caused some resistance, given that the composition of U.S. classrooms often do not reflect separate bounded communities, but rather a collection of intersectional ones. In addition, the realities of globalization, rapid technological advancements and increased global immigration imply that bounded communities no longer exist in society and thus do not translate into the culturally homogeneous classrooms that are more conducive to the methods associated with the Cultural Alignment Orientation (Hodge et al., 2019).

In contrast, we adopt the Classroom Participation Orientation elaborated by Hodge and Cobb (2019), which views culture as "a network of local hybrid practices that people jointly constitute as they negotiate their places in specific settings" (p. 863). Through this lens, students develop ways of participating in or resisting classroom practices based on a range of resources, practices, and identities that they bring to the classroom from their home, community, societal discourses, popular culture, and the media (Hodge et al., 2019, p. 863). In other words, the Cultural Participation Orientation views classroom culture as something to be negotiated by students with different experiences and intersecting identities. Rather than starting by aligning classroom practices with those from students' home communities, the Classroom Participation Orientation begins with classroom practices that promote rigorous disciplinary (e.g. data science) learning. From there, the central question seeks to understand how that instruction can be modified, either by adjusting specific classroom practices, modifying activities, or providing additional evidence-based supports that may enable students who draw on diverse resources and identities to participate equitably and substantially (Hodge & Cobb, 2019). Importantly, equitable participation does not mean that all students participate in the same way or to the same extent since their identity influenced ways of participating are different.

Due to our commitment to the Cultural Participation Orientation, our analysis serves as an attempt to understand the role that each of the instructional design elements played in supporting social norms and equitable participation in ethical data science discussions, with particular attention to the ways the teacher adjusted those elements in-situ. As a consequence, the following **research questions** were formulated to guide our analysis:

1. Which social norms became stable over time, and in what ways did students participate in and contribute to their constitution?

2. How did the designed/modified task and participation structures support/constrain equitable participation in the activities and social norms of an ethical data science course?

In the sections that follow, our methodology and relevant findings will be discussed.

Methodology

Course Structure

The course structure included 20 instructional days which occurred over four weeks in July. The tools and materials used by students throughout the learning process were designed to reflect processes used and ethical considerations made in the data science industry, and to leverage students' rationale for making ethical decisions in data science contexts. Some core activities include in-class data processing and machine learning labs, the Data Science in Society project, Ethical Dilemmas activities and discussion and Book Discussions.

Students developed their Python programming skills outside of class through DataCamp.com and completed collaborative in-class labs through Google Sheets, Jupyter Notebooks, and Google Colab. The purpose of these labs was for students to gain experience following complex data science procedures and making complex decisions that have an effect on a multitude of entities in society, and to guide their methods for the Data Science in Society Project. Thus, they enacted the *data investigation process*, that includes (1) framing the problem, (2) considering and gathering data, (3) processing data, (4) exploring and visualizing data, (5) considering models, and (6) communicating and proposing solutions (Lee et al., 2020) in the context of real world, sociopolitical datasets, engaging in critical and ethical inquiry along the way. For instance, we used Jupyter Notebooks and Google Colabs to enact the data investigation process through machine learning labs in the contexts of coal ash contamination in the U.S., and civilian gun ownership across the globe. At this time, coal ash contamination was a major issue in the participant's home state, while gun rights were a looming public policy issue due to increased mass and school shootings in the U.S.. Students explored, cleaned, and processed the data, then attempted to build regression, classification, and clustering models to predict outcomes based on their generated research questions. Students then applied their learning to their Data Science in Society Project, where they chose a personally meaningful sociopolitical injustice to explore,

develop solutions, and communicate their findings through a conference style poster, presentation, and research report. The program culminated with a gallery walk of student projects.

Simultaneously, students explored the ethical implications of their potential work by exploring real media related to ethical dilemmas in the data science industry. They selected articles from a repository created by the instructor, and worked in groups to identify the ethical issue and make ethical considerations from the perspective of a data scientist and citizen. Furthermore, they explored the potential impact of such dilemmas by reading select chapters of *Weapons of Math Destruction* (O'Neil, 2016), *Automating Inequality* (Eubanks, 2019) and *Big Data: A Revolution That Will Transform How We Live, Work, and Think* (Mayer-Schonberger et al, 2013). The purpose for reading *Big Data: A Revolution That Will Transform How We Live, Work, and Think* was to give students an overarching understanding of the data science methodology and the uses of Big Data Analytics in society. This text explores BDA from a generally positive perspective, speaking to its benefits for global society and explores the differences between the BDA methodology and traditional research. At the same time, they read *Weapons of Math Destruction*, a text that describes the negative implications of the BDA methodology for marginalized populations and individuals in society that result from accepting messiness and making causal inferences from correlations in data that hold historical biases. For instance, O'Neil discusses the impact of the feedback loop on the mass incarceration of people of color in the U.S. and the poverty cycle that results from commercial targeting of services like for-profit colleges towards single mothers and women of color. Finally, their third assigned reading, *Automating Inequality*, describes the impact of using BDA to automate eligibility systems for social programs like the Family and Social Services Administration (FSSA). This reading provides anecdotal evidence of the failures related to fully transitioning the FSSA program to an automated system, resulting in a lack of access and loss of benefits for people in need, having short term and long term detrimental effects on the well-being of individuals and their families.

Participants

The participants consisted of 15 rising high school juniors and seniors selected for a competitive, state-funded, summer residential program held at a major university in the Southeastern United States (U.S.). The goals of the program are to provide hands-on, student-driven learning experiences with authentic research opportunities in STEM. We chose the upper high school age group due to their position in the U.S. mathematics curriculum and their familiarity with social media, technology, basic data sources, and basic data manipulation. In addition, we hypothesized that the nature of a STEM program being held over the summer at a

major university typically could attract more privileged types of students in terms of parent and student education, parental involvement, race, ethnicity, and socioeconomic status, and thus, may reflect the demographic make-up of the data science industry today. The general make-up of the program from 2016 to 2021 has been predominantly White and Asian/Indian students who do not require financial assistance with a parity in gender expression. The demographic makeup of the students enrolled in the EDS course reflected these aforementioned trends, including one Black girl, one Indian-American girl, five White girls, four White boys, two Indian-American boys, and two Asian-American boys (all self-reported without the "-American" label). With that being said, students' identities are not singular. Rather, they intersect with a multitude of identities along the lines of race, ethnicity, gender expression, socioeconomic status, etc. that further influence their experiences of privilege and marginalization (Kokka, 2020). Thus, if their acceptance into the program is considered an educational privilege (as it was here) then the the composition of the EDS class was homogenous in the sense that all of the students held at least one privileged identity (White, male, high SES, academic privilege, etc.), but heterogeneous in that the cultural and gendered experiences that the students brought to the class, including their ways of participating in tasks and discussions, were diverse.

Researcher Roles and Positionality

The first author served as the sole instructor for the EDS course while the second author was positioned as an observer, data collector, and co-analyst. Both authors identify as White females from middle class backgrounds who taught inquiry and discourse based mathematics at the middle and high school levels and currently work with preservice mathematics teachers. At the time of this writing, the first author/instructor is a doctoral candidate in a Curriculum Instruction in Mathematics Education program with a bachelor's degree in pure mathematics and a masters certification in both secondary mathematics teaching and data science. The second author is a full professor of mathematics education and an expert in Design Based Research and inquiry mathematics teaching. Both authors have worked over the past 4 years to develop potential profiles for students' ethical reasoning in mathematics and data science contexts from the perspective of promoting critical mathematics consciousness in students with relative privilege (like themselves). The goals of this work have centered around the promotion of ethical reasoning among students who may not have experience working with marginalized populations, while also promoting intercultural participation and communication for the future.

Data Collection & Analysis Methods

The data used to analyze the emergence of social norms, equitable participation, and students' feelings of belonging in EDS whole class discussions included video recordings of class sessions that demonstrate students' ethical reasoning, individual and collective student feedback from Google Forms, class discussions, individual check-ins, and focus groups, research field notes, and design team meeting notes. The video data was analyzed according to Glaser and Strauss's constant comparative method for analyzing longitudinal data sets in discursive settings (Glaser, 1965; Cobb & Whitenack, 1996). Generally, this method follows a multi-phase approach to analyzing video recorded student discourse in which students' social relationships and mathematical learning are first characterized in an episode-by-episode analysis, followed by a macro-level analysis to shed light on sociological and psychological patterns in their interactions over time. Our process of analysis is documented in Table 1 below, where *student contributions* refer to verbal statements that students make in whole class discussions that fall under one of the social norm categories, occurring when they attempt to explain, question, critique or indicate agreement with purpose, going beyond simplistic responses such as a yes or a no. Figure 1 illustrates trends in student contributions over time, where a bold vertical line indicates macro level shifts in student contributions.

Table 1. Process of Analysis

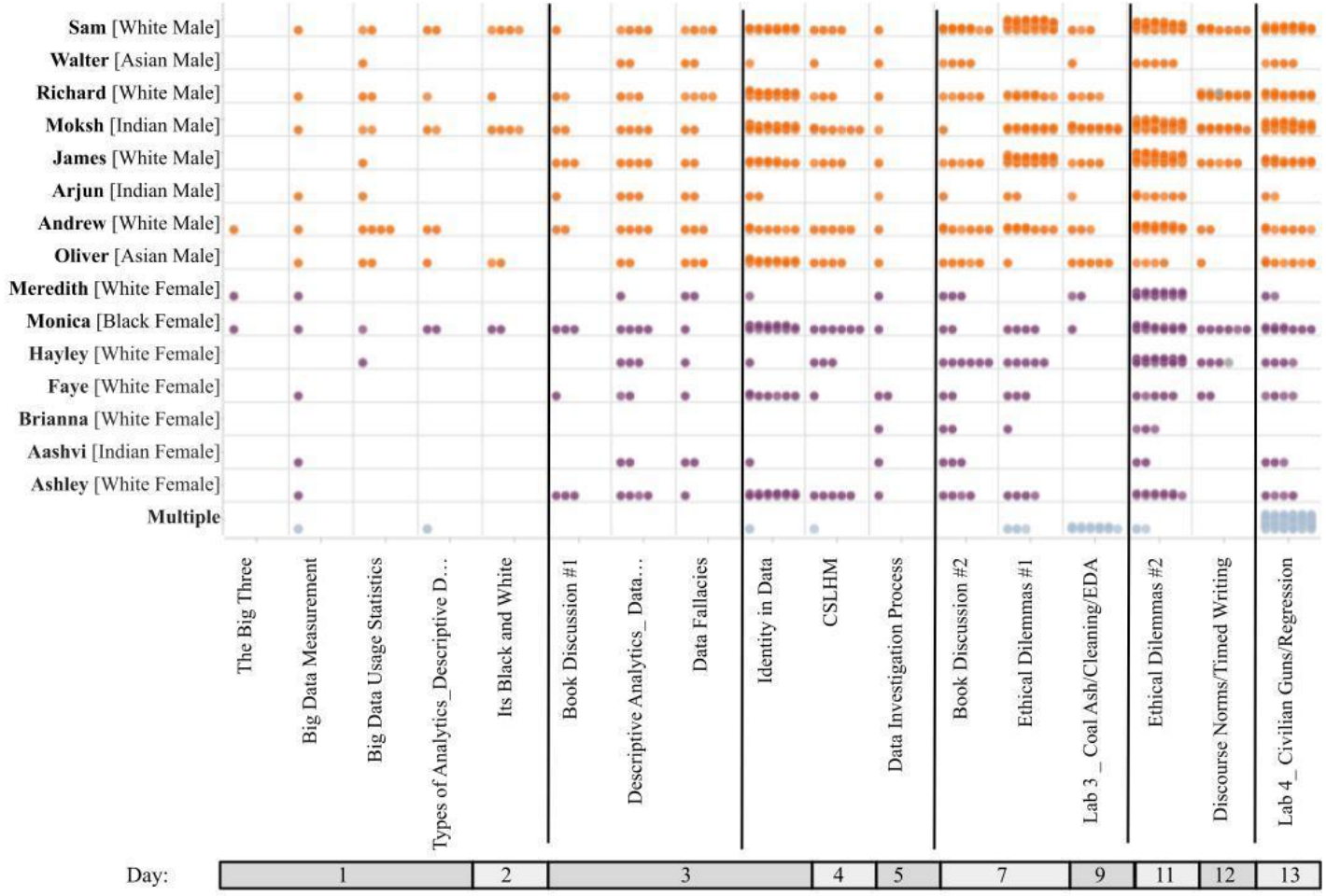
Phase	**Actions**	**Purpose**
Overview	Read through all of the video transcripts chronologically.	Capture an overview of the negotiation of social norms, e.g. when the teacher prompted the students to explain, did they oblige or resist?
Micro Analysis #1	2 authors independently coded video transcripts for social norm contributions in Google sheets. Met weekly to calibrate codes.	Qualitatively capture the ways in which students contributed to the negotiation of social norms as well as the quantity and nature of contributions for each student.
Macro Analysis #1	Transformed coding spreadsheet into a dataframe with social norms and student identity features as attributes. Analyzed trends in student contributions using statistical	Select key activities that illustrate significant shifts in student participation patterns (see Figure 1, where macro level shifts in student contributions are designated by a bold vertical line.)

	visualization software (Tableau and CODAP) to identify: • Where student contributions were high or increased • Where the variability of contributing students was high	
Micro Analysis #2	Independently coded selected activities for activity structures, participation structures, and discursive moves made by the teacher within these activities. Met weekly to calibrate.	Identify design elements that may have supported stability of social norms and equitable participation in discourse.
Macro Analysis #2	Chronologically documented how and when the social norms were being negotiated and/became stable (if at all), and looked at variability in student participation in these norms.	To determine when/if participation was equitable among the students.
Identity Analysis	Read through relevant student feedback and focus group notes.	To determine what elements of the design, or teacher moves likely contributed to student empowerment and equitable participation.

Limitations

There were several limitations with regard to the course experience and the study itself. The most salient of which are related to the course being only 4 weeks long, the first week being virtual, and the student research requirements of the program. Although students were with the instructor for 5 hours per day, relationship-building, developing knowledge about students' ways of participating, and establishing social norms for discourse takes a considerable amount of time, especially in learning contexts that students may not be familiar with. In addition, the program requirement for students to individually conduct research for

Figure 1. Count of Students Verbal Contributions by Date and Activity



publication over the course of 4 weeks served as both an opportunity and constraint for the students and teacher in the EDS course. On the one hand, immersing students in the research process was meaningful in that it developed their understanding of the scientific method and data investigation process. On the other hand, students had little experience conducting literature reviews and writing research reports, requiring that the instruction forgo several ethical data science activities to support students in their writing and research more than she had anticipated. Finally, we were met with difficulties related to the nature of a residential program during the COVID-19 pandemic that included the temporary removal of COVID-positive student and teaching assistant. In addition, our ways of participating were sometimes negatively influenced by the need to social distance. Despite these limitations, our analysis of the first three weeks of the course yielded some unexpected but important findings. Significantly, it was found that the negotiation of a new social norm to make space, coupled with students' developing beliefs in the importance of meaningful and equitable participation, proved to be essential for students to contribute equitably in the social norm to *explain* one's thinking.

Findings

The findings of our analysis related to the first research question include that 1) the norm to explain was the first and only to become fully stable, while the remaining norms were still in the negotiation stages at the end of the course, and 2) in their enactment of equitable participation, a new norm emerged where students attempted to *make space* for others' explanations. Regarding the second research question, the task structures that supported student empowerment and equitable participation in EDS course discussions include decision making, pluralistic, and qualitative task structures. The participation structures that supported equitable participation include requiring that all students present when reporting out as small groups and that students engage in small group talk prior to reporting out individually in whole group discussions. Furthermore, the discursive moves that supported student's equitable participation in the EDS course included 1) co-establishing social norms by facilitating a space for students to negotiate them according to their cultural, gendered, and personal resources, 2) collaboratively defining equitable participation as necessary for collective understanding, and 3) promoting rough draft thinking by explicitizing that there are "no experts on ethical data science" in the classroom.

To illustrate these findings, we first document the social norms that appeared to become stable within the first three weeks of the course (e.g. the norm to explain), followed by evidence of the emergence of the new social norm to

make space for others' explanations. We then characterize the negotiation of this new norm to make space and provide conjectures related to the designed and/or modified course elements that seemed to promote equitable participation. Finally, by drawing on insights from the identity literature and students' feedback throughout the course, we further attempt to characterize the core design elements that promoted students' belief in the norm to *make space* for others and their observed empowerment to take up that space.

Observed Stability of Social Norms for Discourse

Our analysis indicates that the social norm that students were expected to explain their thinking became stable early on while the norms to indicate agreement/disagreement, ask clarifying questions and attempt to understand each other's thinking were still in the negotiation stages at the end of the third week (Week 4 was dedicated solely to their research projects and thus did not include whole class discussions). Initially we found it encouraging that students felt obligated to explain their thinking with or without prompting from the teacher. However, the discourse patterns further revealed that certain students explained only when called on by name by the teacher. For instance, the following discourse patterns, where some students respond to prompts from the teacher and others without, were typical in the first few days of the course.

Instructor	Gerrymandering, um, yeah. Uh, Arjun, did you wanna talk about [your experience with] that a little bit?
Arjun (Indian male)	Yeah. Back when I lived in Atlanta, we had like these districts that was like, Super long and super thin. And they were all like messed up and I was like, what's going on?
Instructor	Yeah. Are any of you familiar or not familiar with what gerrymandering is?
Instructor	All of you have heard of it?
Sam (White male)	I am, but I would also like to add on to the point, um, that Arjun made that just because there are districts, which are like long and skinny and all that, it doesn't necessarily mean they're gerrymandered. Um, if you want to see like more about gerrymandering stuff, I think you need to look a little bit more into the details than just the shape--like you gotta see the race makeup, the, you know, age, makeup, stuff like that and make sure it's even that way.

Interactions like this indicate that at the individual level, some students consistently felt obligated to explain, while others (namely most of the females and Asian students) only did so when explicitly asked. Significantly, the latter

students were more often females and/or Black and Asian students, indicating that their disproportionate contributions may be attributed to their identities and cultural or gendered ways of participating.

A New and Essential Social Norm: Making Space

Over the first three full weeks of the course, the students seemed to notice that the same few students contributed to class discussions, stating in their feedback that "our discussions were typically dominated by the same students" or that they noticed that "not a lot of [the girls] spoke up." Significantly, many of these students seemed to handle this by either making an effort to contribute when others seemed to dominate the conversation (step up), or by providing *space* for their quieter peers to speak (step back). Thus, a new social norm emerged that involved students feeling obliged to *make space* for others' voices to be heard in classroom discussions.

Importantly, the designed task and participation structures seemed to encourage the students themselves to negotiate behaviors that would allow them to share their own ideas while also providing space for others to share theirs. For instance, in the excerpt that follows, which occurred on day 3, Moksh begins to negotiate how to make space for his group mates to explain their thinking by explicitly deferring to them in their group presentation:

Moksh (Indian male)	For society in general, data science can provide multiple opportunities because [...] if they teach at least some part of data science to the general population in high school, they can get to know that it is something that they could pursue and it could like help society [...] *and I'll leave it to my group.*

By day 7, the students began to adopt more explicit techniques for eliciting their peers' contributions, as seen in Monica's reflective feedback below:

Monica (Black female)	The teacher set [expectations for meaningful and equitable participation] in the way of giving us instructions or what to talk about, but the students mainly took hold of and regulated those things. One specific example of this I remember was during a group discussion where all the tables were in a circle. We were discussing a reading, and, while I had something to say, I was too nervous to say it. One of my friends in that class was directly across from me and noticed I didn't say anything, so he repeatedly looked at me and gestured in a way that told me to speak. I couldn't at first, but he was so persistent that I did end up saying what I had thought.

While the designed course elements seemed to foster students' participation in the social norm to explain, there was evidence that specific task and

participation structures seemed to encourage both the provision of space by dominant students and empowerment in those with seemingly fragile data science identities in EDS classroom discussions. In the following sections we respond to research question 2 by presenting each of these supports and plausible identity connections to validate our conjectures.

Task Structures that Supported Making Space

The task structures that supported equitable participation and the provision of space included *decision making*, *pluralistic*, and *qualitative* task structures. That is, in sociopolitical contexts, students were given the opportunity to decide for themselves, argue, and challenge diverse ideas related to the ethical decisions that they would make as a data scientist or as a citizen. These decisions were drawn from their personal experiences and research into the positive and negative aspects of the Big Data industry. Notably, positioning students as decision makers seemed to be one of the most important structures for inviting diverse students to participate more equitably in class discussions. This not only placed the onus on the students to argue what they believe is right, but the requirement to argue *pluralistically* (make arguments both for and against e.g. automated eligibility systems, facial recognition software, predictive policing, etc.) further pushed them to contribute in a manner that went beyond simplistic responses or those intended to demonstrate competence. Rather, this task structure enabled students to consider perspectives that they may not have otherwise considered, giving value to their peers' diverse perspectives and experiences. As an example, consider the following excerpt from the second Reading Discussion where students discussed data messiness and its implications for automated eligibility systems like the Family and Social Services Administration (FSSA) and Food Assistance Programs (SNAP). Here the students not only demonstrated that the social norm to explain one's thinking had become taken-as-shared, but the variability in contributors indicated that some of the more hesitant students may have felt empowered to have their voices heard:

Ashley (White female)	So with these systems [FSSA/SNAP] --I don't think that we should automate it. Cause just because you're eligible, sometimes what you're given is not what you need. Cause these systems, they might give you money, but you might like, you might need food instead or a job. You're just giving them what they need, like supplies, but you're not giving them a way to survive. [...] And if you're automatically eligible and you're getting services, you might not have the incentive to go out [...] and find a job?

Sam (White male)	Going off of that um, I think it's important to think about how like -- I think most people today, even if they're getting money, [...] like all of us, we wanna be productive members of society, right? Even if we get a million bucks, I think some of us would still try to do something with that money instead of sit around. So I don't think that giving money through welfare lowers people's willingness to work. And in addition to that, I don't think that giving welfare money is really a good place to stop. I mean like creating new jobs by public works is a great way to go and the government's done that a lot before to get us out of recessions and what not [...]
Instructor	[Students look for teacher's response] Don't look at me, this is y'alls conversation!
Monica (Black female)	I agree with that point and I was gonna say um the idea that um giving money to those in need will stop them from wanting to get a job is a good argument against keeping the automated systems like they are because they don't actually help people in the program, [...] So if we work more on trying to help the population that's receiving these [benefits], or even people who are denied eligibility-- even giving them resources [...] Something that'll help them cultivate skills instead of just trying to push them away with what little things we give them.

As this excerpt shows, the book readings served as a starting point for students with fragile data science identities to enter the discussion and make relevant connections to their communities and personal experiences. For example, Monica's reasoning related to insufficient resources for eligible citizens was based on her personal experiences and community knowledge of public assistance programs. That is, she drew on her observations that people receiving benefits are often given minimal support while being denied the opportunity to cultivate life skills. Therefore, we conjecture that these task structures may have empowered the girls who were uncomfortable speaking out in technical settings the opportunity to contribute in a meaningful way, according to their experiences and identities.

Consequently, discussions of this nature served two purposes: 1) to open the floor for non-dominant students to speak to their experiences; and, 2) to promote collective understanding of the social positioning of marginalized groups in society as it relates to the data science methodology. Yet, an additional point to make regarding these task structures is that unlike Critical Mathematics Pedagogies that forefront social injustices of the past or present, the act of making decisions for the future enabled the students in the EDS course to look beyond who is the oppressor/oppressed and toward making informed decisions that are not harmful to others. Rather than create a polarizing environment for heterogeneous students, positioning students as decision makers in sociopolitical and ethical contexts both created a space for students with fragile data science identities to

contribute in a meaningful way, and served to develop a unified sense of community and caring in the classroom (collective social orientation). Importantly, this required that the students consider alternative viewpoints and experiences, and use them to develop reasonable solutions to the issue at hand. That is, they were required to measure the quality, feasibility, and consequences of their actions based on both their personal experiences and their collective understanding of the potential implications of data science for different groups in society, constituting what we refer to as *qualitative* task structures. With regard to space, the qualitative task structures deterred students from contributing to show competence, and forced them to provide and consider alternative viewpoints in order to promote collective understanding.

Participation Structures that Supported Making Space

We further noticed that students' active participation in the social norm to explain was heavily dependent upon the participation structures that the teacher enacted. In particular, whether students were required to participate in groups or individually, and whether each student was required to speak out. On day 1, there was a noticeable lack of structure to whole class discussions. As a result, the students attempted to negotiate the social norm to explain one's reasoning, recognizing that at least one student should respond to the teacher's prompts, but they did not show concern for diverse perspectives. In the early lessons, this was evidenced by a select few students, primarily boys, continuously responding first to prompts. As a result, the instructor implemented small group presentations within the whole class discussion to provide structure and encourage non-dominant voices.

Small Group Presentations

While this participation structure did not necessarily promote equitable participation, it did catalyze a peer negotiation of space within those presentations. For instance, in the context of the excerpt that follows which occurred on day 1, students were required to work in small groups to conceptualize the scale of Big Data measurement, then report on their findings as a group to the rest of the class. While the teacher still had to prompt certain group members to jump in, students demonstrated the negotiation of space by deferring their explanations to their group members.

Instructor	So group one, please jump in.

Moksh (Indian male)	So, uh, we, we just felt like we should go with like the base bases of life, I guess. And we chose bases of matter. We chose atom. Then we moved on to the molecule and then we thought that we're gonna do a human next. So we slowly went to the cells[...] *and I'll let the other guys take over.*
Monica (Black female)	Um, from there we went to tissue and then blood vessels and then the organ as a whole, and *I'll save the last one for our last member.*
Arjun (Indian male)	Then we did the organ system, the human body, and then groups of people
Instructor	And every individual bite or unit is an atom is that correct? Awesome. I love that. [...] group two?
Ashley (White female)	So we set it up, um, with the byte being the smallest of the yellow ones [starting with a single grain of sand]
Instructor	I love how you showed your scale through the sizes of the blocks. That's interesting
Instructor	Somebody else from group 2?

As seen in this excerpt, some of the students began to make space for their peers' contributions by explicitly deferring to them in their presentations. Yet, these norms were still being negotiated as evidenced by the teacher prompting students to jump in and explain (e.g. "Somebody else from group 2"). Furthermore, this structure alone did not result in equitable participation as evidenced by males taking the lead in presentations or by presenting for their entire groups in surrounding activities. Consequently, the teacher again modified the group presentation participation structure on day 3, explicitly requiring that all students in the group present.

All Students Present

Enactment of the required participation structure, that all students present, resulted in a student to student negotiation that focused not only on the provision of space, but on who was afforded that space. That is, dominant students began to step back for others to have their voices heard, while quieter students began to step forward. By day 7, in their group presentations to the whole class, the students required no prompting to step in from the teacher or their peers and demonstrated variability in presenters, indicating that the students were negotiating the social norm to *make space* from the perspective of equitable participation, while the social norm to explain one's reasoning had become taken-as-shared.

Support for Individual Participation

Outside of small group presentations, we noticed that females were more apt to participate early on if participation was an explicit requirement made by the teacher (like in the group presentations). However, this requirement is more difficult to make in a whole group setting where students are expected to report out individually. This was a point of contention for the instructor as she did not want to force students to report out on topics in which they do not feel empowered to speak to, but still wanted to resolve issues of inequitable participation in whole group discussions. Significantly though, the teacher noticed that after imposing the group participation structure in course activities, girls began to participate more readily in whole group discussions where a group presentation structure was not enacted. Thus, it is conjectured that the group participation structure in surrounding activities may have served as a motivator for those students who typically sit on the margins of class discussions to speak up in discussions without that enacted structure. In addition, a final participation structure that was sought by the female students in their feedback, was to integrate small group talk into whole class discussions, e.g. affording time for students to confer with their group mates before responding publicly to a prompt. According to the female participants, this allowed them to consider and discuss the prompt prior to speaking out in the whole group context, and thus removing some of their feelings of vulnerability.

Establishing the Need for Meaningful and Equitable Participation

The process of establishing social norms for meaningful and equitable participation requires ongoing attention. For instance, after a breakdown of the social norms on day 11, the instructor modified her lesson plan to facilitate a Timed Writing activity on day 12 for the purposes of reestablishing the social norms for meaningful discourse and to promote students' belief in the need for equitable participation. The discussion that ensued was significant because it not only gave us evidence of how students framed the idea of equitable participation, but also had a significant impact on their ways of participation moving forward.

In this activity, students were to open a Google Doc, and write continuously for two minutes each in response to eight prompts. The teacher then asked the students to respond to the first six prompts verbally as a class. The final two prompts were intended as reflective questions that supported the first six, but students were not expected to discuss them publicly unless they were comfortable doing so. She took projected notes on their responses in order to provide a collective visual representation of the class expectations for discourse and participation. The timed writing prompts are listed in Table 2, followed by our analysis of student responses to prompts 6 and identified discursive practices that seemed to support their beliefs in the importance of meaningful and equitable participation.

Table 2. Timed Writing Prompts

1.	What is your purpose for being in this course? What are your goals? What can you do to accomplish these goals? What can your classmates do to help you accomplish these goals?
2.	What does it mean to be an academic? What behaviors does this entail?
3.	What does it mean to engage in academic discourse with your peers? What behaviors from you and your peers may support academic discourse?
4.	What counts as a "good" question in an ethical data science course?
5.	What counts as a "good" explanation in an ethical data science course?
6.	What counts as meaningful and equitable participation in class discussions and tasks? Why is this important?
7.	Do you feel that you meaningfully participate in every discussion/activity? Why or why not? If you hesitate to meaningfully participate in every discussion, why do you think this is the case? What changes could be made to encourage your meaningful participation?
8.	Do you feel that your participation allows for other voices to be heard? Explain. What could you do differently to encourage and value the voices of your diverse peers?

Regarding Prompt 6, it was necessary to define the term equity in order to help students conceptualize and qualify equitable participation as necessary. Consider the following excerpt from the whole class discussion:

Instructor	What is the difference between the word equitable and the word equal?
Sam (White Male)	Equitable is just getting what they need, uh, equal is everyone gets the same thing.
Instructor	[...] So when we are having equitable participation, what do you think that means?
Moksh (Indian Male)	When people who speak most speak a little bit less and people who don't speak much, speak more.
Instructor	Right? And it just means giving that space. And it's not saying that people who speak up need to be quiet and, and not talk the entire time, but it's waiting, encouraging others maybe to speak up that don't necessarily speak up more often.[...] it's being aware of how your position in the classroom or in whatever room you're in, can affect how others communicate, and

	then being someone who can encourage those others to communicate, or vice versa. It's if you are not necessarily someone who likes to speak up, challenging yourself to get out there and, and speak up and ask those questions and share your opinion because it's a valid and valuable opinion that people should hear.
Richard (White Male)	[...] I was kind of thinking like, equitable is like, you give your participation and you receive like output from other people.
Instructor	Knowledge from others, right? [...] Why is it important to have diverse people in different institutions or in different classrooms or in different jobs or as data scientists?
Moksh (Indian Male)	So that represents the population. So that our values and stuff are represented.
Instructor	Yeah. Why?
Monica (Black Female)	Because like, people from different backgrounds carry like, like different experiences with them. So if you don't have one person's experience that may be representative of that person's group, then you're missing that kinda nuance and those kinds of things that could help your product or whatever you're doing, be more fair and equal for everybody else.

In the excerpt above, the students themselves conceptualize the meaning of equitable (as opposed to equal) and apply this conceptualization to the classroom learning environment by describing what this means in terms of student behaviors (e.g. Moksh explains that equitable participation translates to conversationally dominant students stepping back to let others have a voice). The teacher then uses this as an opportunity for students to make conjectures about why equitable participation is important. Significantly, this discussion served to redefine students expectations for meaningful participation such that, rather than place the onus of participation on individual students as a means to evidence their competence, intelligence, or work ethic (typical of traditional classrooms), as negotiated in the EDS classroom, equitable participation must be positioned as essential for the promotion of authentic understanding.

Connecting Back to Student Identity

We conjectured that students' participation in the social norm to make space for others to explain their reasoning is intricately connected to their personal identities and social orientation. That is, their beliefs about who should have

a voice in the classroom depends on their positioning in that space and in society, while their obligations for learning (self, peers, society, etc.) (Cobb et al., 2009), may dictate how students participate within that space. Thus, to better understand students' motivations for participating (or not) in the social norm to explain one's thinking, we drew on student feedback collected by the instructor throughout the course.

Male Participation

Findings from these data sources confirmed that despite the enacted task and participation structures, elements of students' fragile STEM identities related to gender and culture may have had an effect on their ability/willingness to participate in the norm to explain. For instance, our analysis of student participation and feedback from the EDS course suggests that, from the onset, males as a collective group seemed much more comfortable explaining in class activities, though some of the Asian males expressed discomfort in qualitative discussion. This held for most task and participation structures and was seemingly stable from the first week of classes. Consider the following male students' responses regarding their feelings toward participating at the beginning of the EDS course:

Oliver (Asian Male):	I did not feel any reservations about participating at the beginning of the course. Asian identity likely impacted this, because it's usually stereotypical to think that Asians are at the top of the class so it influenced my ability to participate.
Sam (White Male)	I felt pretty good as in school it's pretty normal for me to be active in discussions so it wasn't too hard for me here.
Arjun (Indian Male)	At the beginning of the course, I didn't feel much competence in my ability to meaningfully contribute to the class/group discussions. This was because I didn't know much about data science and its ethical implications. Thus, I didn't have a lot of meaningful ideas to share with the class. Hence, I put in a lot of effort to understand how data science works and its ethical implications upon the society. [Additionally] I didn't know my peers that well and didn't know how they will perceive my responses. I was very anxious about not making a fool of myself, so I refrained from participating.

We conjecture that differences in male participation and their feelings of belonging could be due to cultural differences between the males in the course. Namely, the White males were comfortable in any setting (potentially speaking to their dominant positions in U.S. society) while the Asian males and one of the Indian males seemed less comfortable speaking out in qualitative discussions than in the more technical lessons. When compared to Sam's responses, Arjun and

Oliver's responses reflect findings from the literature regarding differences in the agentive and communal goals between White and Asian cultures, their positive STEM identities, and their cultural emphasis on STEM fields which are traditionally situated in technically, abstract, and/or procedural settings (Riegle-Crumb et al., 2020). Thus, it is possible that effects of the Asian minority myth or the "good at math and science" stereotype are internalized by Asian males to favor "masculine" technical educational settings. At the same time, such designated identities also convey Asian males as ""passive, compliant, and apolitical" (Riegle-Crumb et al., 2020, p. 106), qualities that are societally projected as positive characteristics that align with their academic and occupational success but restrict them from being comfortable in sociopolitical settings.

In addition to males' generally high levels of participation, we also observed a noticeable lack of space given to others, namely females, in class discussions. At the beginning of the course, class discussions were largely dominated by four White males and one Indian male. Gradually, as participation and task structures were modified to allow more space for their quieter peers, some of the females began to take up that space either by their own volition (Monica) or by designed participation structures from the teacher (e.g. all group members must present). However, while navigating participation norms and structures, the dominant males continued to control, albeit subtly, by consistently presenting first or contributing most to group presentations. Importantly, this did not seem to be a conscious move on the part of these students. Rather it seems more likely that their conditioning from performance-based classroom environments that promote quick responses, coupled with their agentive goals, may have played a role in how they participate in class discussions. That is, their comfortability with, and motivation to prove their competence and ability in what they would typically consider a competitive environment (Abele et al., 2007; Ridgeway 2001).

It is further conjectured that the males in the EDS course may have consciously or unconsciously viewed their female counterparts as less competent (Grunspan et al., 2016), as evidenced by the males consistently taking the lead or presenting for their female counterparts. That is, the males either placed themselves in a superior position according to their agentive motivation to show competence, or in what they may have considered a supportive group role from a communal standpoint. With that being said, after the Timed Writing activity in week 3 (discussed in a subsequent section) there was evidence that dominant students were beginning to think deeply about the space that they afford to others. For instance, consider Andrew's (White male) statement that

> I am by no means the leader of every discussion and the most frequent speaker, but still speak more than a handful of other students in this class. I think this is because I don't like silence, but *that is just an excuse and more conscious awareness will make it very easy to just wait for other voices to be heard*.

Female Participation

With regard to the girls in the course, our findings were analogous with the STEM identity literature which states that the designated identities of females in STEM impact both the self-efficacy of the females themselves and the social expectations of their peers. In the context of the EDS course, this in turn seemed to affect the girls' feelings of subordination and their ways of participating in classroom activities and norms. After noticing the lack of participation from females in class discussions in the first two weeks of the course, the teacher attempted to understand the girl's hesitations by conducting a small focus group discussion between class sessions. Responses included that they (1) felt others knew more about the subject and thus preferred to listen, and (2) were fearful of being wrong in front of classmates and/or the teacher. Thus, the collective female students' perceptions of others knowing more about the content and thus having more important contributions contributed to their lack of confidence in participating in the norm to explain their reasoning during whole group discourse. However, like for the males, the females demonstrated different ways of participating in and negotiating this social norm, supporting that self-efficacy and participation in data science settings are not only gendered but cultural as well (Riegle-Crumb et al., 2020).

At the beginning of the course, the White females' lack of participation appeared to stem primarily from their feelings of incompetence regarding their data science and sociopolitical knowledge in relation to their peers and the teacher. That is, they did not want to seem less intelligent or able, by saying something wrong.

Faye (White Female)	At the beginning of the course, I did not feel very competent in my ability to meaningfully contribute to discussions in class. This was because I knew little of the subjects being discussed, since I had no previous experience in data science.

In contrast, Aashvi, the sole Indian female in the course, felt very comfortable with the data science content but felt more discomfort in the sociopolitical/ethical discussions and with public speaking in general. In addition, she cited her discomfort sitting away from her friends in cases where small groups were assigned, indicating a potential internalization of the gendered, racial, and

intellectual *other* stereotype imposed upon Asian females (Shah, 2019; Shrake, 2006). That is, the model minority and "good at math" stereotypes position Asian females as superior to their female counterparts, but as subordinate to her male peers in a technical setting. At the same time, like her Asian male peers, she may be viewed as passive and apolitical, potentially speaking to her discomfort with public speaking and sociopolitical conversations (Riegle-Crumb et al., 2020, p. 106).

Aashvi (Indian Female)	At the beginning of the course, I felt very competent in my abilities in meaningful contribution to the class because I had a little prior knowledge in the field of data science.[...] In the middle of the course, I realized that the class discussions were more than just specific knowledge of the field of data science. It was also about the impact of data science to the people around the world [...] which I wasn't very well versed in. As a result, I felt a little less confident in my abilities to meaningfully contribute in class discussions. However, towards the end, after the encouragement from the instructor and feeling more confident about myself, I felt more propelled to express my opinions.

Unlike the other females in the class, Aashvi's prior knowledge related to data science contributed to her feelings of competence at the beginning of the course. Yet, her observed lack of participation in the norm to explain her reasoning during class discussions resonated more with her expressed discomfort speaking in socio-political contexts. Thus, Aashvi's negotiation of the norm to explain her thinking was intimately tied to her feelings of competence both with the technical and qualitative course content and in relation to her peers.

Finally, Monica, the sole Black female in the course, again participated differently than the others, likely due to her cultural positioning. At the beginning of the course, she felt few reservations about participating in class discussion, but felt much more comfortable discussing sociopolitical topics than technical ones. Like Asian females, Black females deal with the effects of intersectional marginalization (Crenshaw, 1991) and stereotype threat (Spencer et al., 1999) in STEM classrooms. In contrast however, Black women are simultaneously subordinated based on gender *and* race to both their White and Asian counterparts (Riegle-Crumb et al., 2020). While it could be expected that this would impact her participation and performance in a negative way, Monica demonstrated resilience to such stereotypes through her agentic and communal motivation. Namely, she noticed a lack of participation from other females which catalyzed her motivation to speak up and dismantle the male dominated discourse that had taken a hold on the class.

Monica (Black Female)	I felt obligated to participate for the other girls in my class. I noticed that not a lot of them spoke up and I felt that if I talked more, they would eventually do the same.

Thus, she was determined to make herself heard if not for herself (agentic motivation and personal empowerment), then for her female peers (communal motivation). She first took up this space in the sociopolitical/ethical discussions where she felt that she had more experience/knowledge, speaking to the effect of the task structure on her sense of empowerment.

Identity Connections to Task Structures

The argument for implementing *decision making, pluralistic*, and *qualitative* task structures in data science learning environments is related to the gendered and cultural positioning of students in those spaces and in society. Currently, women are positioned on the margins of the STEM disciplines and as subordinate to men in society (Ridgeway et al., 2004). To foster a sense of belonging, it is therefore imperative to provide opportunities for girls that support their ways of knowing and learning (like Monica above). For instance, Carol Gilligan, a pioneer on gender differences in moral development argues that girls tend to be more *connected thinkers* with a desire for understanding, relevant experiences, and discourse while prioritizing selflessness and caring for others (Gilligan, 1982; 1993). As such, activities which promote qualitative and ethical reasoning could be argued as essential for girls' development of self-efficacy in mathematical or technical settings. For instance, consider Monica's feedback related to *qualitative* task structures.

Monica (Black Female)	In the beginning of the course I felt very incompetent in my ability to contribute in our discussions about data science because I knew nothing about it. I knew that others knew about the topic and felt that it would be better if people who knew what they were talking about dominated the floor. When we talked about ethics, I felt more competent because that is an area I know a lot about.

Monica's comment here is indicative of the opportunities afforded to the mathematics education community by the data science methodology. Generally speaking, data science sits at the intersection of mathematics and statistics, computer science, and disciplinary knowledge. It is used daily by a myriad of entities across the globe to make impactful decisions in society. In a classroom context, the seamless integration of sociopolitical and ethical issues into the data science curriculum (i.e. the notion that data science cannot be studied separately from the target population of the dataset), allows instructors to encourage students at

different levels of understanding to contribute to the discussion. That is, students who may not yet feel comfortable speaking to the technical components, can speak to the impact of data science and BDA within their own communities. This serves both as a means to increase their confidence and sense of belonging, as well as promote collective understanding of the differential impact of data science.

While activities that promote qualitative and ethical reasoning seem to benefit students with fragile identities, such activities are often uncomfortable for males and other students of relative privilege (e.g. White females) in the STEM disciplines. However, we argue that engaging students from dominant groups in qualitative tasks may support their development of a collective social orientation as well as serve to dismantle the *privilege hazard* in the STEM disciplines due to their required consideration of the effects of their technical products and newfound experience navigating diverse conversational spaces. In sum, *qualitative task structures* provide a space for the typically masculine and/or relatively privileged students to discover their affective qualities.

Walter (Asian Male)	I thought that the readings gave me an insight on data science that I haven't considered beforehand. They provided real life examples and perspectives and allowed me to understand the adverse effects of not considering ethics while investigating data.
James (White Male)	Ethical Dilemmas in Data Science, Ethical Task, and the Documentaries allowed us to analyze different points of view, and discuss among people with varying life experiences.
Meredith (White Female)	In the Readings and Ethical Dilemmas assignments, I got to see real world examples of how big data is used and think about whether or not it is being used in an ethical way [...]. The readings showed examples where people are being affected [...] and how big data is pretty much screwing up so many people's lives, which I didn't even know was really an issue before starting this course. Just seeing these real life examples opened up my eyes to things that I didn't know were happening in the world.

Importantly, enacting decision making, pluralistic, and qualitative task structures is not enough to promote equitable participation. While the task structures themselves seemed to foster student empowerment by allowing a space for them to speak to their experiences, it did not guarantee that they would be afforded the space by their peers to do so. Rather the teacher must also be intentional about the participation structures that are enacted to create space until its need becomes internalized by the students.

Identity Connections to Participation Structures

The participation structures that supported students' equitable participation in data science activities and discussions included first, implementing a small group reporting structure where all students are required to present. This structure allowed non-dominant students the space to have their voices heard, while promoting the provision of space by dominant students. With regard to students' relational and fragile identities, requiring that all students present in a group reporting structure helps to establish the notion that all students' contributions are important and valid.

In the context of whole group discussions, especially those situated in technical or rigorous mathematical activities, non-dominant students further benefited from engaging in small group talk prior to reporting out. From these students' perspectives, small group talk reduced their feelings of incompetence because they were given a chance to both think, and talk through the topic before being required to speak on it. This simple structure served to reduce their feelings of vulnerability, and empowered them to have their voices and perspectives heard. With that being said, it was also essential to decenter the authority in the class by positioning the students and instructor as co-learners, and by consistently reminding students that "no one here is an expert". Rather, we are all there to learn and discuss the myriad of ways that data science can impact humans and ecologies, drawing on the diverse perspectives and experiences in the room, in order to develop feasible solutions that reduce harm for the future.

Furthermore, as evidenced in their timed-writing responses, many of the students began to consider their positioning in the classroom in relation to their peers (navigating their privilege, participating to encourage others, stepping back to encourage others, using their peers as a source of knowledge, etc.). This was a salient finding since, as Cobb and colleagues (2009) argue, shifts in the students thinking about participation and learning are related to their self-identified obligations for doing so. Findings from the post-course feedback form related to participation revealed that by the end of the course, students felt obliged to learn and participate for others (collective social orientation), likely contributing to the increase in equitable participation. Significantly, the majority of students' obligations from the beginning to the end of the course shifted to include one or both of their peers and society, as evidenced in student responses that follow:

Oliver (Asian Male)	I included my peers for the end of the course because of how I realized that me participating in class would help my peers possibly gain new ideas about a certain topic and pushes them to also contribute to discussions.
Sam (White Male)	Thinking deeper about the actual content of the course led me to realize who really benefits from this.

Monica (Black Female)	I felt obligated to participate for, specifically, the other girls in my class. I noticed not a lot of them spoke up and I felt that if I talked more, they would eventually do the same.
Faye (White Female)	I developed relationships with my teacher and my peers, and so my obligation to contribute on their behalf increased. In addition, I realized that data science affects society quite a bit, and so I felt obligated to contribute so I could make a difference in society hopefully in the future, and help others understand some of the things I learned.

On a final note, the results of this study indicate that the process of taking up social norms for participation and discourse are neither the same for all genders or across cultures. Thus, it is imperative that students are not only a part of the conversation in which the norms are developed, but that they serve as both leaders and beneficiaries. For instance, in the Timed Writing activity, the act of students first reflecting on their purpose for being in the course (i.e. to learn and transform society) and what it means to meaningfully and equitably participate, enabled them to engage in a collective discussion about their own needs and the needs of their peers in an academic discussion. This discussion served to remove the impetus to individually perform and instead learn for collective understanding and the betterment of society. Finally, collaboratively framing equitable participation as a means to achieve collective understanding functioned as a key discursive move for fostering students' beliefs in its importance. For instance, in a preceding section, we discussed the teachers' hesitation toward calling on specific students in classroom discussions. A key solution to this issue came in the form of students' contributions being treated as diverse and legitimate knowledge that serves to amplify collective understanding of the topic at hand. As a result, the teacher was able to comfortably call on specific students because it came from a place of seeking a valuable perspective for others to consider. As time passed, the students began to internalize this framing and typically quiet students began to contribute without prompting to have their perspectives heard.

Implications and Conclusion

As demonstrated in this paper, a Cultural Participation Orientation towards analyzing and refining educational design elements can support the negotiation of social norms for equitable participation in ethical data science classrooms. Given that students participate differently and according to their fragile, relational, and designated identities in STEM spaces, it is the teachers' responsibility to develop a cultural awareness of herself and her students and select course design elements that facilitate opportunities for learning which both honor and empower those

students, and foster collective learning for the class. In addition to the design structures offered in this paper, we argue that by facilitating a space where students with diverse intersecting identities are able to co-create a hybridized learning environment, educators are positioned to analyze student participation structures and modify classroom practices to support participation and meaningful discourse from students with different backgrounds. Importantly, and in contrast to the Cultural Alignment Orientation, this hybridized space is not intended to reflect the practices of bounded outside communities, but is instead developed by the students, for the students, in that particular space, and may not translate outside of that environment.

On a final note, with regard to privileged student populations, the intentional discursive moves and designed structures of the EDS course enabled the dominant students to reflect on their positions both in society and in the classroom as well as to value and encourage the voices and perspectives of others. Thus, it is essential to accept that privileged students are very capable of giving space, but they need the impetus to do so along with ongoing opportunities to reflect on why it is important. However, creating such an environment entails explicitly attending to the design elements that privilege some and restrict others in the classroom, industry, and societal contexts. Continued commitment to such initiatives by educators may help to dismantle gendered notions of STEM and data science success, as well as promote a communal social orientation both within and beyond the classroom. As a culminating point, consider the following course takeaways from select students:

What is your biggest takeaway from this course related to you as a learner, collaborator, human-being, etc.?

Walter (Asian Male)	That seeking help is not something I should be afraid of. I feel like [Instructor] created an environment that allowed us to comfortably ask questions and I really appreciated it.
Andrew (White Male)	This course has helped me become more confident in forming opinions and participating in academic discussions. I have been very unproblematic and un-opinionated for most of my life but this class (content and people) have helped me be less indifferent.
Faye (White Female)	My biggest takeaway [...] is probably learning to try to share my viewpoints. It was discussed a lot in the course how important it is to share my viewpoint because different viewpoints are valuable. I hope in the future I will be more willing to speak up and communicate better.

Aashvi (Indian Female)	My biggest takeaway [...] is to showcase my opinions. I learned that it is very important to partake in discussion and talk about my opinions so that others and I can gain more insight and learn new information.

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