EQUITABLE PARTICIPATION IN A MATHEMATICS CLASSROOM FROM A QUANTITATIVE PERSPECTIVE

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Inequity is a pressing concern in the mathematics education community. Recent research shows how inequity in everyday classroom interaction can shape student participation in subtle ways. This paper focuses on a tool, EQUIP, which uses a quantitative approach to illuminate aspects of such inequities. EQUIP cross-tabulates relatively low-inference indicators of classroom interaction with demographics (e.g., gender, race), in order to highlight inequities in participation across different groups of students in a given classroom. We present analyses of whole-class discussions in an elementary mathematics classroom taught by an experienced teacher with strong commitments to equity. Findings show that even though in most ways participation was distributed equally by gender and race, an intersectional analysis revealed statistically significant inequities for Latin@ male student participation.

Keywords: Equity and Diversity, Classroom Discourse, Gender, Research Methods

Equity is a theme that cuts across seminal policy documents in mathematics education (National Council of Teachers of Mathematics, 1989, 2014; National Research Council, 1989). The fundamental idea is that mathematics should be accessible to all students, rather than to only the privileged few (Ernest, 1991; Gutiérrez, 2002). And yet, while there has been some progress on this front, research shows that mathematics remains relatively inaccessible for children of color, young women, and students living in economically marginalized communities (Oakes, 2015).

In researching equity at the classroom level, prior research has conceptualized equity in terms of students' access to opportunities to participate in mathematical discourse and classroom activities (Esmonde, 2009; Herbel-Eisenmann, Choppin, Wagner, & Pimm, 2011; Langer-Osuna, 2011). Grounded in sociocultural perspectives that view participation and learning as fundamentally linked (Lave & Wenger, 1991; Nasir, 2002), much of this work has utilized qualitative methodologies. Indeed, our own work to date on equity in mathematics classrooms has been qualitative in nature (see Shah, 2009, 2013). However, the resource-intensive nature of high quality, in-depth qualitative analysis can make it difficult to conduct such research on a large scale. In this paper, we ask: what are the potential affordances (and limitations) of a quantitative approach to analyzing equity in classroom interaction, and how might quantitative approaches complement extant qualitative methodologies?

This paper introduces a classroom observation tool for analyzing equity-related patterns in classrooms called EQUIP (**E**quity **QU**antified **I**n **P**articipation). EQUIP offers a way of gathering and analyzing quantitative data on relatively low-inference dimensions of classroom participation. To illustrate our approach, we present an analysis of participation patterns in an elementary mathematics classroom taught by a highly experienced teacher with strong commitments to equity. Findings show that while in most ways participation was distributed equally by gender and race, an intersectional analysis (i.e., cross-referencing gender and race) revealed significantly lower levels of participation for the Latin@ males in the class. We argue that a quantitative methodological approach made it

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possible to identifying this inequity for Latin@ males, which otherwise may have been too subtle for even an equity-minded teacher to notice. We conclude by reflecting on how quantitative and qualitative methodologies for studying equity in mathematics classrooms might complement each other.

Conceptualizing Equity in Terms of Participation

Equity and equality are distinct concepts and should not be conflated. Whereas equality means that all students are treated in an identical manner, equity means that students should be treated in a fair manner (Gutiérrez, 2002; Secada, 1989). Achieving equity might involve one group of students being treated differently than another group of students. However, in certain situations, equality can be thought of as a baseline, or minimum requirement, for equity.

From a theoretical standpoint, we follow other researchers in conceptualizing equity in terms of student participation in classroom practices (see Boaler, 2008; Esmonde, 2009; Langer-Osuna, 2011). All students should have opportunities to participate in the disciplinary practices constitutive of the learning process, such as sharing ideas, asking questions, and justifying one's reasoning (Bransford, Brown, & Cocking, 2000). In order to provide students such opportunities, teachers should allot students ample time to engage in classroom discourse (Ball, 1993; Cazden, 1988;).

Equitable participation is about both *who* participates and *how* students get to participate (Wager, 2014). On a basic level, an equitable classroom can operationally be defined as one in which the amount of participation proportionally aligns with the demographics of the class. For example, if Black students make up 21% of the students in the class, then approximately 21% of class participation should be by Black students. However, beyond the issue of *who* participates, opportunities to participate should also be of a cognitively demanding nature (cf. Stein, Grover, & Henningsen, 1996). A classroom where all students participate—but only in low-level, Initiate-Response-Evaluate sequences—would be considered less equitable because students are not afforded opportunities to act as sense-makers.

Intersectionality

Building upon decades of work by activists, Kimberlé Crenshaw coined the term *intersectionality* to highlight complexities in the lived experiences of women of color that cannot be captured by examining race or gender alone (Crenshaw, 1991). Taking up intersectionality in Black feminist studies, Patricia Hill Collins defines intersectionality as "particular forms of intersecting oppressions," noting that "intersectional paradigms remind us that oppression cannot be reduced to one fundamental type, and that oppressions work together in producing injustice (Collins, 1999, p. 18). Mathematics education researchers have also leveraged intersectional perspectives to address issues of equity that affect traditionally and historically marginalized students in schools (e.g., Esmonde & Langer-Osuna, 2013; Gutiérrez, 2013). As we will show, our work is informed by the concept of intersectionality.

Methods

Video data were collected during a two-week, university-based elementary mathematics summer program. The program consisted of 30 hours of instructional time (3 hours per day, for 10 days), which focused on fraction representations and how to participate in mathematical discourse. A typical class session involved small-group work, individual work, and whole-class discussions (WCDs). The course instructor had over 30 years teaching experience and a strong disposition towards equity. During the program, the instructor collaborated with various colleagues in the mathematics education community to discuss pedagogical issues, such as how to manage equitable student participation.

The program consisted of 30 rising 5th grade students, who had been identified as struggling at

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their home schools by coordinators of the summer program. Racial demographics were as follows: 21 (70%) Black Students, 5 (17%) Latin@ students, and 4 (13%) White students. Gender demographics were evenly distributed between male and female students within each racial category. The forthcoming analysis focuses on classroom interactions in WCDs, which are a centerpiece of mathematics classrooms at all grade levels, and thus represent an important context for study.

Analytical Approach

The field has produced observation tools for analyzing mathematics classroom activity, several of which account for issues of equity (e.g., Schoenfeld, 2014; University of Michigan, 2006). However, a limitation of these tools—perhaps because equity was not their primary conceptual focus—is that they do not illuminate how opportunities to learn can become inequitably distributed across markers of difference (e.g., gender, race, language proficiency). The EQUIP analytical approach is predicated on three basic equity-related questions: 1) who gets to participate; 2) what is the nature of that participation; and 3) how are different forms of participation distributed across the students in the class? That is, do all students participate in cognitively rich ways, or are those opportunities only made available, for example, to the White and Asian students, or male students, or English dominant students in the class?

EQUIP uses "participation sequences" as a fundamental unit of analysis. A participation sequence is a consecutive sequence of verbal turns between a single student and a teacher. When another student speaks, a new participation sequence begins. Each participation sequence is coded using the following relatively low-inference dimensions of participation: *WCD type, solicitation method, student wait time, talk length, type of student talk, teacher solicitation, and explicit evaluation*. These dimensions concern: whether or not the discussion was mathematical (*WCD type*); whether and how the teacher solicited the student's participation (*solicitation method*); the level of mathematical explanation requested of the student (*teacher solicitation*); the time allotted by the teacher prior to the first verbal turn in the participation sequence (*wait time*); the level of mathematical explanation provided by the student (*type of student talk*); the most number of words uttered by a student in a single uninterrupted talking turn (*talk length*); and whether or not the teacher verbally assessed a student's response (*explicit evaluation*).

Findings

Overall, the data show considerable evidence of equitable classroom activity. The interactive style of WCDs in this particular classroom provided students opportunities to participate in rich mathematical discussions. This is evidenced by: the length of student talk, long wait time, and minimal explicit evaluation by the instructor. With respect to the length of student talk, students contributed on average 31 words per participation sequence, which indicates participation that goes beyond abbreviated or simple contributions. Further, wait time exceeded three seconds in 71% of participation sequences, which indicates that students were given time to think before responding to teacher solicitations. Finally, the teacher did not explicitly evaluate student responses in 80% of participation sequences.

In the next sections, we complexify these initial findings by disaggregating the data by gender and race, as well as by conducting an intersectional analysis by gender and race simultaneously.

Disaggregation by Gender

There were generally equal levels of participation for male and female students. We used a chi-squared test to determine whether there were any statistically significant differences in the quantity and quality of participation. Table 1 focuses on three dimensions measured by EQUIP that provide information about student participation: participation sequences, WCD type, and the type of student talk. For participation sequences, there was no significant difference by gender. For WCD Type, a

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chi-squared analysis also showed no difference by gender in student participation across mathematical and non-mathematical WCDs, $X^2 = 0.2193$, $p > 0.05$. For type of student talk, a chi-squared analysis also showed no difference by gender across four different types of student talk, $X^2 = 4.1227$, $p > 0.05$. While three dimensions related to teacher moves did show significant differences by gender, the effect sizes (Cramer's V) were "small" or "very small."

Table 1: Participation Sequences for WCD Type and Student Talk by Gender

	Participation Sequence (n = 1343)	WCD: Math (n = 1067)	WCD: Non-math (n = 276)	St. Talk: What (n = 393)	St. Talk: How (n = 40)	St. Talk: Why (n = 321)	St. Talk: Other (n = 586)
Female	647 (48%)	518 (80%)	129 (20%)	205 (32%)	21 (3%)	147 (23%)	273 (42%)
Male	696 (52%)	549 (79%)	147 (21%)	188 (27%)	19 (3%)	174 (25%)	313 (45%)

Disaggregation by Race

Compared with gender, analysis showed greater disparities in student participation by race. There were significant differences in student participation by race in nearly all of the dimensions. For the sake of continuity, this section focuses on the same three dimensions as in the previous section: participation sequences, WCD type, and the type of student talk (see Table 2).

For participation sequences, a chi-squared test indicated a significant difference by race, $X^2 = 18.581$, $p < 0.05$. The effect size (Cramer's V = 0.083) was small. As shown in Table 2, Black students were more likely to participate, while Latin@ students were less likely to participate. For WCD type, a chi-squared test indicated no significant difference by race, $X^2 = 0.1038$, $p > 0.05$. For type of student talk, a chi-squared test showed a significant difference by race, $X^2 = 11.1139$, $p < 0.05$. The effect size was very small (Cramer's V = 0.0644).

Table 2: Participation Sequences for WCD Type and Student Talk by Race

	Participation Sequence (n = 1340)	WCD: Math (n = 1067)	WCD: Non-math (n = 276)	St. Talk: What (n = 393)	St. Talk: How (n = 40)	St. Talk: Why (n = 321)	St. Talk: Other (n = 586)
Black	1018 (76%)	810 (80%)	212 (21%)	301 (30%)	32 (3%)	230 (23%)	458 (45%)
Latin@	150 (11%)	119 (79%)	30 (20%)	50 (33%)	5 (3%)	35 (23%)	57 (38%)
White	172 (13%)	138 (80%)	34 (20%)	42 (24%)	3 (2%)	56 (33%)	71 (41%)

Intersectional Analysis by Gender and Race

When considered independently, analyses indicated that, in general, participation by gender was more equally distributed, but that participation by race was somewhat inequitable. An intersectional analysis of gender and race revealed additional nuances in the equity dynamics of this classroom (see

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Table 3). For WCD type, a chi-squared test indicated a significant relationship, $X^2 = 30.2288$, $p < 10^{-7}$. Using a Fisher's exact test, we found that the effect size was small for mathematical WCDs (Cramer's V = 0.168) and medium for non-mathematical WCDs (Cramer's V = 0.292).

In addition to inequities in *who* participated in WCDs, we found inequities in the quality of student participation. A chi-squared test examining the relationship between the types of student talk and the intersection of race and gender showed that the relationship between the variables was significant for Why-level student talk, $X^2 = 15.5739$, $p < 0.001$. The effect size was small to medium (Cramer's V = 0.220).

A key finding here was that Latin@ male students in the class were much less likely to participate in Why-level Student Talk than any other group of students. From the previous discussion about racial patterns (Table 2), the data show that Latin@ students overall were less likely to participate in Why-level talk compared with Black and White students. However, the intersectional analysis reveals a gender disparity between Latin@ male and female students. In fact, in terms of the overall participation, the number of female Latin@ students' participation sequences was 2.75 times the number of male Latin@ students' participation sequences. This is striking in relation to the more modest differences between genders among both Black and White students.

Table 3: Participation Sequences for WCD Type and Student Talk by Race and Gender

	Participation Sequence (n = 1340)	WCD: Math (n = 1067)	WCD: Non-math (n = 276)	St. Talk: What (n = 393)	St. Talk: How (n = 40)	St. Talk: Why (n = 321)	St. Talk: Other (n = 586)
Black Female	447 (33%)	362 (81%)	85 (19%)	139 (31%)	16 (4%)	97 (22%)	194 (43%)
Black Male	575 (43%)	448 (78%)	127 (22%)	162 (28%)	16 (3%)	133 (23%)	264 (46%)
Latin@ Female	111 (8%)	85 (77%)	26 (23%)	38 (34%)	3 (3%)	27 (24%)	43 (39%)
Latin@ Male	38 (3%)	34 (89%)	4 (11%)	12 (32%)	2 (5%)	8 (21%)	14 (37%)
White Female	89 (7%)	71 (80%)	18 (20%)	28 (31%)	2 (2%)	23 (26%)	36 (40%)
White Male	83 (6%)	67 (81%)	16 (19%)	14 (17%)	1 (1%)	33 (40%)	35 (42%)

Discussion

A key takeaway from this study is that even in the classroom of an experienced, equity-minded teacher, inequities can emerge. In a sense, this is an important but unsurprising finding. Classrooms are complex spaces, and noticing subtle inequities can be difficult for even the most highly trained, well-intentioned teachers. Still, tools like EQUIP can support both researchers and practitioners in identifying inequities in classrooms. In our view, the methodological approach described here represents a step in that direction.

Overall, the data suggest that this was a classroom characterized by rich opportunities for students to participate in whole-class discussions. When disaggregated by gender and race, the data show minimal differences in participation. This is remarkable considering that there were over 1,000 participation sequences in the data set. However, an intersectional analysis revealed inequity in Latin@ male participation. Disaggregated analyses of this kind at increasing levels of granularity that account for intersectional subjectivities can provide important nuance to discussions of equity. This quantitative approach emphasizing relatively low-inference (but high leverage) dimensions of

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classroom activity has the potential to facilitate research on equity at scale.

To be clear, in highlighting the affordances of this approach, we do not mean to suggest that equity can be reduced to a mere "technical" concern (Secada, 1989). Equity—as distinct from equality—revolves around deep philosophical questions of fairness and justice that cannot be fully quantified. Students' subjective experiences around issues of equity are also critically important (Martin, 2006). That is, independent of the numbers, students must also *perceive* classrooms to be equitable spaces. Thus, in the spirit of looking across methodological borders, our goal is to consider how quantitative and qualitative methodologies might complement each other in mixed methods approaches to researching issues of equity in classrooms.

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