

Conceptualizations of Equity in Mathematics Education Research: 2000-2022

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We present work in progress that addresses the question: How do researchers in mathematics education define and operationalize the concept of equity in their work? Using a wide search of articles published in mathematics education research journals over the 2000-2022 period, we identified an initial sample of 47 empirical and theoretical articles, which was then reduced to 28 articles that operationalized or defined equity. In 17 of the 28 articles that included a definition, we found that equity definitions encompassed mainly notions of fairness, access, participation, and demanding mathematics, and we observed several references to bridging, identity, agency, and power. We summarize the scholars' rationales, purposes, and motivations for addressing equity across the 28 articles and suggest that a more critical stance is needed in the operationalization of a definition of equity.

Keywords: equity, mathematics education research, literature review, instruction

Addressing equity in mathematics classrooms has been a concern for mathematics education researchers since the 1980s (Secada, 1989; Stanic, 1989) and for the RUME community at least since 2018, when the following Equity Statement was issued:

The SIGMAA on RUME recognizes that equity issues are present and relevant in our research and practice. The SIGMAA on RUME affirms that as an organization we are committed to being critical and introspective about the ways that equity can be more meaningfully integrated into our discipline (<http://sigmaa.maa.org/rume/Site/About.html>)

The statement addressed “ways in which equitable practice can be furthered in the context of mathematics instruction” and “ways in which the SIGMAA on RUME aims to increasingly value and cultivate research on issues of equity in undergraduate mathematics” issuing “calls of action to the community to begin to remove or circumnavigate (...) barriers [to equity].” However, our perusal of the literature yielded very few research mathematics education studies addressing equity in undergraduate education and moreover, we found a multiplicity of definitions and in some cases, studies without a definition, perhaps suggesting that there is a common understanding of the construct. We believe that for advancing equity work through research, understanding how the community defines *equity* is critical. Most of the information, however, comes from work on K-12 contexts.

Prior to the 2000s, much work on equity was driven by significant differences in student outcomes by student characteristics such as gender, race, ethnicity, and socio-economic (e.g., Lee et al., 1997; Secada, 1995; Warren & Roseberry, 1995). The publication of the *Principles and Standards for School Mathematics* by the National Council of Teachers of Mathematics (NCTM)

in 2000 marked the first time in which equity was explicitly addressed as a principle¹ for teaching and learning in schools, paired with a notion of ambitious mathematics (Lampert, 2001) that was expected to be made available to all students. From such work, we have learned that equity is not equality (Secada, 1989) and that equity and social justice are intertwined terms. Yet, to inform research that improves practice, the research community needs a definition that can be operationalized, so that equitable teaching can be systematically studied. For this reason, we engaged in a literature review process that would allow us to answer the following questions as related to the US context: (1) What are the definitions or operationalizations of equity used in articles published in mathematics education journals in the period 2000-2022? and (2) How do researchers justify and motivate their equity work?

Methods

We searched for empirical or theoretical articles in peer-reviewed scholarly journals under the assumption that such work would have been vetted by the mathematics education community. The journals included: *Cognition and Instruction*; *Educational Researcher*; *Educational Studies in Mathematics*; *Journal for Research in Mathematics Education*; *Journal of Mathematics Teacher Education*; *Journal of the Learning Sciences*; *Journal of Urban Mathematics Education*; *Mathematical Thinking and Learning*; *Race Ethnicity and Education*; and *Review of Educational Research*. We chose 2000 as the starting year for the review, when the *Principles and Standards of School Mathematics* (NCTM, 2000) were published. This was necessary because most of the work on equity has been advanced with the K-12 context and has been used to investigate tertiary contexts (e.g., Leyva et al. 2021).

We searched various databases (e.g., ERIC, ProQuest, PsychInfo) for articles that dealt with equity and mathematics instruction (“equit*” AND “instruct*”, “equit*” AND “teach*”, and “equit*” AND “classroom”; added “math*” for non-math specific journals). We only selected articles that collected United States data. This was done to provide a common historical, cultural, political, and social context (e.g., the legacy of slavery, the Civil Rights and women’s movements, or immigration policies) for framing equity which is harder to assume for studies conducted in other countries. The process of identifying the analytical sample involved two steps (see Figure 1), screening (to eliminate articles that did not address equity) and focused reading (to identify key elements in the article related to equity). Eight researchers were involved in the process.

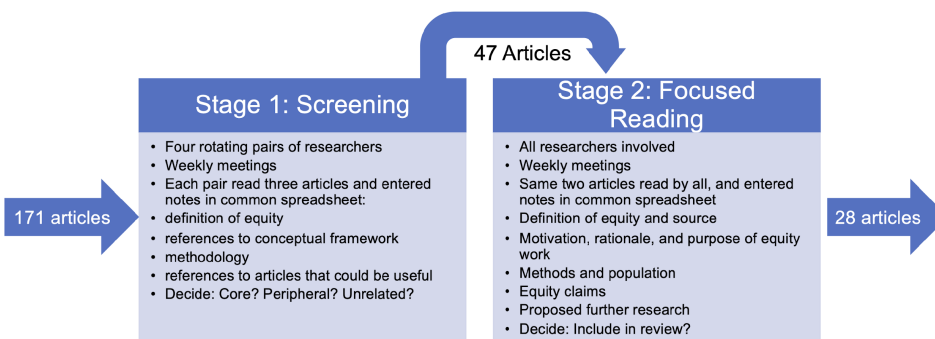


Figure 1. Article reviewing process. Note: Core: equity is central to the article. Peripheral: relevant topic for contextualizing equity. Unrelated: no mention of equity beyond reference list.

¹ **Equity.** Excellence in mathematics education requires equity—high expectations and strong support for all students. (NCTM, 2000, p. iv)

Preliminary Findings

The 28 articles included in this report were published in eight of the 10 journals chosen (see Table 1). Of these, five were theoretical papers and 23 were empirical studies. Twelve of the 23 empirical studies targeted students at various levels from elementary school through undergraduate students at university as the research population, eight on teachers, and three on both. Of the 12 articles that target students, three focused on elementary grades, six on middle school, six on high school mathematics, four combined data from middle school and high school, and four on undergraduate mathematics. Five articles did not specify a grade level. Sample sizes were relatively small: 1- 4 teachers for studies that focused on teachers and less than three classes for studies that focused on students. Two studies of students had large samples (288 and 522); two studies of teachers had over 20 participants (23 and 39). The theoretical papers did not specify a target population.

Table 1: Distribution of the 28 papers across the research journals

Journals	# Articles per Journal
<i>Journal for Research in Mathematics Education, Journal of Urban Mathematics Education</i>	6
<i>Mathematical Thinking and Learning, Race Ethnicity and Education</i>	4
<i>Educational Studies in Mathematics, Journal of Mathematics Teacher Education</i>	3
<i>Review of Educational Research, The Journal of the Learning Sciences</i>	1

In what follows, we present our findings on the definitions and operationalizations of equity and the rationales, motivations, and purposes for conducting equity research.

Definitions of Equity

Of the 28 articles included in this analysis, only 17 either defined or operationalized equity. The earliest two pieces, by Cobb and Hodge (2002) and Gutiérrez (2002), proposed two distinct conceptualizations of equity. Cobb and Hodge defined equity and diversity as correlated terms, with diversity referring to the different students' (in and out of school) practices that they participate in and with equity referring to how, once the common practices and less common practices are recognized, students can successfully access them, through mathematical reasoning that has "clout" (Bruner, 2009). Gutiérrez (2002) proposed that equity can be recognized when researchers can't predict inequities (in outcomes or in achievement) by individual traits. Her definition has three elements related to the practices enacted by teachers, students, and mathematics to (1) develop proficiency in dominant mathematics; (2) be critical of math and its role in society; and (3) improve the relationship between people, mathematics, and society to erase inequity (that requires the cultivation of individual agency and the recognition of power) (p. 174). These two definitions made references to mathematics tangentially, Cobb and Hodge in terms of classroom practices and discourse and Gutiérrez in terms of "dominant" mathematics.

Esmonde (2009a, b) published two articles in 2009, both of which addressed equity. In her conceptualization of equity, two key distinctions are made—first, that equity relates to *fairness* ("a qualitative sense of fairness", 2009b, p. 1010) and second, that equity and equality are not the same. Esmonde used a definition of equity that refers to a fair distribution of opportunity to learn and a fair distribution of opportunities to participate in ambitious mathematics. In the set of articles we reviewed, this is the first time we observed an explicit reference to the *kind* of

mathematical content and instruction that teachers should be striving to offer, embracing students' contributions, beyond a general description of *dominant* mathematics.

The definitions present in the 12 articles published after 2009 have elements that strongly resonate with these four and in some cases advance the attention that researchers put on studying equity in classrooms. There are several constant features; for example, references to access to worthwhile, high level, or meaningful, rigorous, mathematics experiences and inquiry (e.g., Cross et al., 2012; Dunleavy, 2015; Felton-Koestler, 2019; Louie, 2018, Munter et al., 2019) or that all students should be offered such practices (Cho et al., 2022; Cross et al., 2012; Dunleavy, 2015; Hand 2012). But there are also differences, for example defining equity as a *process* (Gregson, 2013) with two components – first, giving students the opportunity to learn mathematics content, its processes and norms, and second, supporting those who do have not had access to those, in bridging their own cultural knowledge to get to the dominant one (e.g., Felton-Koestler, 2019; Lo & Ruef, 2020). The goal of this type of equity in mathematics is to reduce social inequity. This definition resonates with Gutiérrez's 2002 definition, but also with her 2012 article that framed equity as learning to “play the game” to being able to “change the game” (p. 11).

We observed other differences in how authors further specified the object of equity or how equity was to be realized; for example, in terms of how students relate to each other in classrooms and the recognizable actions that can lead to democratic learning communities (Sengupta-Irving, 2014), recognizing “competent sense-makers” (Dunlevy, 2015, p. 62), and acknowledging that racialized experiences can burden students when doing highly cognitive demand work (Munter, 2019); these scholars address agency, power, and identity, even when this is not explicitly stated. These definitions can be seen as influenced by Gutiérrez's (2012) chapter that defined equity along two axes, a dominant one that related access and achievement and a critical one that related to identity and power. The influence of this piece is seen throughout several of the articles, notably Mintos et al. (2019), who used this framing in their study of how equity was taught in secondary teacher education programs.

One final element of the definitions from the later articles refers to how researchers and teachers notice, become aware, or recognize equity or inequity, and indicate that such noticing is fundamental to social justice work. We note that while all 17 articles made some reference to fairness in access and opportunity to participate and learn, very few assumed a critical stance regarding the role of mathematics in maintaining the status quo or addressed specific individual identities. Almost all the articles emphasized that equity work should be for *all* (e.g., “broad range of learners from dominant and nondominant ethnic, racial, and linguistic backgrounds in rigorous mathematical inquiry”, Hand, 2012, p. 237) which erases the need to attend to identity.

Purpose, Motivations, and Rationale for Conducting Equity Research

In our analyses, we defined *purpose* as the objective of the article, specifically the questions the authors wanted to answer or the argument they wanted to make; *motivation* as the reason why authors identified the purpose, or the broader context that made the purpose worth pursuing; and *rationale* as the authors' reasons for why equity is worth researching; the rationale signals macro-level aspects (e.g., society) whereas purpose and motivation are specific to the article. Empirical studies and theoretical articles had different purposes. The most common purposes in empirical studies related to analyzing teachers' practices and implications for equity (e.g., Battey, 2013; Gregson, 2013), teachers' learning about and understanding of equitable instructional practices (e.g., Felton Koestler, 2019; Mintos et al., 2019), understanding what specific curriculum or pedagogy works for whom (e.g., IBL for women, Ernest et al., 2019), and

understanding the relationship between equity and how students work in groups (e.g., Esmonde, 2009a; Lo & Ruef, 2020). The most common purposes of theoretical pieces were to offer a new perspective on equity research, for example that equity research needs a critical perspective (Gutiérrez, 2002) or that equity is “a delusion” and antiblackness needs to be addressed (Martin, 2019). Motivations included (1) responding to or testing out a reform curriculum or pedagogy (e.g., Lubienski, 2000; Johnson et al., 2020), (2) addressing gaps in understanding of teacher practice and preparation (e.g., Gregson, 2013; Hunt et al., 2022), and (3) arguing that current perspectives on equity are incomplete (Gutiérrez, 2002; Louie, 2018). The latter was present in theoretical and empirical articles and includes motivations for countering a deficit-based lens (e.g., Berry et al., 2014; Boaler, 2002b). Rationales included the unequal access to learning mathematics and achievement gaps by social identity groups (race, gender, or SES). In this case, the rationale for researching equity was that students need or should be able to participate and succeed in mathematics, and that this is not currently happening. In contrast to unequal access, Martin (2019) and Gutiérrez (2002) centered the field of mathematics, not the students, as the rationale for why equity needs to be attended to. Gutiérrez (2002) noted that the field of mathematics could benefit from perspectives from marginalized groups and Martin (2019) pointed out that mathematics needs fundamental change to support the liberation of Black learners. Though all the articles argued for change in some respect, Gutiérrez and Martin are notable because they shifted attention to mathematics away from students’ success and reminded researchers that students have agency in this process.

Discussion

Across the articles analyzed, we saw definitions and purposes that directly responded to, or challenged, reform practices and definitions of equity in the wake of NCTM’s (2000) *Principles and Standards*. In post-secondary education, the two studies that investigated equity did so by identifying *inequities* (in performance, e.g., Johnson et al., 2020; in participation, Ernest & Reinholz, 2019), so equity is only possible to identify when it does not occur. We recognize the need for equity after inequity has been measured. Such approach is aligned with Gutierrez’s 2002 proposal that we will be able to say that equity is achieved when we can’t predict performance based on identity traits. Our findings suggest that such a strong focus on responding to calls for reform might prevent giving greater attention to taking a critical perspective on equity. The scholars’ focus on the dominant axis of access and achievement (Gutierrez, 2012) may unintentionally disengage with the critical access that requires attention to both identity and power. Finally, we noted that the varied definitions are symptomatic of a field that has not grappled with unifying forces to collectively investigate equity so that it can further inform practice across contexts.

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The * indicates an article included in the review.

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