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A Critical Review of Educator and Disability Research in Mathematics Education: A Decade of Dehumanizing Waves and Humanizing Wakes

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Disabled students have historically been dehumanized in education, generally, and in research and practice related to school mathematics (K–12), particularly. Typically, they are only offered access to low-rigor school mathematics emphasizing rote procedures and narrow skills, often segregated physically and socially from their nondisabled peers. Educators are crucial to the humanization of disabled students via anti-ableist and antiracist work toward systemic transformation. The purpose of this review is to take stock of the current knowledge base of educator and disability research concerning school mathematics, recommending directions for humanizing future research and practice. Through a humanizing mathematics education lens, we analyze 61 articles involving educators, disabilities, and school mathematics published during the decade between 2007 and 2016. Results of our analysis point to not only the continued perpetuation of dehumanizing approaches and positioning but also substantial shifts toward humanization in mathematics education for disabled students. Over half of the studies reflected humanizing shifts. Yet, overwhelmingly, studies continue to avoid meaningful intersectional considerations of race and disability.

KEYWORDS: mathematics, special education, teacher education, ableism, disability, equity, identity, systemic change, race, literature synthesis, humanizing education

As early as 1994, 92 governments and 25 international organizations expressed via the Salamanca Statement (UNESCO, 1994) their disposition to “promote the approach of inclusive education, enabling schools to serve all children, particularly those with special educational needs” (Tomlinson, 2017, p. 3). This global impetus crystalized in 2006 with the enactment of the Convention on the Rights of Persons with Disabilities (CRPD), which fosters inclusivity under the principles of *dignity, full and effective participation and inclusion in society*, and *effective education* as a matter of human rights for disabled¹ students (Broderick, 2018). In U.S. K–12 schools, such human rights principles have been slow to materialize. Many disabled students continue to be dehumanized through exclusion in nearly all aspects of schooling (U.S. Department of Education [USDOE], 2016), facing the stigmatization of being labeled (e.g., Shifrer, 2013), being more likely to receive suspensions (e.g., Krezmien et al., 2006), being exposed to dangerous restraint and seclusion practices (Gage et al., 2020), as well as subjected to bullying and harassment (e.g., Hartley et al., 2015) compared to their nondisabled peers. Those with more “severe” disabilities are often thought of as visitors in general education classrooms (Tan, 2017b; Tan & Thorius, 2019) and at times forced to spend their academic learning time cleaning or collecting trash and recycle materials.²

Dehumanization is particularly acute in mathematics education research and practices,³ where disabled students are often constructed as deficient and need remediation (Borgioli, 2008; Lambert & Tan, 2020; Tan & Thorius, 2018; Tan, Lambert, et al., 2019). They are pathologized and segregated from their nondisabled peers physically, socially, and intellectually while being subjected to watered-down mathematics content and learning processes (Borgioli, 2008). Moreover, the mathematics of disabled students (Tan & Kastberg, 2017), such as their personality, courage, brilliance, creativity, resourcefulness, unique perspectives, and ways of knowing and being, are often nullified because individualizing their education, paradoxically, equates to prescribing a single oppressive and acultural mathematics teaching method (i.e., direct teaching akin to Freire’s [2000] banking concept). In turn, opportunities to cultivate reasoning, understanding, insights, and cultural connections of mathematics as a human endeavor are less available to disabled learners compared to their nondisabled peers (Jackson & Neel, 2006; McKenna et al., 2015). Yet evidence suggests that disabled students can engage in rigorous, rich, and sophisticated forms of mathematics in nontracked and inclusive settings (Baroody, 1999; Tan & Thorius, 2018; Van den Heuvel-Panhuizen, 1996; Watson, 2002). Such disconnect between research findings and mathematics classroom practices points to limited research knowledge, existing practices, and work with educators that advance inclusive and equitable practices in general (Waitoller & Artiles, 2013) and, in particular, humanizing mathematics education for disabled students (Tan, Padilla, et al., 2019).

Disturbingly, the role of educators is often absent in disabled mathematics educational research, where the overwhelming focus is on students as the unit of analysis in remediating their deficits. In Lambert and Tan’s (2020) review of the literature, for example, research that included disability was far less likely to have educators as a unit of analysis when compared to research in mathematics

education that did not include disability. While 36% of articles that did not include disability were focused on educators, only 7% of articles that included disability focused on educators. We take studies that focus on educators as a unit of analysis to mean that educators' role is a central variable to the study (e.g., examining the effects of teacher professional development on disabled students' mathematics achievement outcomes, analyzing teachers' mathematics curriculum and pedagogy involving disabled students, or studying teachers' perspectives and attitudes involving the inclusion of disabled students in general education mathematics).

Focusing only on the mathematics of disabled students without meaningful consideration of the social and situatedness of mathematics teaching and learning is reductive and dehumanizing. Research that erases that context can be dehumanizing insofar as it presents a limiting view of students' potential. Indeed, over the past few decades, the field of mathematics education research has taken both a social (Lerman, 2000) and a social-political turn (Gutiérrez, 2013). Yet Lambert and Tan (2020) report that mathematics education research that includes disability most often takes up behavioral (27%) and medicalized (22%) approaches to learning, with less research taking constructivist (10%), sociocultural (6%), or sociopolitical (7%) perspectives. In contrast, mathematics educational research that was not focused on disability most often investigated teaching and learning through constructivist (33%) and sociocultural (21%) approaches to learning, with only 4% of that research taking a behavioral perspective. Disability in mathematics is studied with a lens that focuses on behavior rather than developing understandings of the complex sociocultural and sociopolitical contexts through which learning occurs. Given that mathematical knowledge and inquiry-based skills constitute a crucial gatekeeping stumbling block for students to thrive in and out of schools (Martin et al., 2010), Lambert and Tan's (2020) research points to the importance of education researchers and practitioners in improving the lives, cultural connections, and opportunities for and with disabled students (see also York-Barr & Duke, 2004). This is particularly crucial for disabled students of color who experience the everyday intersectional oppressive weight of racism and ableism (Annamma et al., 2013; Bal & Trainor, 2016).

Ableism encompasses social prejudices, discrimination, and constructions of and against disabled individuals as inferior and incapable (Hehir, 2002). Ableism operates in the mathematics classroom, including towards disabled students of color (Lambert, 2015). This can result in self-defeating and distorted disabled identities grounded on internalized learned helplessness, which lead to default marginalizing decisions and practices by mathematics educators (Padilla & Tan, 2019b; Tan, Lambert, et al., 2019; Tan, Padilla, et al., 2019). Racism and ableism are not the same processes but, rather, can coconstruct and influence each other (Annamma et al. 2013). Disabled students of color experience the effect of both processes of exclusion and dehumanization; thus, we must better understand how the processes interrelate and how they feel to students. Therefore, we regard the intersectional dimensions of anti-ableist and antiracist humanizing practices as core in transformative mathematics education. Indeed, teacher educators' top priority of "deep, integrated focus on equity" (Association of Mathematics Teacher Educators [AMTE], 2017, p. 1) is central to addressing nuanced and intersectional justice issues of racialized and gendered disability dynamics with both practicing

and prospective educators to move toward global calls for humanization of disabled individuals and their sociopolitical modalities of inclusivity in mathematics contexts. Consequently, using a critical lens and grounding our analysis firmly on Disability Critical Race Studies' (DisCrit) (Annamma et al., 2013) intersectional race and disability tenets, we take stock of the current knowledge base, recommending directions for humanizing future research and practice.

Our Positionality and Approach

We are Disability Studies in Education (DSE) scholars. As such, our research is concerned with critically understanding social, cultural, historical, and individual concepts of disability (American Educational Research Association [AERA], 2017). DSE analyzes disability through social models (and revolutionary models [e.g., Tan, Padilla, et al., 2019]). DSE posits disability as a social construction dealt via spaces of exclusion and oppression in educational contexts (Annamma, 2018; Gabel, 2005). DSE scholars acknowledge biological differences but are critical of the unjust responses to those differences (Siebers, 2008). Such responses are grounded in ableist perspectives (e.g., medical model) that, in contrast to a social model, view disability as deficits located within individuals (Valle & Connor, 2011). DSE scholars also aim to better understand and disrupt in creative and collaborative ways ableist practices, which lead to a disabling view of individuals (AERA, 2017; Lambert & Tan, 2017, 2020; Lewis & Lynn, 2016). For example, DSE scholars critically examine educators' stereotypic perceptions and discriminatory practices in schools.

We are deeply connected to disabilities as scholar-activists, being a parent of a disabled individual, as a Blind person, and/or as former classroom teachers who worked closely with and for disabled students and their families. Two of us identify as scholars of color. Despite our DSE and critical disabilities studies grounding, which calls for radical antideficit and anti-ableist redefinitions of disability (e.g., Kumari Campbell, 2009), for this study and to facilitate dialogue with educational researchers and practitioners, particularly in the categorization of articles in our sample, we have opted to explore educational research centering on disability (as a collective of 13 disability categories defined by the Individuals with Disabilities Education Improvement Act [IDEA, 2004] and across K–12 grade levels) and race that involves educators of mathematics. We attempt to critically capture broad change tendencies within recently published empirical research, specifically relating to (de)humanization.

Humanizing Mathematics Education

We define humanizing mathematics education as a justice- and human rights-seeking political struggle for and with disabled individuals and their families within and through school mathematics. This struggle involves anti-ableist, anti-racist, and pandisability stances (i.e., encompassing the full range of human disabilities) that target various dimensions of mathematics educational domains (Padilla & Tan, 2019a, 2019b). Because "humanization is anti-oppressive and counter-hegemonic" (Camangian & Cariaga, 2021, p. 2), humanizing mathematics education seeks to affirm and cultivate complex, intersectional, and gifted cultural beings through inclusivity, equity, and social justice for and with

marginalized groups. Undergirding this current study's humanizing mathematics educational lens are frameworks from DisCrit (Annamma et al., 2013), disability studies in mathematics education (DSME) (Tan & Kastberg, 2017), and rightful presence (Calabrese Barton & Tan, 2020).

Disability Critical Race Studies

DisCrit foregrounds the examination of race and disability as differentiated yet interconnected and coconstructed spheres of oppression (Annamma et al., 2013). DisCrit emerged as a response to the lack of critical race analysis in disability studies (Bell, 2006). Examinations of race are central: "Given the ways that race has figured so prominently in special education status . . . it is nothing short of irresponsible to leave race out of dis/ability related research in special education" (Annamma et al., 2013, p. 4). DisCrit's tenets include analysis of how race and disability are coconstructed, the multidimensionality of identity, the material and felt effects of being labeled as raced and disabled, and the voices of those in these intersections. Mathematics educational research has long fundamentally ignored analysis of race and racism, both in terms of teacher beliefs and institutional structures (Martin, 2009). In a review of mathematics educational research, Parks and Schmeichel (2012) found that most mathematics educational research that included race simply noted it as a variable or reported race while discussing participants, but few analyzed how race mattered in their findings. Using DisCrit as a theoretical reference point, one realizes that educational research has ignored both race and the relationships between racism and ableism. Therefore, there is an urgent need to consider how students' mathematics ability is distributed and withheld along racial lines and vice versa. Doing so would greatly improve mathematics education research capacity to address multiple oppression dimensions in their complex manifestation.

In particular, we focus our literature synthesis on the DisCrit concept of *dysfunctional educational ecologies* (Annamma & Morrison, 2018) whereby the gifts of disabled students of color are negated in favor of normalized and Eurocentric curriculum, pedagogies, and ways of knowing and doing. Thus, dismantling dysfunctional learning ecologies are acts of resistance (Annamma & Morrison, 2018) against such dysfunctional tendencies. Keenly cognizant that oppression dynamics derived from ableism are unique and often do not parallel those associated with institutionalized and other forms of racism, we expand this concept of *gift* to mathematics education. We do so by examining the extent to which research and practices draw on, for example, disabled individuals' personalities, courage, brilliance, creativity, resourcefulness, unique perspectives, and ways of knowing and being in mathematics teaching and learning contexts. Such expansion is in line with DSME's framework.

Disability Studies in Mathematics Education

Tan and Kastberg's (2017) concept of DSME embraces the sociopolitical turn (Gutiérrez, 2013) in humanizing mathematics education. They assert that systemic-level changes are required to examine, for example, the role of identity and political struggle. Similarly, DSME proposes that researchers critically and collaboratively work to address issues of disability in mathematics education research

that have long been ignored, minimized, and marginalized. Thus, mathematics education research must, for example, reckon with the normalizing discourse that considers the disabled as “less than” their nondisabled counterparts and, thereby, are historically denied opportunities to thrive socially and economically. The political struggle, hence, requires researchers and educators, alongside disabled students of color and their families, to demand rectification of the cumulative educational debt they are owed (Thorius & Tan, 2015). Political struggle also represents a major tenet of Calabrese Barton and Tan’s (2020) *rightful presence* framework, which we turn to next to provide further clarity on humanizing mathematics education.

Rightful Presence

In framing rightful presence, Calabrese Barton and Tan (2020) problematize the notion of inclusion as equity for minoritized youth. Consequently, they propose the following three tenets:

- (1) Political struggle is integral to disciplinary learning: the right to reauthor rights; (2) Rightfulness established through presence: making visible the intersections and justice/injustice in the present while orienting towards new social futures (*see also* Annamma et al., 2013 as this is also a core DisCrit tenet, with the important caveat that DisCrit authors explicitly address intersectional dimensions of race and disability as central to their analysis); and (3) Shared burden/cost between currently powered and the othered. Culture of disruption towards justice, where modes of power/authority are collectively called in question. (p 4)

While Calabrese Barton and Tan do not explicitly name disabled students, their assertions poignantly reflect the *illusive and elusive* nature (Park, 2020) of the more than four-decade-old inclusion movement for disabled students (e.g., Turnbull et al., 2013). In this sense, one is invited to question who benefits and why is it that inclusion is typically conceptualized as an “extension of rights . . . located in the abstract future” (Calabrese Barton & Tan, 2020, p. 4). Calabrese Barton and Tan argue that centering on attaining such illusive and elusive extension of rights is inadequate. For example, the mere extension of rights neglects (a) ways in which sanctioned mathematics curriculum is grounded in White supremacy and White privilege Eurocentric and ableist perspectives (Yeh, Tan et al., 2021) that maintain and reproduce social hierarchies, (b) educators’ negative views of disabled students (Allday et al., 2011; Tan & Thorius, 2018), and (c) social inequities beyond classrooms and schools (Martin et al., 2010). Thus, rightful presence in mathematics education requires a careful combination of injustice recognition and justice-oriented struggle in the immediate present. Indeed, justice concepts are central to how researchers have framed inclusive education involving disabled students to address in tangible ways exclusionary and oppressive research and practices through intersectional analysis (Waitoller & Annamma, 2017; Waitoller & Artiles, 2013). This, in turn, is consistent with calls from educational scholars at large to deal proactively with systems of

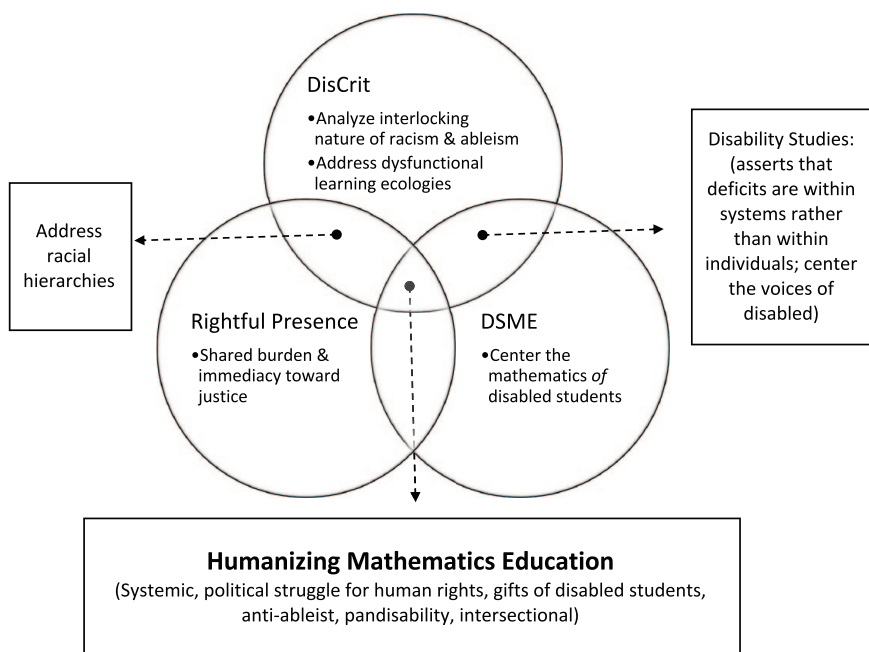


FIGURE 1. *Core ideas from each major framework and their intersections that we utilized to inform this study's conceptual lens.*

oppression (Dyches & Boyd, 2017; Pantíc & Florian, 2015; Waitoller & Artiles, 2013; Ware, 2001).

In sum, we synthesize *DisCrit*, *DSME*, and the *rightful presence* framework to guide a humanizing mathematics education lens. We pull central concepts from each of the three frameworks and areas they overlap (see Figure 1). From *DisCrit*, we are guided by the interlocking examination of racism and ableism as well as the notion of students' gifts. From *DSME*, we take these gifts as the mathematics of students. In line with *DisCrit* and *DSME*, we are critical of and resist the medicalized and deficit-oriented approach to disability. Drawing on *rightful presence*, we problematize inclusion as equity aligned with an interrogation of the historical stagnation in mathematics education for disabled students. Thus, resisting, agitating, and dismantling dysfunctional ecologies means, for example, immediately building a more robust knowledge base around recognizing and honoring multiple ways of knowing and doing mathematics (de Freitas & Sinclair, 2020; Turner et al., 2012). Critically examining and synthesizing existing literature is one path towards immediately informing educational researchers and practitioners. For this literature synthesis, we targeted empirical studies broadly related to the role of educators in mathematics disability research as they are pivotal in the humanization of mathematics education. Our literature synthesis is driven by two research questions:

- (1) To what extent does the central focus of studies published during the period between 2007 and 2016 approach or depart from humanizing mathematics education?
- (2) What are the central features of these studies related to de/humanizing mathematics education?

Methods

We searched the literature using keyword searches in ERIC, Education Research Complete, and PsycINFO databases to identify studies published between 2007 and 2016. We selected this range because (a) we wanted to capture relevant and relatively recent articles; (b) it follows the 2006 global impetus derived from the enactment of the CRPD, which fosters inclusivity; (c) previous related literature reviews essentially examined articles in prior decades (1982–2008, e.g., Boyd & Bargerhuff [2009] as well as van Garderen et al. [2008] who reviewed work in this area between 1984–2008 and 1998–2007, respectively); and (d) since the core of our analysis started in 2017, we decided to limit the articles to those published through 2016. The current review also expands upon an exploratory review on a similar topic that covered years 2013 to 2015 (Tan & Lambert, 2019) by not only covering 7 additional years of research and examining 46 more articles but also including a humanizing mathematics education analysis.

For this current review, we intend to avoid, to the extent possible, conventional divisive boundaries in education (e.g., general education vs. special education), but instead engage educators, researchers, policy-makers, and activists broadly, and in particular those who have an interest in humanizing mathematics education for and with disabled students. In our search and, subsequently, in the analysis, we did not delineate articles that fit into a particular field of study, such as mathematics education or special education. Thus, what we consider as *mathematical educational research* encompasses contributions from multiple fields of study. Moreover, our search for articles was not intended to be exhaustive but to capture an adequate sample of studies for analysis and address our research questions.

The search for articles chosen for this review involved using keywords with wildcards⁴ across three spheres of terms. The first sphere of keywords attempted to capture articles that included teachers and teaching interactions. The terms used in this sphere were: *teach* education, professional development, interaction**, or *discourse*. The second sphere targeted the central role of mathematics in the study: *math**. The third sphere of keywords attempted to capture articles with disabilities as central to the study (i.e., encompassing any of the 13 categories under the IDEA): *disab*, special education, inclusi*, autis*, emotional, deaf*, impairment*, developmental, blind*, traumatic brain injury, or speech*. The search was designed to locate articles that contained at least one term in each of the three spheres (i.e., *sphere 1 AND sphere 2 AND sphere 3*) in the abstract field.

Criteria for Inclusion

Overall, we reviewed 1,416 articles through an iterative process (see Figure 2) involving various combinations of the keywords and spheres. We examined the

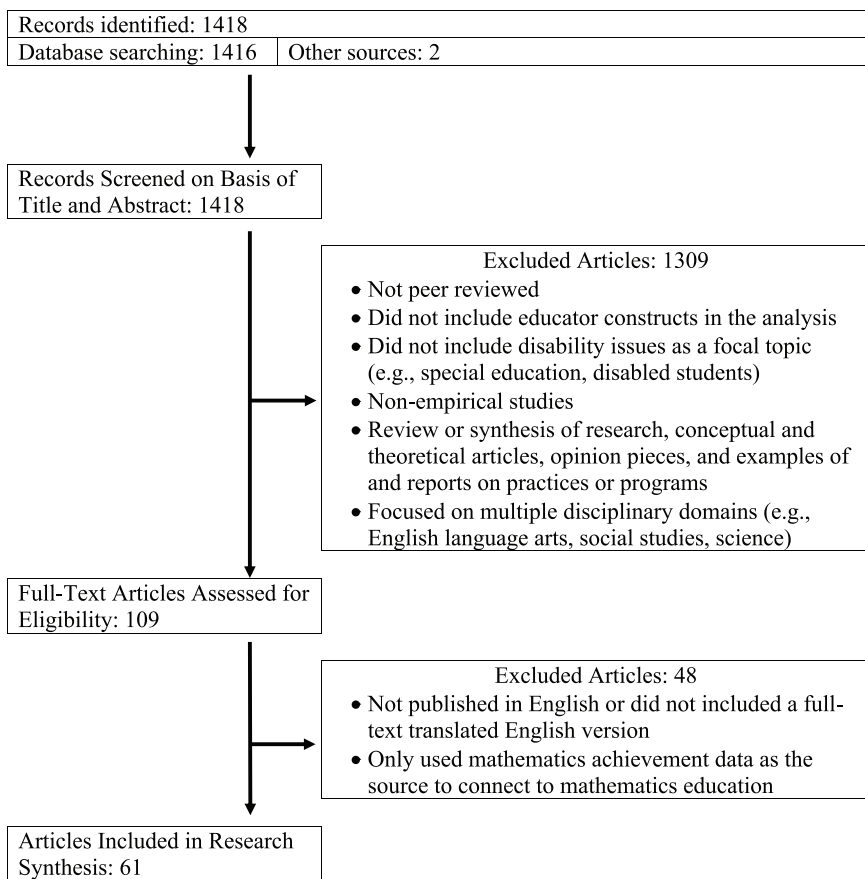


FIGURE 2. *Flowchart for article search and screening.*

title and abstracts to decide whether they met the following criteria. Articles had to (a) be published in English or included a translated English version in peer-reviewed journals; (b) focus on educators of mathematics, such as prospective and practicing K–12 teachers, teacher educators, researchers, and mathematics as central units of analysis; (c) include issues of disability as a focal topic (e.g., disabled students, special education); and (d) be original empirical studies. Thus, we excluded review or synthesis of research, conceptual and theoretical articles, opinion pieces, and examples of and reports on practices or programs.

After reviewing the title, abstracts, and keywords of the 1,416 articles, we identified 59 studies that met all three criteria. The most common reason for studies not to qualify for this review was that their sole focus was on the effects of specific interventions on disabled students (e.g., using a flashcard procedure for teaching mathematics skills [Mangundayao et al., 2013]). Thus, the unit of

analysis was primarily the effects of the interventions on student outcomes (e.g., scores on assessments) while excluding any educator constructs in the analysis of the intervention (e.g., teacher growth, knowledge, or decision-making). Also, numerous nonempirical studies appeared in the search results that were excluded (e.g., practical strategies to advance inclusive practices). Lastly, we excluded studies focused on multiple disciplinary domains beyond mathematics (e.g., English language arts, social studies, science) or studies that used mathematics achievement data as the sole source of connection to mathematics education (e.g., Hornstra et al., 2010), meaning that mathematics education was not a central focus. We added two additional studies (Eriksson, 2008a, 2008b) through a hand search of the *Journal of Mathematical Behavior*, a prominent journal in mathematics education that did not turn up in our original search but that we knew from experience had published disability-related articles. We included a total of 61 articles in our review (a list of the 61 articles is available as Supplemental Table S1 in the online version of the journal). We sent the list of the 61 references and the description of the criteria to two scholars with expertise in the literature of mathematics education involving disabilities. We asked them to determine whether any other studies could meet our criteria. These scholars agreed that all the relevant articles to their knowledge were included in the list and that we had obtained an adequate sample; thus, we did not conduct additional manual searches.

Analysis

We addressed our research questions through a conceptual review (Kennedy, 2007) using a five-step iterative process involving (Step A) organizing the articles into three broad categories; (Step B) deriving subcategories from each; (Step C) examining each article's positioning, paradigms, and phenomena to designate the categories and subcategories from (Step A) and (Step B) into zones; (Step D) determining if each zone approached or departed from humanization of mathematics education related to disability which we labeled as toward humanizing, dehumanizing, or neither humanizing nor dehumanizing; and (Step E) examining the extent to which race was an integral part of each article. Figure 3 captures an overview of our analysis process; while Figures 4–6 include the overview with specific examples. We emphasize the iterative developmental nature of the analytical process involving refinement based on how the steps are mutually informative (as circular feedback loop, respectively noted as bidirectional arrows in Figures 3–6). For example, although Step E appears as the last step in the analysis process, we attend to issues of identity from the onset in Step A as well as that Step E informed the refinement of Step A. Throughout the process, we engaged in collaborative coding sessions. We made all coding categories and coding decisions through a consensus process.

For Step A, we utilized the following categories a priori: (i) *sociopolitical*, which consists of political struggles in mathematics education such as issues of identity, access, and power (Gutiérrez, 2013); (ii) *pedagogy and practices*, which includes mathematics teaching practices (e.g., standards-based curriculum alignment, coteaching); and (iii) *mathematics content knowledge*, or developing or assessing educators' mathematics content knowledge, or teacher perceptions of mathematics. We drew the essence of these three categories from the AMTE's

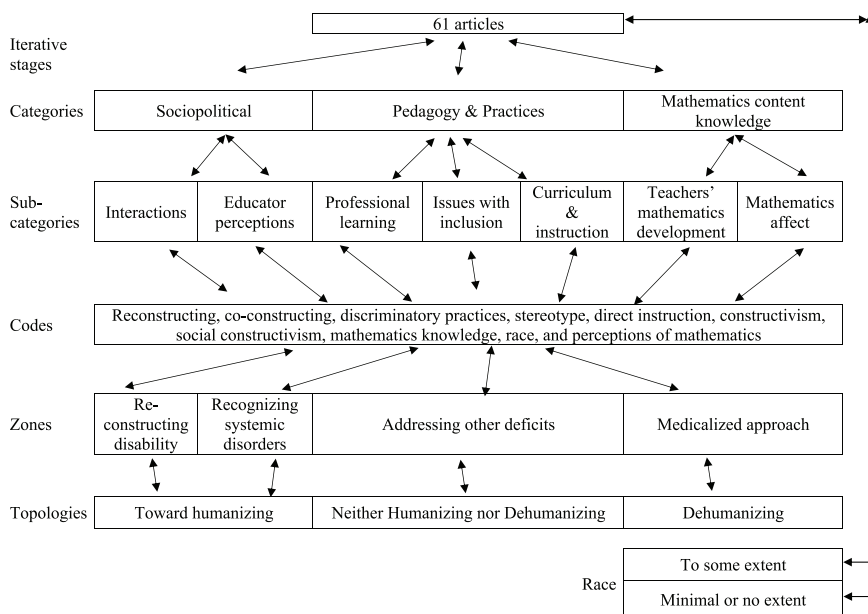


FIGURE 3. *Process of iterative article analysis.*

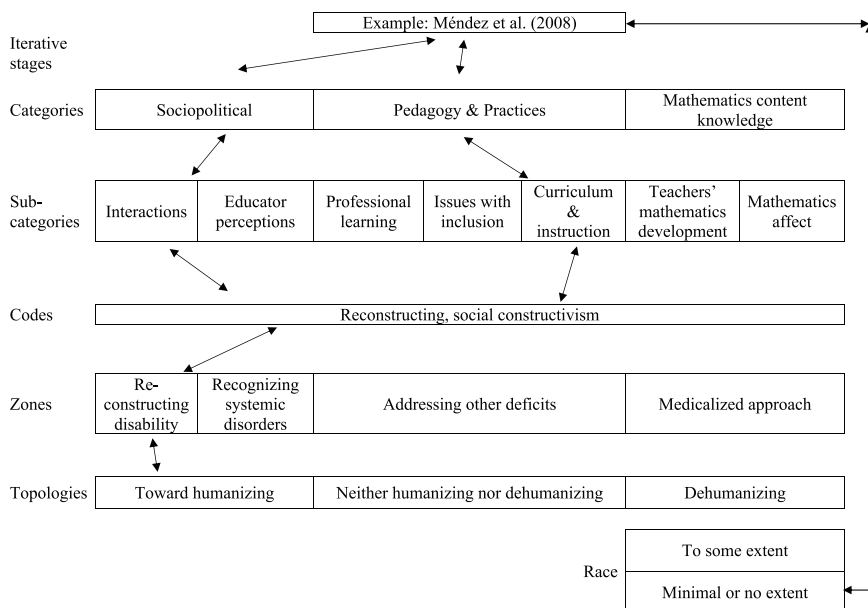


FIGURE 4. *Process of iterative article analysis (humanizing example).*

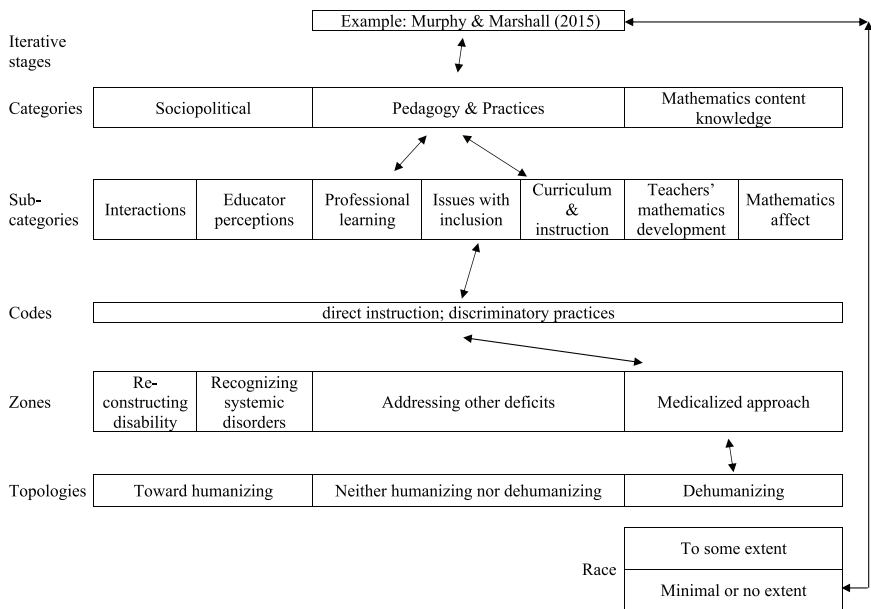


FIGURE 5. *Process of iterative article analysis (dehumanizing example).*

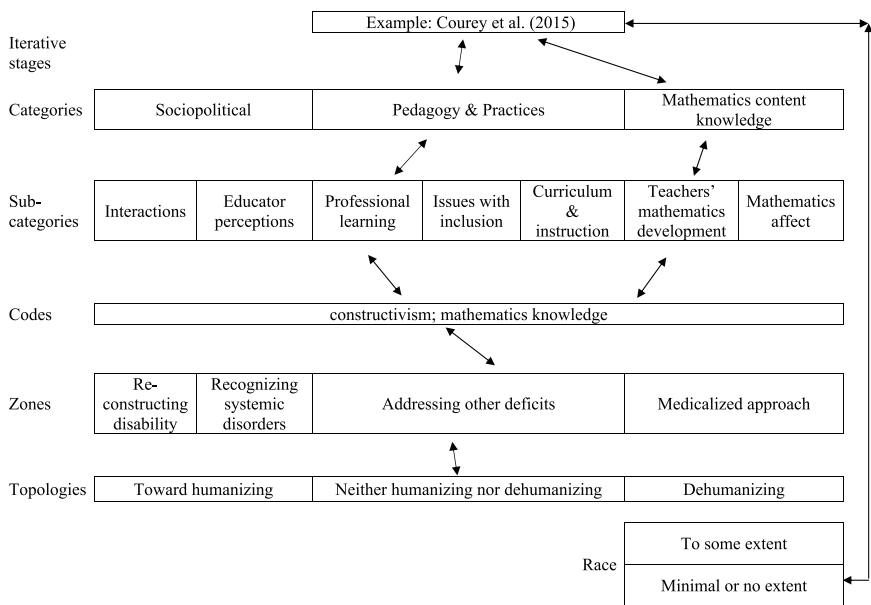


FIGURE 6. *Process of iterative article analysis (neither-nor example).*

Standards (2017). Along the same line, the AMTE has a fourth category titled *Students as Learners of Mathematics*, which we subsumed within our sociopolitical category. We situate the extent to which educators position disabled students as doers and thinkers of mathematics as an identity issue. However, we contextualized the description of these categories based on our analysis and the focus of this critical literature synthesis. Thus, we defined articles as fitting into the sociopolitical category as those where (i.1) disabled students are positioned as mathematics doers and thinkers in social activity (concurrently positioning educators and/or other students as colearners); (i.2) the role of educators in constructing disability identities is examined, or educators' potentially problematic practices and power dynamics involving disabled students are considered; (i.3) educators' affect toward disabled students and/or mathematics are taken into account; or (i.4) the role of race of disabled students and/or educators are considered to a great extent.

We also grounded categories (ii) and (iii) within the notion of disabled students' *access* to educators with strong mathematics content and mathematical content knowledge for teaching (Ball et al., 2008). All studies centered on at least one of these three categories, while several studies examined two or three. The categorization process involved each of us individually reading and sorting the 61 articles into three categories. After doing so, we met to discuss each of our categorization methods and sort the remaining discrepancies. Our disagreements mainly were around how each of us interpreted the sociopolitical category. We then refined the description of the sociopolitical category to reconcile our different interpretations and then build consensus on the categorization of articles that should or should not be in a given category.

For Step B, the first author examined the articles within each of the three broad categories and derived keywords or phrases based on the central focus of each study. During this process, the first author recategorized several articles as they seemed to better fit into another category. The first and second authors met to discuss this recategorization and agreed. The first author then collapsed the keywords or phrases into two or three subcategories for each category. For example, in the sociopolitical category, the first author determined that several articles focused on interactions between teachers/researchers and disabled students. Other articles in that category focused on educators' perceptions of disabled students in mathematics but did not include any analysis of interactions. Thus, the first author coded those articles accordingly and collapsed those into two subcategories titled *interactions in mathematics education* and *educators' perceptions of disability*.

Moreover, as these subcategories emerged, the first author shifted some articles to other categories or subcategories as they seemed to fit better elsewhere. Once all of the subcategories were complete, the first and second authors held a meeting to discuss and refine these subcategories. Agreements were thus achieved after deliberating and reconciling differences. We intended for categories and subcategories to remain somewhat broad in capturing the main thrusts and foci of each article. For example, with the subcategory titled *issues with inclusion*, we wanted to cluster these studies together prior to conducting a deeper analysis in

Steps C and D, where we analyzed their framing of inclusion in a more critical and nuanced manner.

For Steps C and D, we utilized the humanizing mathematics education lens to critically examine each article's positioning, paradigms, and phenomena to broadly address the two research questions (i.e., the extent to which articles approach/depart from humanizing education and its central features). We chose the areas of positioning, paradigms, and phenomena to "take into account the narrative or argumentative structure of the discourses analyzed" (Cardano, 2020, p. 126). This, in turn, was based on our ongoing engagement and immersion (Tesch, 1990) with the 61 articles during Steps A and B and in deliberating about the central messages of each article which were further developed and refined during the analysis process.

We approach positioning and paradigms as components of methodology. This meant, for example, examining not only the methods applied but also their underlying assumptions. For positioning, we looked at how each study situated disabled students, their families, and/or educators. We derived such positioning from either the authors or the participants in the study (e.g., perception data). Examples of questions that guided this positioning analysis included the following: to what extent are disabled students seen as capable mathematics learners and doers, and what level of power do students and their families have in the decision-making process?

Regarding paradigm, we examined each study's approach to addressing teacher education involving disabled students in mathematics and teachers' mathematics development. We sought implicit and explicit references to major learning theories in mathematics education such as behaviorism (e.g., direct, step-by-step instruction), constructivism (e.g., conceptual understanding of mathematics and relationships), socioconstructivism (e.g., constructivism pertaining to social classroom interactions), and sociopolitical (e.g., equity-oriented). Lastly, for phenomena, we examined each study's global takeaway regarding disability construction (e.g., reliance on medical or social model) impacting mathematics education. Thus, we interpreted each study's explicit and implicit signals. Importantly, not all three domains applied to each study, and the application of the domains was based on what we could derive from each study.

Next, the first author examined the articles within one or more of the three domains (paradigm, positioning, and phenomenon) from which the following summative codes were attached: *reconstructing disabilities*, *co-constructing disabilities*, *discriminatory practices*, *stereotype*, *direct instruction*, *constructivism*, *mathematics knowledge*, and *perception of mathematics*. The first author used these codes to capture the core idea or signal of each article as they relate to humanizing mathematics education (an article can be tagged with multiple codes). The first author then collapsed the codes into four zones (i.e., reconstructing disability, recognizing systemic disorders, addressing other deficits, and medicalized approach) based on these codes and the central message signaled by the studies as a collective. The authors met to discuss and refine these zones, coming into an agreement after deliberating and reconciling differences by giving priority to humanizing mathematics education considerations. We also collapsed these four zones into three topologies, namely, *dehumanizing*, *toward humanizing*, and

neither toward nor against humanizing. We did so based on the extent to which they approached or departed from humanizing mathematics education.

For Step E, we examined articles for presence and absence (Cardano, 2020) of race considerations, including proxies to race such as culture, ethnicity, identity, and students with free and reduced meal status. The latter is an important indicator that could be connected to modes of institutionalized racism such as color evasiveness (Parks & Schmeichel, 2012; Wise, 2010). In other words, quantitative or mixed methods studies that try to evade having to deal with the sociopolitical dimensions of race are likely to mask these issues by alluding to so-called socio-economic indicators such as the school's proportion of students with free and reduced meal status. In turn, this could be an indirect indicator of race or color evasiveness on the part of mathematics education researchers. Not wanting to deal with the structural equity and inclusion issues associated with race considerations as linked to disability could be in itself a form of epistemic racism, perhaps an unconscious one, and it deserves exposing and analyzing under the tenets of DisCrit and rightful presence. We targeted the analysis of the extent to which race was included in any given study, such as demographic information, theoretical orientations, and findings. We fundamentally analyzed the studies in line with DisCrit tenets that call for research that examines the intersection between concepts of race and ability, including analysis of the structural elements that coconstruct or make invisible these concepts in educational theory and practice (Annamma et al., 2013).

Results

Table 1 provides an overview of our analysis's results. We represent the results from Steps A and B in the first two rows, which list the three categories and their subcategories. Results from Steps C and D are represented in the first column of the third through seventh rows as the following three topologies: humanizing wakes (third and fourth rows), dehumanizing waves (fifth row), and neither humanizing nor dehumanizing (sixth row). Only two articles included considerations of race to some or great extent, which are marked with a superscripted *R* in Table 1. Organized around the three topologies, in the sections that follow, we describe in more detail how outcomes of our analysis address the research questions: To what extent does the central focus of studies published during the period between 2007 and 2016 approach or depart from humanizing mathematics education? What are the central features of these studies related to (de)humanizing mathematics education?

Humanizing Wakes

Studies we designate as humanizing wakes topology are anti-ableist and align to a great extent humanizing mathematics education. We characterize them as *wakes* because, in contrast to *waves*, they are not necessarily "natural" or traditional in the sense of how disabled students are, for the most part, constructed in mathematics education research such as in need of remediation (Boyd & Bargerhuff, 2009; Lambert & Tan, 2017; Tan, Lambert, et al., 2019; van Garderen et al., 2008). In another register, wakes also relate to coming to consciousness on systemic oppressions (Sharpe, 2016). Thus, studies in the

TABLE 1
Landscapes of educator, disabilities, and mathematics education research

Categories	Pedagogy and practices			Sociopolitical		Issues related to mathematics knowledge	
	Professional learning (<i>n</i> = 15)	Issues with inclusion (<i>n</i> = 11)	Curriculum and instruction (<i>n</i> = 14)	Interactions (<i>n</i> = 9)	Educator perceptions (<i>n</i> = 7)	Teachers' mathematics development (<i>n</i> = 7)	Mathematics affect (<i>n</i> = 4)
Humanizing wakes: Reconstructing disability (<i>n</i> = 9)	Eriksson (2008b)		Göransson et al. (2016)	- Lambert (2015)^g - Eriksson (2008a) - Figueiras & Arcavi (2014) - Hostins & Jordão (2015) - Méndez et al. (2008) - Xin et al. (2016)	Peltenburg et al. (2012)		
Humanizing wakes: Recognizing systemic disorders (<i>n</i> = 24)	- Gerretson & McHatton (2009)^g - Johnson & vanderSandt (2011)^g	- Ekstam et al. (2015) - Karvonen, Flowers, et al. (2013) - Mayrowetz (2009) - Swanson et al. (2012) - Travers (2011)	- Amato et al. (2013) - Clark et al. (2014)^{g,a} - Gagnon et al. (2014) - Hinton et al. (2015)^g - Kurtz et al. (2010) - Maccini et al. (2012) - van Garderen et al. (2008)	- Heyd-Mezuyanim (2013) - Murzyn & Hughes (2015) - Randhare Ashton (2014)	- Bailey et al. (2015) - Faulkner et al. (2013) - Kurz et al. (2014) - Hinton et al. (2015)^g - Malone & Fuchs (2014) - Shiffrer (2016)	- Flores et al. (2010) - Hinton et al. (2015)^g	- Clark et al. (2014)^g - Gerretson & McHatton (2009)^g - Johnson & vanderSandt (2011)^g - Rosas & Campbell (2010)
Dehumanizing waves: Medicalized approach (<i>n</i> = 16)	- Browder, Jimenez, et al. (2012) - Harris et al. (2014) - Hurlbut & Tunks (2016) - Kretlow et al. (2011) - Pape et al. (2015)^g - Thompson (2012) - Weisenburgh-Snyder et al. (2015)	- Griffin et al. (2013) - Murphy & Marshall (2015) - Rimpola (2014) S. Smith (2016) - van Ingen et al. (2016)	- Boue & Joshi (2012) - Browder, Trela, et al. (2012) - Karvonen, Wakeman, et al. (2013) - Maccini et al. (2013)			Pape et al. (2015)^g	

(continued)

TABLE 1 (continued)

Categories	Pedagogy and practices			Sociopolitical		Issues related to mathematics knowledge	
	Professional learning (<i>n</i> = 15)	Issues with inclusion (<i>n</i> = 11)	Curriculum and instruction (<i>n</i> = 14)	Interactions (<i>n</i> = 9)	Educator perceptions (<i>n</i> = 7)	Teachers' mathematics development (<i>n</i> = 7)	Mathematics affect (<i>n</i> = 4)
Neither humanizing nor dehumanizing: Addressing other deficits (<i>n</i> = 12)	- Burton & Pace (2009) - Courey et al. (2015)^a - Lyublinskaya & Tournaki (2014) - Tournaki & Lyublinskaya (2014) - Thornion et al. (2009)	Pfister et al. (2015)	- Graybeal (2013) - Griffin et al. (2009)			- Afamasaga-Fuata'i & Sooaemolelagi (2014) - Courey et al. (2015)^a - Faulkner & Cain (2013) - Herzberg et al. (2016) D. Smith & Penny Rosenblum (2013)	

Note. Articles with a superscripted *R* (R) included race to some or great extent.

^aArticles that appear in more than one category. These articles were double counted for the column categories but not for the rows.

humanizing rows worked to (a) reconstruct disabilities away from deficit framings and/or (b) recognize systemic disorders in mathematics education.

Reconstructing Disabilities

We situate reconstructing as essentially approaching disabled students as mathematics doers and thinkers and their teachers as having agency. This directly counters traditional notions of disability as a deficit and seeks to learn about the mathematics of disabled students (Tan & Kastberg, 2017). Moreover, notions of constructivism and social constructivism were either explicitly or implicitly signaled in these studies. Hostins and Jordão (2015), for example, examined a mathematics episode involving a student labeled as having an intellectual disability. The authors focused and reported on the qualities of the mathematics interactions that countered disability as deficient. Guided by elements of social constructivism, the authors examined how the participants (one teacher and one student referred to as JF) interacted during a Base Three Game. The game is very accessible while involving complex forms of mathematical thinking. The analysis of observations and artifacts from the game indicated that JF used symbols to differentiate his results and those of the teacher, worked interchangeably between quantities and game pieces, and differentiated based on form. The teacher then guided the advancement of JF's intellectual engagement by introducing psychological instruments such as mathematical tools to explore ("+" symbol). The authors posited that additional tools could be introduced to continue to unearth JF's "potential possibilities" (Hostins & Jordão, 2015, p. 14).

Méndez and colleagues' (2008) study also examined reconstruction interactions between a student with an intellectual disability label, Maria, and her teacher. The teacher shifted practices from passive forms of learning (e.g., completing mathematics problems from a remedial textbook) to a more active one based on a community of learners and mutual learning. In the former setting, Maria and other disabled students were aware of lowered expectations and performed accordingly. As her teacher's practices shifted, so did Maria's role as a passive participant in the mathematics learning process to an active one. Similarly, other studies in this group reconstructed disabilities by showcasing disabled students either as having mathematical potential (Peltenburg & van den Heuvel-Panhuizen, 2012) or as powerful mathematics doers and thinkers (Eriksson, 2008a; Lambert, 2015) via professional learning (Eriksson, 2008b), multimodal approaches (Figueiras & Arcavi, 2014), or teachers structuring powerful and constructivist-based classrooms (Göransson et al., 2016). Aptly, Eriksson (2008a) concludes with a critical remark "it is relevant to call in question whether the category 'intellectually disabled' is beneficial or detrimental for the pupils," to which they affirm that "we ought to avoid them" (p. 9). Similarly, Xin and colleagues' (2016) study showcased a disabled student's engagement with a task focused on reasoning to which the authors state: "These findings suggest that teachers of students with LD [Learning Disabilities] may facilitate more educational success if they introduce struggling learners to higher-level reasoning tasks, even before computational fluency is attained" (p. 445).

Recognizing Systemic Disorders

We interpreted studies in the humanizing wakes' second zone as recognizing (a) coconstruction of disability as a deficit, (b) ableist practices and affect, and (c) power imbalances. Disability was located within ableist systems and practices rather than within individual children.

Coconstruction of disability as a deficit. Heyd-Metzuyanim's (2013) study, for example, attributed both student and teacher factors toward a disability as deficit identity construction. In particular, Heyd-Metzuyanim examined teaching-learning interactions in mathematics involving a seventh-grade female student, Dana, and her teacher, the study's author. The 5-month study involved pre- and post-student interviews and assessments of mathematical skills. Despite intensive individualized mathematics interventions, the author reported that Dana showed no improvement in her mathematical skills. Results also indicated that Dana felt less competent in mathematics between the first and last interviews. Rather than concluding that such instance as Dana's failure to respond to evidence-based mathematics interventions, Heyd-Metzuyanim posited that she (the teacher) had a major role in contributing to Dana's disabled identity as deficit construction. Specifically, the author attributed such contribution to historical patterns of identifying processes (identity construction via interactions) and excluding Dana in deep meaning-making mathematics practices such as participating in classroom discourses. Thus, Dana was ascribed to an identity based on what others perceived about her lack of mathematics abilities. Such coconstruction disorders are also implicated on a larger scale in Shifrer's (2016) study, involving a data set of 16,370 students, which found how disability labels in mathematics contexts contribute to teachers' more negative attributions and expectations. Similarly, Bailey and colleagues (2015) reported that teachers constructed disabled students from a deficit orientation in describing them as burdens who required more teacher attention, lacked persistence, detracted the learning of other students, and required more specialized technical skills.

Ableist practices and affect. We identify the consequences of such negative attributions and expectations in, for example, Faulkner and colleagues' (2013) study, which pointed to ableist-based decision-making. Their study examined patterns in eighth-grade placement decisions into algebra courses using the Early Childhood Longitudinal Study-Kindergarten dataset that included over 3,000 students. The authors investigated teacher evaluation measures on students' mathematics ability and scores on a cognitive mathematics assessment. Focusing on fifth- and eighth-grade waves, the authors found that disabled students were less likely to be placed into algebra courses by the time they entered eighth grade compared to students not receiving special education services. Of interest was that disabled students who scored high on the mathematics assessment but were scored low on mathematics evaluations by their teachers were "virtually prohibitive of placement in algebra" (p. 338). Indeed, low teacher evaluations were powerful predictors for algebra placement for disabled students.

We also located the recognition of systemic disorders in studies that examined mathematics classroom pedagogy. For example, Kurz and colleagues (2014) found that disabled students spent less time on standards-based learning compared to nondisabled students. The authors reported that disabled students in the general education classrooms had less instructional time with state-specific standards and less content coverage than nondisabled students. Consequently, regardless of setting type (general or special education classrooms), disabled students faced inequities when engaging with mathematics state standards. This also includes, for example, lack of curriculum alignment to state mathematics standards (Kurz et al., 2010; Maccini et al., 2012; Mayrowetz, 2009), overly focusing on areas such as number operations at the expense of other rigorous areas such as problem-solving (Swanson et al., 2012), or focusing on lower-level mathematical thinking (Griffin et al., 2009; Karvonen, Flowers, et al., 2013; van Garderen et al., 2008). Other problematic practices include teachers' preferences for pull-out arrangements for disabled students' mathematics education (Ekstam et al., 2015; Travers, 2011) and uneven utilization of necessary tools such as the abacus for students with visual impairments (Amato et al., 2013).

Teacher attitude also relates to systemic disorders with ableist orientations. Teachers were found to negatively perceive and construct disabled students (Malone & Fuchs, 2014). Moreover, Hinton and colleagues (2015) shed light on how such perceptions relate to teachers' preferences for procedural forms of teaching mathematics that involve applying a predetermined set of steps and rules. Similarly, Clark and colleagues (2014) indicate that being certified in special education is positively correlated with beliefs that mathematics teaching and learning should not include periods when students make meaning of mathematics. Collectively, these systemic disorders are consistent with Gagnon and colleagues' (2014) findings, which pertinently concluded that their "results paint an alarming picture in which the possibility of students obtaining access to a high-quality curriculum of adequate breadth, depth, and coherence is questionable" (p. 62).

Systemic disorders may also take the form of analysis of the dimensions of mathematics affect for teachers of disabled students. For example, Gerretson and McHatton (2009) examined perceptions of special educators towards mathematics during a mathematics methods course. The authors report that participants had negative experiences in mathematics during their schooling. Aversive feelings towards mathematics were also the focus of Johnson and vanderSandt's (2011) study, which examined mathematics anxiety amongst prospective teachers in special education, deaf and hard of hearing, early childhood, and elementary education. The authors reported that deaf and hard-of-hearing teachers experienced the highest level of mathematics anxiety.

Power differentials. Two studies in the recognizing systemic disorders zone examined power differentials in mathematics educational contexts. Murzyn and Hughes (2015) reported that when it comes to placement decisions involving disabled students, special educators dominate while voices of families and mathematics teachers are marginalized. Randhare Ashton (2014) found that in a

coteaching space involving a general and special educator, the general educator and an ableist classroom culture dominated the space. This resulted in “marginalizing practices and segregation to make sure that the students with disabilities kept up with the general education pace” (p. 59).

In sum, studies we designate as humanizing wakes span across all three categories (pedagogy & practices, sociopolitical, and issues related to mathematics knowledge) and their subcategories (professional learning, issues with inclusion, curriculum and instruction, interactions, educator perceptions, teachers’ mathematics knowledge development, and mathematics affect). Studies in this group also include a subset of two that tackle race and disability to some extent, a topic we discuss in more detail in a later section. In contrast, the studies in the dehumanizing waves, which we present next, are heavily concentrated in the pedagogy and practices category and consider the role of race to a minimal or no extent.

Dehumanizing Waves

Although the focus of studies in the dehumanizing waves topology is on educators, disabled students are not positioned as mathematics doers and thinkers. Disability as a deficit remains the central focus of these studies. For the most part, these studies aim to indirectly respond to deficits through “fixing” children, using a limited range of intervention approaches. These approaches are typically educator centered, with utilization of explicit and/or direct instructional strategies that do not position students as mathematical thinkers. Gersten and colleagues (2009) describe explicit instruction as follows: first, the educator models the “step-by-step plan (strategy) for solving the problem” that is specific for a set of problems, followed by asking students “to use the same procedure/steps demonstrated by the teacher to solve the problem” (p. 1210). We characterize such strategies as medicalized, ableist,⁶ and acultural, whereas students are not perceived as mathematics doers and thinkers and cultural beings capable of constructing and reasoning with mathematics concepts. Systemically, these strategies reflect the notion that “oppression makes it necessary to control how oppressed people think” (Camangian & Cariaga, 2021, p. 2). Studies in this topology focused on the targeted professional learning of direct instruction approach or endorsed such an approach.

Dehumanizing studies related to educator development focused on (a) derivations of direct instruction, for example, *tell-show-try-apply* (Browder, Jimenez, et al., 2012), *model-lead-test* (Kretlow et al., 2011), and *systematic instruction* (Browder, Trela, et al. 2012; Maccini et al., 2013); (b) critical and higher-level thinking in mathematics while centralizing direct instruction (Murphy & Marshall, 2015); (c) fixing students by assisting those “who struggle to master the curriculum by immediately identifying, targeting, and monitoring learning needs” (Hurlbut & Tunks, 2016, p. 44) or “become more aware of how disabilities make learning mathematics more difficult” (Thompson, 2012, p. 59); and (d) collaborative practices aimed at leveraging medicalized knowledge in mathematics education (Rimpola, 2014; S. Smith, 2016; van Ingen et al., 2016). For example, Weisenburgh-Snyder and colleagues (2015) examined the effect of a precision teaching intervention involving frequency-based practices (e.g., completing 100 mathematics problems of the same type on a worksheet) and frequent data

monitoring and feedback as the instructional method on students' mathematics performance. Teachers were taught to implement this intervention with disabled students or those considered at risk for a mathematics learning disability. The intervention included professional learning that covered topics such as direct instruction, applied behavior analysis, instructional design, classroom behavior management, and response to intervention processes. Similarly, in Pape and colleagues' (2015) study, participants engaged in the content on "characteristics and learning problems of students with learning disabilities" and "evidence-based practice in mathematics for students with learning disabilities" (p. 19). Specifically, the evidence-based approach draws from the explicit instruction framework for teaching mathematics as the authors cited Miller and Hudson's (2007) practices for building foundational mathematics knowledge. Thus, disabled students' identity from a deficit orientation is ever present in determining the type of interventional "treatment" and outcomes, such as in Karvonen, Wakeman, and colleagues' (2013) study, which included analysis of student outcomes and ability "types" as part of examining teacher decision-making and beliefs.

In sum, studies in the dehumanizing waves topology are guided by notions of (a) responding to deficits in structured and orderly ways dictated by a medicalized view of disability and (b) the idea that mathematics learning entails following directions and practicing procedures rather than students expressing their understandings and/or engaging with peers. As such, they move away from the humanization of mathematics education by, for example, limiting disabled students' multiple ways of knowing and doing mathematics and drawing on their lived experiences.

Neither Humanizing nor Dehumanizing

Studies in this third topology neither approach nor depart from humanizing mathematics education in substantial ways. Unlike studies in the dehumanizing topology, articles in this topology do not aim to indirectly "fix" disabled students or to "erase" their identitarian ethos. Unfortunately, those studies we cluster under the dehumanizing waves topology have an obvious emphasis on enacting various modes of epistemic violence against disabled students, whose identity and knowledge potential are undeniably disregarded and openly marginalized. Instead, studies we heuristically categorize as *neither/nor* in this review aim to develop broad educator knowledge related to mathematics education without necessarily aiming to reconstruct disability as those studies we designated as enacting humanizing wakes. We struggled with the prospect of placing quotation marks around the word *neither/nor* in this case. However, since avoiding the "fixing" of disabled students can also be construed as a political act with possible sociopolitical consequences in classroom and other schooling or educational contexts, at least via indirect dynamics of research and practice, we opted not to do so. Importantly, by using *neither/nor*, we do not mean lack of a critical stance regarding humanizing dimensions. We reiterate that its meaning for this review is fundamentally heuristic insofar as it places these studies at an intermediate stance in their theoretical or practice approach toward humanizing mathematics education. Therefore, these are studies whose clustering responds that, as a whole, they avoid the "erasing" of disabled students' identitarian features and mathematical knowledge potential

through any given theoretical or evidence-based approach. However, in their aims to develop broad educator knowledge related to mathematics education, they do not necessarily look for ways to reconstruct disability as those studies we designated as humanizing. In our interpretative stance, for instance, generic attitudinal change studies do not qualify for them to be incorporated into the humanizing wakes cluster of articles (e.g., Burton & Pace, 2009). This generic approach is tantamount to the soft kind of cosmopolitan multiculturalism criticized by Gaztambide-Fernández (2012) regarding their lack of enactment of any genuine sense of transformational justice or solidarity-based pedagogies.

A study clearly delineated as neither/nor in our view is that of Faulkner and Cain (2013), who examined the effects of a professional development course designed to improve educators' mathematical knowledge on number sense. These authors reported that both general and special educators made significant gains in content knowledge for teaching mathematics due to the professional development course. The focus of other professional learning studies included prospective special educators' development of proportional reasoning (Courey et al., 2015), technological pedagogical content knowledge (TPACK) for teaching mathematics and science during a technology methods course (Lyublinskaya & Tournaki, 2014; Tournaki & Lyublinskaya, 2014), transcribing Braille mathematics materials (Herzberg et al., 2016; D. Smith & Penny Rosenblum, 2013), building teachers' competency with scaffolding strategies (Pfister et al., 2015), remediating prospective teachers' mathematics knowledge (Afamasaga-Fuata'i & Sooaemalelagi, 2014), providing practicing teachers with an overview of mathematics standards and practices (Thornton et al., 2009) that included mathematics content (e.g., Gerretson & McHatton, 2009), the use of a specific technological tool (Graybeal, 2013), and improving attitudes about disabled students in mathematics among prospective general education teachers (Burton & Pace, 2009).

Intersections With Race

We found exceptionally few articles that included a meaningful analysis of the interactions between race and disability, even within the humanizing wake. In our analysis of how race was conceptualized within the articles, we drew on the work of Parks and Schmeichel (2012) and the tenets of DisCrit (Annamma et al., 2013), which include analysis of how race and disability are coconstructed, the multidimensionality of identity, the material and felt effects of being labeled as raced and disabled, and the voices of those intersectional actors in these intersections.

Fifty-nine articles in our sample either were silent when it came to race, minimally mentioned it as part of their participant demographics or as a variable, or provided broad statements of equity and diversity without analysis of race in their findings. An example of these broad statements is the following: "general education teachers must be adequately prepared to teach students . . . who have identified or suspected disabilities . . . have diverse cultural and racial backgrounds" (Hurlbut & Tunks, 2016, p. 25).

Two articles included substantial race analysis as part of their findings—one of these papers used quantitative methods, and the other rested on qualitative methods. Clark and colleagues (2014) used surveys to analyze the mathematical content knowledge and beliefs about the mathematical struggle of a diverse group of

teachers, including both general education and special education teachers. Clark and colleagues specifically note that most quantitative research that includes variables around race and gender can essentialize these differences and often lacks analysis that understands identities as fluid. They found that special education teachers had lower levels of attitudinal beliefs toward the practical realization that students' struggle is important in mathematics. Teachers of color were more likely to both have a mastery-oriented approach to mathematics and to pay attention to their students developing mathematical identities. There was an extended analysis of the positionality of teachers of color in relationship to mathematical pedagogy, demonstrating attention to analysis on the role of race in the findings. There was also an analysis of the different preparation methods of special education teachers, which could affect results. We note that disability in this study was not a variable for teachers but only for students. Thus, there was no intersectional analysis of teacher identity that included both race and disability. However, the analysis does discuss how structural and institutional elements affect teacher beliefs around mathematics.

In an ethnographic and interview study of the perspectives of Latinx students with learning disabilities (LD) and their mathematics teachers, Lambert (2015) summarized the aim of her study as to "describe some points at which gender, race, and language intersected with conceptions of ability and disability" (p. 3). Race and intersections with language for Latinx students figured centrally in Lambert's theoretical perspective and analysis, both for the two disabled student participants (Ana and Luis) and their teachers (Ms. Marquez and Ms. Alton). Lambert also discussed the process through which a Latino with a label of LD was positioned as a behavior problem in math class, connecting such positioning to the systemic issue of the overrepresentation of Latinos in the category of behavior disabilities.

Discussion

In this literature synthesis, we sought to take stock of the current knowledge base of the central role of educators in disability mathematics education research and recommend directions for humanizing future research and practice. Results of our analysis point to three topologies—humanizing wakes, dehumanizing waves, and neither humanizing nor dehumanizing. Thirty-three studies encompassed the humanizing wakes (just over twice the amount of dehumanizing wave articles). They represent a larger proportion of the 61 studies reviewed, which is very promising for humanizing mathematics education. We interpreted these studies as reconstructing disability or recognizing systemic disorders. They take on the work of understanding, for example, the crucial role of teachers and teacher educators in identity formation and rejecting ableist assumptions regarding disabled students. The nine studies coded as reconstructing disability students show that disabled students have powerful mathematical minds and insights. Such studies reflect the type of labor needed "to construct disruptive, different knowledges" (Kumashiro, 2000, p. 43) and pave the way for future research to better understand, recognize, and value disabled students as mathematics doers and thinkers. This can ultimately translate into practices that dismantle dysfunctional educational ecologies where marginalized youths' gifts are ignored (Annamma &

Morrison, 2018). Challenging these paradigms supports mathematics educators to position marginalized students as producers of new and valuable knowledge (Solorzano & Yosso, 2002), representing a major shift in identity reformation and power dynamics.

Yet there are concerning signs given that within the 33 studies encompassing the humanizing wakes, only 2 substantially tackled the intersection of race and disability. These two articles demonstrate how both a qualitative and quantitative analysis can begin to integrate analysis of race with disability in line with the tenets of DisCrit. We can see race and disability as more than a variable or a demographic in both studies. Lambert (2015) provides an analysis of how race, language, and disability interrelate in the self-understandings of disabled Latinx students, as well as how their teachers interact with the students. The study also analyzes how institutional structures, such as behavioral expectations, can position disabled students of color.

Clark and colleagues (2014) foreground race in their analysis of teacher mathematical knowledge and pedagogical beliefs without essentializing race. Using DisCrit (Annamma et al., 2013) as a reference point for guidance on a thorough examination of the intersections between race and disability, both articles could have gone deeper in their analysis, demonstrating the complex work that is possible when taking the intersections between race and disability seriously. Lack of intersectional analysis is endemic within, for example, the larger field of teacher education research (e.g., Pugach et al., 2020; Waitoller & Artiles, 2013). More concerning is that in mathematics education research, the erasure of dimensions pertaining to unique knowledges of students of color across disability and racial identities results in what Martin et al. (2019) call *epistemological violence*. Thus, much future work with the humanizing wakes remains to be developed. For example, as a way to bring race explicitly into the analysis along with the complex ways in which it relates to disability and vice versa, educators and researchers can critically reflect on ways to apply Gholson and colleagues' (2012) three fundamental questions on students of color's brilliance in mathematics that were originally formulated to center on Black students: "What do I really believe about Black children and their abilities? How does my work reflect those beliefs? and Given that Black children are brilliant, how does this affect my research agenda?" (p. 4). We extend these questions to apply to segments of students who experience multiple levels of marginalization across the full range of disabilities (i.e., pandisability): What do I really believe about children of color and their abilities? How does my work reflect those beliefs? Given that disabled children of color are brilliant, how does this affect my research agenda and pedagogical practices? Our interpretative analysis of this article dataset shows that in the 33 humanizing articles, the three questions have been positively addressed to some extent concerning disability but not in intersectional analysis including race.

We also stress that challenging ableism and humanizing mathematics education requires working for and with disabled students and their families. A core tenet of DisCrit is that it "privileges voices of marginalized populations, traditionally not acknowledged within research" (Annamma et al., 2018). We note that across all studies, voice and power are often located outside of the individuals most impacted by ableism, such as in the analysis of how unilateral decisions are

made by special educators during Individualized Education Program meetings concerning mathematics (Murzyn & Hughes, 2015). Yet in a coteaching context, general educators and their ableist classroom culture can come to dominate that space (Randhare Ashton, 2014). Positive and meaningful outcomes largely depend on effective educational experiences, opportunities, and coadvocacy; however, disabled students and their families have very little say in their education regarding, for example, placement decisions into specific mathematics courses (Padilla et al., in press; Tan, 2017a). As such, it is essential to form a deep sense of awareness of the social forces that perpetuate ableism across all facets of mathematics education (e.g., inequities in mathematics course placement, decision-making based on stereotypes), intentionally cultivating emancipatory forms of inquiry (e.g., Lewis & Lynn, 2016) and practices (e.g., Gutstein, 2003). Drawing on notions of counterstories and critical reliance on student and family-centered funds of knowledge (Moll et al., 1992; Williams, 2016) and lived experiences will also be meaningful in advancing the power component of humanizing mathematics education. Disabled students' narratives, as well as those of their families as coconstructors of agentic knowledge, can help advance the discipline. Indeed, cumulative meaningful mathematics learning opportunities and experiences lost (Tan & Kastberg, 2017) and educational debt owed to disabled students (Thorius & Tan, 2015) are sufficient rationale to meaningfully incorporate disabled students' voices into educational research and practice.

Our literature synthesis also points to dehumanizing waves as an omnipresent, powerful social force. A large portion of the literature focuses on medicalized and ableist approaches such as direct instruction as the only option for mathematics intervention for all disabled students (Gersten et al., 2009). This approach is oppressive and positions disabled students as acultural and incapable of having unique ways of knowing and doing mathematics. It treats mathematics as fixed with facts and procedures that must be mastered and memorized through performance rather than as an ever-expanding human endeavor where the answer to the fundamental question of what *mathematics is* continues to be explored and remade (Gutiérrez, 2017). For educational researchers and practitioners, whose work is strongly influenced by disciplinary fields of general education and special education, which are often at ontologically incompatible stances (Cochran-Smith & Dudley-Marling, 2012), shifting power means carrying out anti-ableist and intersectionality infused research as a way to enact students' rightful presence (Calabrese Barton & Tan, 2020). Also, in line with Paris and Winn's (2013) critical humanizing research contributions, it is paramount to adopt a critical stance toward teacher and leadership education research. Articles we designate in the dehumanizing wave typology signal research designs and monolithic conceptions of knowledge and power that run the risk of perpetuating the deficit practices they intend to examine. Such research legitimizes either directly or indirectly oppressive ideologies embedded in purely diagnostic and medicalizing conceptions of disability and intersectionality.

For teacher educators, beyond dismantling rigid institutional practices of siloing special and general education (Pugach et al., 2020), it is paramount to support prospective and practicing teachers to strategically and practically challenge the dehumanizing waves with humanizing wakes. For example, teacher educators can

support teachers to centrally and meaningfully address antiracism and anti-ableism within curriculum parameters and standards, objectives, and instructional/pedagogical strategies (Matias, 2013; Thorius & Santamaría Graff, 2018). In our work with teachers, we find introducing various practical tools and frameworks to be vital in nurturing teachers to innovate (e.g., Tan & Padilla, 2019; Tan & Thorius, 2019). Notably, and in line with Annamma and Morrison's (2018) dismantling dysfunctional learning ecologies, teacher educators should also emphasize the importance of nurturing authentically caring relationships with their disabled students of color. Given the everyday oppressions that disabled students of color and their families face, dismantling dysfunctional learning ecologies also includes the process of healing and radical love in the realm of mathematics education (Yeh, Martinez, et al., 2021). Love (2019) reminds us that to authentically care for students and nurture their spirits, we as teachers must truly come to know them. For example, we must reckon with the fact that "the social and emotional health and well-being of communities of color and multiply-marginalized people have much more to do with their alienation from resources born off of their oppression" (Camangian & Cariaga, 2021, p. 3).

In his work with an urban teacher education program, for example, the first author has engaged prospective secondary mathematics teachers in ethnographic explorations that require them to build a rich case profile of disabled students of color that go beyond capturing essentialist student data such as test scores, (mis) behaviors, and other deficits (e.g., gaps in mathematics skills). He asks prospective teachers to consider qualitatively rich questions such as the following: *What are the students' dreams and aspirations? What do they value? What brings joy to their life? What are they most proud of? What are the different ways they are brilliant, courageous, and resourceful? What changes do they want to see? Who inspires them and why?* It is crucial in these explorations with prospective teachers to highlight the importance of the investment of building a deeper, more humanizing understanding of their disabled students of color and come to see their wholeness (Sins Invalid, 2019). Consistent with a pandisability orientation, creating a more humanizing understanding is particularly important for students who are considered to have more "severe" disabilities as they are often not thought about as being able to formulate ideas and reason mathematically (Tan, 2017b; Tan & Thorius, 2019). In parallel with coursework focused on concepts of rightful presence (Calabrese Barton & Tan, 2020), prospective teachers, in turn, better connect with their students at emotional, spiritual, healing, historical, and political levels and thus can more innovatively operate within and beyond oppressive practices (e.g., by creatively disrupting/introducing humanizing elements within existing behavior intervention plans in their mathematics classrooms or designing and implementing mathematics lesson plans that more meaningfully includes severely disabled students). As with Heyd-Metzzyanim (2013), they reckon and reflect on their own actions that perpetuate ableism and the coconstruction of disabilities as a deficit during mathematics interactions. They work toward turning those oppressive/dehumanizing structures to be more antioppressive/anti-ableist (e.g., by creating innovative and collaborative behavior plans whose focal aim is to dismantle dysfunctional classroom/school practices (Annamma & Morrison, 2018), including intentionally elevating the voices

of disabled students of color and their families, thereby facilitating discourse on the mathematics of oppressed students). Consequently, such practical and humanizing exercises can establish touchstones for teachers in their future professional and personal work of engaging with internal reckoning and political struggle for and with those most marginalized.

Limitations

We acknowledge several limitations for this review. First, the criteria for including articles with an analysis on educators rather than just on disabled students resulted in a higher likelihood that these articles would not solely focus on student deficits. This means that, more likely, articles for this literature synthesis would gravitate toward the humanizing topology rather than the dehumanizing one. Another limitation is that all article inclusion decisions were primarily made by the first author during the early stages of the process. This could have primed subsequent collective conversations among the writing team. We also recognize that we may have excluded relevant research for this review. It is challenging to find all articles relevant to the study (Boote & Beile, 2005). We do not present interrater reliability for this study, as we reached a consensus on all coding categories through multiple research meetings. Because we aimed to understand this research literature and did not have preexisting categories for coding, our collaborative process focused on collective development and meaning making around each code. This meant that our analysis process was biased and circumscribed to our positioning as disability studies education scholars during, for example, the examination of each article's methodology. We also note that publication bias is a major problem in our area of study. For example, it has been noted that research on the potential of students with significant disabilities to learn academic concepts is limited, not by the potential of those learners, but by the ideological predispositions of researchers themselves (Courtade et al., 2012). Another limitation is that given our broad-level analysis of positioning, paradigm, and phenomena, we did not explore important and more nuanced issues (e.g., the complex ways within each article on how teachers' particular pedagogical knowledge and knowledge of mathematics influence the extent to which they humanize mathematics education). Furthermore, much more will need to be known through careful analytical examinations of broader contextual variables (e.g., compliance dynamics [Voulgarides, 2018; Voulgarides et al., 2021]) that preempt how educators of mathematics approach the very prospect of humanizing disability practices as a feasible prospect in their career delineation as well as in their everyday sociopolitical stance.

Conclusion

In this literature synthesis of a decade of educator and disability research in mathematics education, a sizeable proportion of studies (33 of 61 or 54%) focused on humanizing disabled students, both by reconstructing disability and recognizing systemic disorders. Collectively, these studies provide important insights into moving research and practices toward humanizing mathematics education not only for disabled students but for all. *DisCrit* (Annamma et al., 2018), *rightful presence* (Calabrese Barton & Tan, 2020), and *humanizing*

mathematics education (Tan et al., 2019a) are inherently about acts of political struggle for the inherent rights of all to belong, coexist, and benefit from one another's presence and intellectual and diverse contributions. For the next decade, we recommend a continued focus on humanizing mathematics education in general, with increased attention to intersectionality, including the role of power and institutions. We call for increased inclusion and central participation of pandisabled students in mathematics educational research focused on inquiry and meaning making. In addition, we recommend that mathematics educators and researchers engage in critical reflection on their roles in relegating disabled students to limited pedagogies. Such a continued critical reflection and commitment will contribute powerful and impactful wakes in transforming processes and outcomes in mathematics teaching and learning for and with disabled students of color in schools and beyond.

Notes

¹ We intentionally use *disabled* in our language throughout this article to signal its political, social, and institutional impositions on sets of individuals as well as conveying disabled community's collective power. Also, we acknowledge different preferences when it comes to person-first or identity-first language (Dunn & Andrews, 2015). We align with many in the disabled community in utilizing identity-first language throughout this article to communicate empowerment, pride, uniqueness, and the richness of self and their communities (e.g., Garland-Thomson, 2012; Sequenzia, 2016). However, in paraphrasing, quoting, and summarizing other scholars' works, we may utilize person-first language.

² The authors' personal experiences as observers in schools across the United States, as well as numerous cases as reported in news outlets (e.g., Kalb, 2016). See also Thorius et al. (2014).

³ Throughout the article, we refer to mathematics education researchers and practitioners as those whose work relates to grades K–12.

⁴ A wildcard is the character * used with search engines to return results that contain at least the prerequisite characters (e.g., the search term "*disab**" will return results such as *disability*, *disabilities*, and *disabled*).

⁵ Here, the adjective *higher-level* can be interpreted as ableist as it may elude to a form of hierarchy. However, we interpret Xin and colleagues' (2016) description of *higher-level* along the lines of the potential to learn more about a student's gifts, perhaps in comparison to the researchers' previous limited knowledge about this student, and in the way that parallels what we have described in this article's theoretical section as gifts in mathematics education.

⁶ Direct instruction is not in and of itself ableist in all contexts; however, when only one pedagogical approach is applied to all disabled students regardless of their understanding and/or the mathematics at hand, we see this as ableist. Nondisabled students are not given the same limitations on how they can learn mathematics.

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An asterisk indicates studies included in the analysis of this literature synthesis.

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