

## Research Article

# Disability and Educators in Mathematics Schooling Research: A Critical Exploratory Review

Paulo Tan, PhD & Rachel Lambert, PhD

University of Hawai'i at Mānoa & University of California, Santa Barbara

**Abstract:** In this exploratory review, we use a disability studies lens to analyze the focus and outcomes of 15 recently published research articles that spotlight the role of educators in the mathematics schooling of students with disabilities. The results of our review not only point to continuation of problematic positioning and paradigms in research, but also underscore the value in supporting special educators' mathematics understandings. Moreover, we note advancements in socio-contextual and socio-political research approaches that afford better understanding of the re/construction of disabled students, spaces, and pedagogy phenomena. We assert that outcomes of this review can inform more just research and practices for students with disabilities in mathematics education.

**Keywords:** Mathematics Education; Education; Disability Studies in Education

This exploratory review uses a Disability Studies in Mathematics Education (DSME) lens to analyze the focus and findings of recently published research that focuses on educators in disability mathematics education, and to recommend directions for future research and practice. Because mathematics is a human endeavor filled with creativity, all students should be afforded opportunities to engage in meaningful mathematical sense making connected to their lives. Such opportunities must also leverage their unique ways of thinking rather than experiencing only procedural instruction in which they must replicate the thinking of others (Gutiérrez, 2017). Opportunities that support the development and connections of mathematical reasoning and understanding as a human endeavor often do not exist for mathematics learners labeled with disabilities. Although evidence suggests that students with disabilities can engage in rigorous and sophisticated forms of mathematics (e.g., Peltenburg, van den Heuvel-Panhuizen, & Robitzsch, 2013; Lambert, 2015; Tan, 2017), this group of students typically are only offered low rigor mathematics (Jackson & Neel, 2006; Tan, 2016). Thus, we examine the literature for insights into the role of educators in fostering or limiting students with disabilities' opportunities in mathematics education.

Understanding the role of educators is crucial to advancing just practices (Waitoller & Artiles, 2013), yet such understanding has received very limited range when it comes to mathematics education involving students with disabilities. In a related study, we found that articles on mathematics education that did not include students with disabilities were far more likely to focus on educators as a unit of analysis compared to those that did include disability (Lambert & Tan, 2016). Related to problem solving, Lambert and Tan (2017) reported that teachers of students with disabilities were most often conceptualized as technicians following a predetermined, scripted curriculum, rather than as agentic. The concept of teachers of students with disabilities as technicians in educational research and practice mirrors the

positivist paradigm within traditional special education which values replication of practices in research (Cochran-Smith & Dudley-Marling, 2012; Skrtic, 1991). Special education research has traditionally centered on "... evaluating the effectiveness of instructional practices on children's learning but have focused less on the influence of teachers' understandings of the content they teach and the instructional practices they choose..." (Griffin, Jitendra, & League, 2009, p. 320). While mathematics education is grounded in constructivist and social-constructivist traditions, special education mathematics is rooted in behaviorism and cognitivist perspectives (van Garderen, Scheuermann, Jackson, & Hampton, 2009; Woodward, 2004). For this study, we employ an analytic framework, Disability Studies in Mathematics Education DSME0, that integrates disability studies with critical approaches to mathematics education to explore the role of educators in constructing disability and in affording or limiting opportunities.

### **Disability Studies in Mathematics Education**

DSME (Tan & Kastberg, 2017) is grounded in sociocultural traditions, synthesizing elements of disability studies (Gabel, 2005) and equity in mathematics education (Gutiérrez, 2013) scholarship. Disability studies scholars examine disability as a social construction that results in exclusion and oppression (e.g., Linton, 1998). They are also critical of special education and its groundings in positivist traditions that locate deficits within individuals and perpetuate ableism (Valle & Connor, 2011; Ware, 2005). Similarly, equity in mathematics education scholars problematize social forces that marginalize students and offer four interdependent equity domains: access, achievement, identity, and power (Gutiérrez, 2013). We draw on these domains and integrate disability studies concepts to ground our analytic framework.

The first domain, access, involves opportunities to engage meaningfully in a rigorous curriculum. This includes full access to and meaningful participation in mathematics educational programs with non-disabled peers, as well as access to teachers with strong mathematical and pedagogical content knowledge. In turn, achievement in these programs consists of students constructing knowledge alongside a full range of peers and making connections to their lived experiences outside of school, as well as other measures of achievement. According to Gutiérrez (2013), identity and power are interconnected concepts, each one shaping the other. Students with disabilities have been positioned through deficit constructions such as having gaps in mathematics knowledge (Tan & Thorius, 2018). In turn, they are not perceived as mathematics doers and thinkers, but as a collection of deficits (Tan, Lambert, Padilla, & Wieman, 2018). DSME scholars center on the role of power in mathematics education. Those without disabilities typically both construct and identify disabilities, determining "appropriate" forms of mathematics instruction and the spaces in which students with disabilities are allowed to learn (Tan & Kastberg, 2017), using unproductive concepts such as remediation (Tan & Thorius, 2018).

In sum, employing a DSME lens affords us a critical dimension that examines taken-for-granted assumptions and marginalizing practices in mathematics education involving

individuals with disabilities. As such, it strives for more productive and liberating forms of educational research in mathematics for and with this group of individuals. Indeed, a DSME lens can inform future research and practice, locating mathematics disabilities more broadly across multiple dimensions (e.g., student, teacher, classroom, curriculum) of teaching and learning, rather than a singular focus on individuals. It helps us imagine new possibilities in inclusive mathematics curriculum and spaces (Greenstein & Baglieri, 2018). Thus, we turn to the literature for progress on this front and to recommend future work with the following interrelated guiding questions:

1. What is the focus and outcomes of studies published from 2013–2015 that examined the role of educators in mathematics education and disability?
2. How were students with disabilities in mathematics framed in these studies?

## Method

The articles for this study were drawn from a larger dataset (Lambert & Tan, 2016) that included 1,463 empirical studies in mathematics education between 2013–2015. These articles focused on K–12 educators, students, and families but excludes research that focus' exclusively on mathematics at the undergraduate level unless the participants were prospective teachers. Also, this larger dataset involved educational database searches (i.e., ERIC, JSTOR, and PsychINFO) looking for descriptors and keywords of mathematics, math, and numeracy. For this review we examined these articles to determine whether they met the following criteria: the articles had to (a) be published in English or translated into English in peer-reviewed journals, (b) focus on mathematics educators (e.g., prospective and practicing K–12 teachers, teacher educators, mathematics educational researchers) and mathematics as central units of analysis, (c) include issues of disability as a focal topic (e.g., students with disabilities, special education, inclusive 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. The result of this process yielded 15 empirical research articles for examination.

For our analysis of the first research question, we utilized a conceptual review (Kennedy, 2007) to organize the articles into specific categories and to analyze each article within these groups. The back-and-forth process of analyzing and organizing the articles was central to refining the categories and themes. We identified the following categories a priori: (a) social-context (SC) aspects of mathematics education (Martin, Gholson, & Leonard, 2010) such as teacher's beliefs, perspectives, and attitudes related to mathematics and disability, (b) pedagogical content knowledge (PCK), which includes mathematics teaching practices (e.g., standards-based curriculum alignment, co-teaching), and (c) mathematics content knowledge (MCK), or developing or assessing educators' mathematics content knowledge or teacher perceptions of mathematics. All studies centralized at least one of these three categories, while several studies examined two or three. The categorization process involved each author individually reading and sorting the 15 articles into the three categories. After this process, we held a meeting to discuss how each of us categorized the articles, exploring any discrepancies

in sorting. Our disagreements were mostly around how each of us interpreted the socio-context category differently. In turn, we refined the description of the socio-context category to reconcile our different interpretations and to then agree on the categorization of articles that should or should not be in this category.

Next, we developed themes within each of the three categories. The first author examined the articles within each of the three categories and derived codes which were 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 author met to discuss this recategorization and agreed. The first author then collapsed the codes into the two or three themes for each of the categories. As themes emerged, the first author continued to shift some articles to other categories or themes as those articles fit better elsewhere. Once all of the themes for the first research question were complete, the first and second author held a meeting to deliberate and reconcile any differences. For analysis of our second research question, we employed the DSME lens to formulate themes based on each study's focus and outcomes. This involved interpreting the study's positioning and phenomena. For positioning, we looked at how each study situated students with disabilities (and when applicable, their families), or educators regarding access, identity, and power. 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: (a) To what extent are students with disabilities seen as capable mathematics learners and doers? (b) Where is the locus of power in decision-making regarding the mathematics education of students with disabilities and what are the basis for those decisions? (c) How is the "problem" constructed and addressed (e.g., deficits within and/or beyond students)? For phenomena, we examined each study's findings and global takeaways about how disability construction impacted mathematics education equity components such as access, achievement, identity, and power (Gutiérrez, 2013).

## Results

Table 1 presents a summary of the 15 studies including how we categorized each and the outcomes of our interpretation of their positioning and phenomena. Figure 1 illustrates the results of our analysis encompassing two interrelated major themes: (1) addressing teachers' mathematics understanding as valuable and (2) re/construction of disabled students, spaces, and pedagogy.

**Table 1***Summary of Reviewed Empirical Studies*

<b>Authors</b>	<b>Teacher Participants</b>	<b>Categories</b>	<b>Positioning</b>	<b>Phenomena</b>
Afamasaga-Fuata'i & Sooaemalelagi (2014)	Prospective teachers majoring in early childhood or special education.	MCK	Prospective special educators' mathematics pedagogy can benefit from developing deeper mathematical understandings.	Participants developed a deeper understanding and appreciation of mathematics content, and stated that they were excited to apply more innovative approaches in their classrooms.
Bailey, Nomanbhoy, & Tubpun (2015)	Practicing elementary teachers involved in remedial mathematics and literacy education.	SC	Participating teachers constructed students with disabilities and their families as burdens.	Participants constructed separate special education classrooms as appropriate spaces for students with disabilities.
Clark et al. (2014)	Novice elementary teachers including those certified in special education.	MCK PCK SC	Special educators beliefs about students with disabilities can be positively influenced from professional development.	Special educators belief that mathematics education should include periods of struggle depended on the number of professional development hours they had received.
Faulkner & Cain (2013)	Practicing teachers including those certified in special education.	MCK	Educators can benefit from mathematics content knowledge development.	Both general and special educators made significant gains in content knowledge for teaching mathematics as a result of the intervention.
Faulkner, Crossland, & Stiff (2013)	Dataset of teacher recommendations for 3,055 students (281 students receiving special education services).	SC	Teachers have the power to make placement decisions and made those decisions based on stereotypes related to students with disabilities in mathematics.	Students with disabilities were less likely to be placed into algebra courses by the time they entered eighth grade compared to students not receiving special education services, despite having high mathematics achievement scores.
Griffin, C.C., League, Griffin, V.L., & Bae (2013)	Practicing elementary teachers.	PCK	The authors positioned students with disabilities as benefiting from stereotypical mathematics pedagogy but not with learning with peers.	Participants' adherence to mathematics discourse practices varied to a great degree in inclusive mathematics classrooms.
Harris, Pollingue, Herrington, & Holmes (2014)	Prospective Special education teachers.	PCK	The authors positioned students with disabilities as lacking mathematics vocabulary understanding.	The authors reported that participants felt more confident in teaching mathematics vocabulary to students after the intervention.

Authors	Teacher Participants	Categories	Positioning	Phenomena
Heyd-Metzuyanin (2013)	Researcher serving as the teacher.	SC	The author viewed student's mathematics disability as socially constructed.	The teacher had a major role in contributing to the student's disabled identity construction, and interactional routines in the classroom are co-constructed by students and teachers.
Hinton, Flores, Burton, & Curtis (2015)	Prospective special educators.	MCK PCK SC	Improving special educators' mathematics content knowledge can positively influence their pedagogy.	Participants who categorized their teaching methods as dominated by procedural strategies held lower expectations of their students and had lower scores on content knowledge measures, compared to participants who incorporated conceptually-based pedagogy.
Hostins & Jordão (2015)	Practicing teachers including those who were special education certified.	PCK SC	The authors positioned students with disabilities as capable mathematics doers and thinkers.	Although teachers constructed special education classrooms as a place devoid of specific content learning, the participating student with a disability displayed sophisticated forms of mathematics meaning-making.
Kurz, Elliott, Lemons, Zigmond, Kloo, & Kettler (2014)	Practicing general and special educators.	SC	Participants positioned students with disabilities as not being capable of a higher order of thinking in mathematics.	Students with disabilities in the general education classrooms had less instructional time with state-specific standards as well as less content coverage when compared to students without disabilities.
Malone & Fuchs (2014)	Fourth-grade practicing teachers; research assistants (tutors).	SC	Participating teachers positioned "at-risk" students as problematic, while tutors perceived the same students as more attentive. Students with disabilities benefit from stereotypical mathematics pedagogy.	Tutors rated the students as more attentive than the classroom teachers. Also, tutor ratings had more predictive power than teacher ratings on student fraction concepts performance.
Murphy & Marshall (2015)	General and special education professors; prospective teachers.	MCK PCK	The authors positioned special education professors and prospective teachers as lacking confidence in affording opportunities for Common Core State Standards (CCSS) preparation.	Differences in confidence levels and professional development opportunities exist between general and special education professors. Prospective special educators expressed concern for CCSS mathematics content and pedagogy knowledge.



Authors	Teacher Participants	Categories	Positioning	Phenomena
Murzyn & Hughes (2015)	Practicing general and special educators; school administrators.	SC	Special educators suppressed students with disabilities and their families' voices.	Students with disabilities, their families, and mathematics teachers lacked a voice in decision-making.
Pape, Prosser, Griffin, Dana, Algina, & Bae (2015)	Practicing elementary teachers, including those who were special education certified.	MCK PCK SC	The authors positioned students with disabilities as benefiting from stereotypical mathematics pedagogy.	Participants developed mathematics and pedagogical knowledge to support their students' conceptual understanding and increased mathematics knowledge of their students.

Note. MCK = mathematics content knowledge; SC = social context; PCK=pedagogical content knowledge.

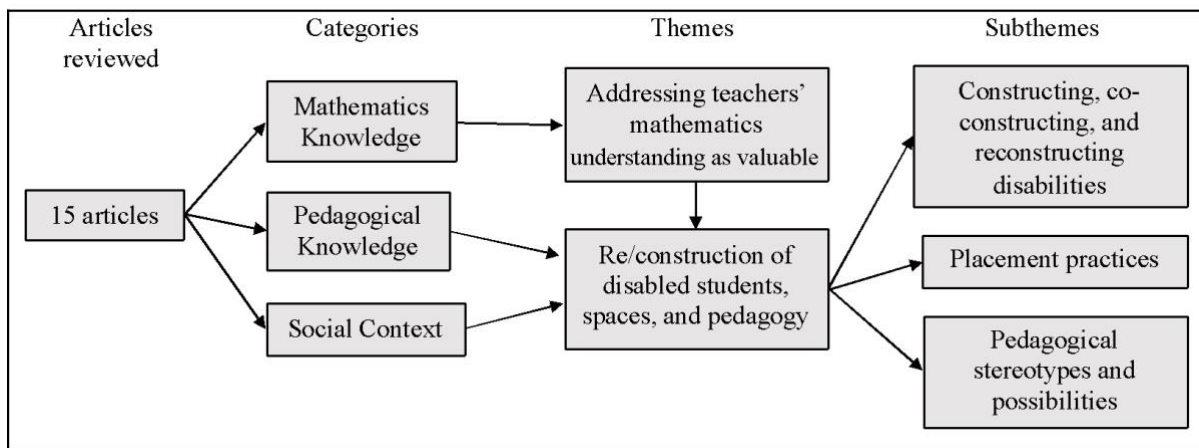


Figure 1. Outcomes of the exploratory review with progression of themes development from left to right.

Image description: Figure 1 illustrates the process and results of our analysis, starting with the 15 articles, then progressing into the three categories, namely: mathematics knowledge, pedagogical knowledge, and social context. From the first category, the figure shows a direct line to the first of two interrelated major themes: addressing teachers' mathematics understanding as valuable. From the second and third categories, the figure shows them converging to the second major theme: re/construction of disabled students, spaces, and pedagogy. From the second theme, there are three sub-themes: (a) constructing, co-constructing, and reconstructing disabilities, (b) placement practices, and (c) pedagogical stereotypes and possibilities.

Next, we describe features of each theme, related subthemes, and, as necessary, a short description of the studies.

## Addressing Teachers' Mathematics Understanding

Five articles in our review address teacher's mathematics content knowledge (Afamasaga-Fuata'i & Sooaemalelagi, 2014; Clark et al., 2014; Faulkner & Cain, 2013; Hinton et al., 2015; Pape et al., 2015) and in general point to the advantages of pursuing this line of research. Afamasaga-Fuata'i and Sooaemalelagi's (2014) study and Faulkner and Cain's (2013) are two that solely focused on mathematics content knowledge, while the remaining three also included pedagogical components. Special educators represented either all of the participants in these studies or at least a notable portion.

Afamasaga-Fuata'i and Sooaemalelagi (2014), for example, noted that prospective special educators expressed excitement about their new understanding from a mathematics methods course and planned to implement these approaches in their own classrooms. The authors examined the development of 84 Samoan prospective teachers' mathematical understandings and mathematics attitudes during participants' engagement in mathematics content learning—problem-solving strategies, metacognitive tools, mental computations, and mathematical processes. These same forms of engagements reflected a new mathematics curriculum that was being implemented in primary schools. Because the participants did not successfully pass a mathematics methods course on their first attempt, they were considered to have struggled with the development of mathematics knowledge. Participants included those who were interested in obtaining credentials in general education, early childhood, or special education. They were enrolled in a 14-week course involving face-to-face meetings twice per week that included lectures and workshops, followed by a teaching practicum. The focus of the course was to learn the different ways to use tools to display mathematical ideas and to develop conceptual understanding. The authors examined relationships between pre- and post-tests, participants' attitude towards mathematics, and post-semester interviews to understand attitudinal changes. The authors reported that in working on mathematical processes, mental computations, multiple problem-solving strategies, and concept maps and diagrams, participants learned to “strategically identify and meaningfully understand and appreciate mathematical ideas, their interconnections and various applications in selecting appropriate methods in solving mathematical tasks or conducting investigations” (p. 357).

Pape and colleagues' (2015) study examined the effects of an online professional development program—aimed to build conceptual mathematics knowledge and pedagogical knowledge—on 23 elementary school teachers (17 general educators, and six special educators). The researchers approached supporting teachers to make deep meaning of mathematics through building conceptual understanding. The study also engaged participants in examining students' thinking within clinical interviews, and participants learned ways to elicit students' mathematical thinking during mathematics activities. Participants were then challenged to implement knowledge gained from the professional development in their classrooms. The authors reported that participants developed pedagogical knowledge to support their students' conceptual understanding and increased mathematics knowledge of their students.



Faulkner and Cain's (2013) study also aimed to support educators' mathematics content knowledge by examining the effects of a professional development course. The course centered on practical experiences that would better translate into stronger classroom practices for students with disabilities in mathematics. Participants in the study included 199 K–12 general mathematics educators and 93 special education teachers certified at the K–12 levels. The authors examined special educators' mathematical knowledge, speculating that it would be lower when compared to their general education peers. Yet, the authors reported that both general and special educators made significant gains in content knowledge for teaching mathematics as a result of the professional development course.

Hinton and colleagues's (2015) study underscores the importance of supporting special educators in developing strong mathematics knowledge and their connections to practice. In their study, 33 prospective special educators were assessed on K–6 mathematics computation and problem-solving content skills. Overall, higher scores on these assessments correlated to teachers' identification of their teaching practices as conceptual, while lower scores related to procedural types of practices. The authors suggested that "participants' lack of focus on conceptual knowledge may be due to their own lack of mathematics understanding and skill" (p. 9). Thus, building understanding in how to support special educators' mathematics content development is a crucial, particularly at the pre-service level. Indeed, Murphy and Marshall (2015) argues such work is important to better prepare special educators to implement more rigorous mathematics standards as mandated by states. Yet, this sense of urgency is not reflected in research. Besides the Afamasaga-Fuata'i and Sooaemalelagi (2014) study, we did not find any other published studies from 2013–2015 focused solely on developing prospective special educators' mathematics knowledge.

### **Re/Construction of Disabled Students, Spaces, and Pedagogy**

The second major theme focused on how learners with disabilities are re/constructed in mathematics education and consequences of such constructions in terms of designated spaces and types of opportunities afforded. The studies within this theme mostly point to inequities in terms of access, achievement, identity, and power (Gutiérrez, 2013). We organize this section into three sub-themes to support the major theme: (a) constructing, co-constructing, and reconstructing disabilities (Bailey et al., 2015; Heyd-Metzuyanim, 2013; Hinton et al., 2015; Hostins & Jordão, 2015), (b) placement practices (Faulkner et al., 2013; Murzyn & Hughes, 2015), and (c) pedagogical stereotypes and possibilities (Clark et al., 2014; Harris et al., 2014; Hinton et al., 2015; Griffin et al., 2013; Pape et al., 2015).

#### *Constructing, Co-Constructing, and Reconstructing Disabilities*

Bailey, Nomanbhoy, and Tubpun (2015) reported that while teachers held positive attitudes towards the principle of inclusion, they constructed students with disabilities as burdens. The authors conducted a survey involving 300 Malaysian primary school teachers who taught remedial literacy and mathematics. The teachers participated in professional development that aimed to support their knowledge of students with disabilities. Participants also noted that students with disabilities required more teacher attention, lacked persistence,

detracted the learning of other students, and required more specialized technical skills (similar sentiments were reported by Malone and Fuchs (2014)). As such, participants expressed that special education classrooms were optimum learning environments for students with disabilities. Moreover, participants constructed families of students with disabilities as burdens, perceiving that these families presented more challenges compared to families of students without disabilities.

The ways students with disabilities are constructed also relates to how teachers categorize their mathematics teaching approaches. Hinton, Flores, Burton, and Curtis (2015) examined prospective special education teachers' mathematics content knowledge, self-efficacy measures on mathematics content, and how the participants described their mathematics teaching methods. The participants (n=33), who were part of an undergraduate teacher preparation program in elementary special education, completed the surveys during the final university course before graduation. The authors reported that participants who categorized their teaching methods as dominated by procedural strategies held lower expectations of their students compared to participants who incorporated conceptual knowledge strategies.

Whereas Bailey et al. (2015) and Hinton et al. (2015) focused on how teachers perceive students with disabilities as a stereotyped group thereby constructing them accordingly, Heyd-Metzuyanim's (2013) focused on the teacher's role in co-constructing disability during mathematics interactions. Heyd-Metzuyanim attributed both student and teacher factors that contributed to a disability identity. In particular, Heyd-Metzuyanim examined teaching-learning interactions in mathematics involving a seventh-grade female student, Dana, and her teacher, the researcher of that study. These interactions are in line with the teacher "making sense of student work/thinking to respond" (Kastberg, Tyminski, & Sanchez, 2017, p. 12). Heyd-Metzuyanim's five-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 interview. Rather than categorize such instances as Dana's failure to respond to evidence-based mathematics interventions, Heyd-Metzuyanim posited that she (the teacher) had a major role shaping Dana's identity construction as disabled. For example, the author identified how Dana was excluded from meaning-making mathematics practices such as participating in classroom discourse. Thus, Dana ascribed to an identity based on what others, including her teacher, perceived about her lack of mathematics abilities.

Unlike Bailey et al. (2015), Hinton et al. (2015), and Heyd-Metzuyanim's (2013) focus on co- or constructing students with disabilities in terms of limitations, Hostins and Jordão (2015) instead analyzed the potential of a student with a disability as a mathematical doer and thinker. This is a way to deconstruct long held assumptions about disability and mathematics. Hostins and Jordão's (2015) analyzed a mathematics teaching episode and the qualities of the mathematics interaction in effect deconstructed disability as deficit. Guided by elements of social constructivism, the authors examine how the participants (one teacher and

one student referred to as JF who carried an intellectual disability label) interacted during a Base Three Game. The game is accessible yet involves complex forms of mathematical thinking. The analysis of observations and artifacts from the games 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 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 the advancement of "superior psychological functions...exposing the understanding of the potential possibilities" (Hostins & Jordão, 2015, p. 14).

Hostins and Jordão (2015) contrasted these possibilities within a larger context devoid of opportunities in these types of mathematics interactions. In this context, despite a national inclusive education policy and curriculum practices guaranteeing that students with disabilities had access to regular education, the authors' examination of teacher discourse during group interviews indicated that participating teachers shifted pedagogical responsibilities of working with students with disabilities to special education spaces. In turn, opportunities for rich mathematical interactions such as the one with JF were not likely to occur given participants' construction of special education places as one with unspecific broad pedagogical descriptions (e.g., "differentiated strategies," "adapting to the needs of each student," "complementary and/or supplementary to learning"). The authors argue that such characteristics contributed to increasing the responsibilities gap between general and special educators, in effect reversing national inclusive education initiatives.

### *Placement Practices*

Construction of disabled students and spaces also relate to placement practices. For one, mathematics teachers and families lack a voice in placement decision-making as documented in Murzyn and Hughes' (2015) study. The authors examined three cases of mathematics placement decisions for high school students with high-incidence disabilities (e.g., specific learning disabilities, emotional and behavioral disorders). Placement in this context is conceptualized as both the location in which students engage with mathematics and the provision of associated special education services (e.g., general education classroom with accommodations and modifications; general education classroom within a co-taught classroom; and special education resource classroom). The authors reported that special education teachers took the lead in making final placement decisions and factors unrelated to student's need influenced their placement decisions (e.g., master schedule, course options). Of note, the participants expressed concern for the lack of mathematics course options in their schools which resulted in students with disabilities having to be placed in the general education mathematics courses. Inherent in these concerns are participants' assumptions that students with disabilities are "low" in mathematics. Kurz and colleagues (2014) reported similar sentiments from their teacher participants. Thus, such concerns indicate constructions of disabled students and separate mathematics learning spaces as natural and necessary. At the same time, the general education is perceived as unyielding and unsupportive of students with disabilities (Skrtic, 1991).

The outcomes from Faulkner, Crossland, and Stiff's (2013) study underscore the constructions of disabled students and separate mathematics learning spaces as natural and necessary. The authors 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 studied teacher evaluation measures on students' mathematics ability and students' scores on a cognitive mathematics assessment. Focusing on fifth- and eighth-grade waves, the authors found that students receiving special education services were less likely to be placed into algebra courses by the time they entered eighth grade compared to students not receiving special education services. Such outcomes occurred despite the fact that students with disabilities who scored high on the mathematics assessment and by that measure alone should have afforded their placement into algebra. However, teachers rated students with disabilities low on a mathematical ability level perception indicator which was "virtually prohibitive of placement in algebra" (p. 338). Indeed, teachers' constructions of students with disabilities were powerful predictors for placement into lower- and remedial-level mathematics courses. In turn, the analysis and understanding of the teachers' role in mathematics education afford important insights into mathematics pedagogy, both its limitations and possibilities.

#### *Pedagogical Stereotypes and Possibilities*

Our final subtheme connects central threads from the two major themes as they relate to pedagogical stereotypes and possibilities. We conceptualize this as research that reinforce stereotypical pedagogical approaches, point to more just possibilities, or both. By stereotypical, we mean that students with disabilities are not thought of creative mathematics doers and thinkers. On the other hand, pedagogical possibilities are those that move away from stereotypical approaches. For example, Clark and colleagues' (2014) report that special educators subscribe to mathematics pedagogy for students with disabilities that should not include student struggle. This contradicts practices sanctioned by the National Council of Teachers of Mathematics (2014) that holds students struggle as core to learning; struggle goes hand-in-hand with creativity. Clark and colleagues also reported that a higher number of professional development hours is related to the belief that mathematics teaching and learning should include periods of struggle in order for students to make meaning of mathematics. Clark and colleagues (2014) examined relationships between teacher characteristics, beliefs, mathematical content and pedagogical knowledge, and student achievement. The study involved 259 upper elementary teachers and 184 middle school teachers, with approximately 17% and 20% respectively held special education credentials. The pedagogical knowledge also included aspects of teachers' awareness of students' mathematical dispositions. Similar outcomes in pedagogical limitations and possibilities were reported by Hinton and colleagues (2015), a study which we described earlier. Their comparison of participants' responses regarding their teaching methods to measures of mathematics content knowledge found that participants who described their mathematics instruction as procedural had lower computation scores compared to those who described their practices as conceptual.

In two studies (Griffin et al., 2013; Pape et al., 2015), we note tensions between

pedagogical stereotypes and possibilities. For example, Pape and colleagues' (2015) study, one we described earlier, included elements in their professional development program that aligned to pedagogical possibilities in that it worked with teachers to approach students with disabilities as mathematics doers and thinkers. At the same time, their program also featured stereotypical pedagogical components such as targeted content on "characteristics and learning problems of students with learning disabilities" and "evidence-based practice in mathematics for students with learning disabilities" (Pape et al., 2015, p. 19). A main characteristic of such practices is its set sequence that includes teacher demonstration, guided practice, and presentation of information in small steps (Miller & Hudson, 2007).

In the Griffin and colleagues' (2013) study, pedagogical stereotypes and possibilities tension manifested somewhat differently. For pedagogical possibilities, the authors aimed to better understand teachers' actions and students with disabilities' engagement and outcomes in two inclusive mathematics classrooms. The authors spent four months observing teacher discourse practices regarding time spent on teaching mathematics terminology, formal assessments, and peer-to-peer interactions, and assessed students' mathematics progress. The authors noted that the teacher who spent more time on direct instruction had students who achieved better mathematics performance outcomes compared to the teacher who spent more time providing peer-to-peer learning opportunities. As such, the authors suggested stereotypical pedagogies. Specifically, they advocated for teacher-directed approaches which incorporate "strategy instruction, offers frequent opportunities for review and practice, involves thorough concept development using manipulative materials and visual depictions, and deemphasizes opportunities for peer-mediated instruction may support the learning of students with disabilities and other struggling students" (Griffin et al., 2013, p. 18).

Lastly, pedagogical possibilities were more limited in Harris and colleagues' (2014) study, which focused on developing prospective special educator's mathematics pedagogical knowledge around an intervention program that emphasizes mathematics fact acquisition, skill-building, and repetition. They described their target students as ones "struggling to understand math terms and their meanings" (p. 96) and that students needed to reinforce vocabulary learning. Similarly, Malone and Fuchs (2014) also recommended deficit-centered approaches by modifying "instruction based on students' needs" which presumably means to address "students' academic deficits" (p. 385).

## Discussion

In this exploratory review, we employed a disability studies lens to analyze the focus and findings of 15 recently published research articles from 2013–2015 that spotlight the role of educators in the mathematics schooling of students with disabilities. In this section we discuss the outcomes of our analysis guided by the interrelated two research questions: What is the focus and outcomes of the studies? How were students with disabilities in mathematics framed in these studies? We also describe implications for future research in advancing access, achievement, recognizing and valuing students with disabilities as mathematics doers and thinkers, and shifting power.



## **Building Mathematics Understanding as Valuable**

The results of our analysis indicate that supporting educators' mathematical understanding is valuable in terms of translating these understandings to practices that approach students with disabilities as doers and thinkers. Developing deep mathematics understanding is one of the most important components of effective mathematics teaching (Ball, Thames, & Phelps, 2008). Yet, such understandings for special and general educators working with students with disabilities have received limited attention (Faulkner & Cain, 2013). The five articles in our review that address teacher's mathematics understanding (Afamasaga-Fuata'i & Sooaemalelagi, 2014; Clark et al., 2014; Faulkner & Cain, 2013; Hinton et al., 2015; Pape et al., 2015) highlight the importance of this line of research. In particular, that supporting educators to make deeper mathematics understanding is associated with the potential of implementing mathematics pedagogy that is more substantive. Importantly, this area of research shifts the deficit focus from students with disabilities to broader factors, in this case, educators' mathematics understanding. Future research can examine the extent to which building deeper mathematical understanding translate to more just mathematics practices for students with disabilities.

## **Re/Construction of Disabled Students, Spaces, and Pedagogy**

Our analysis also points to problems and advancements in the body of research that spotlight the role of educators in mathematics schooling of students with disabilities. We note one such dichotomy in the area of pedagogical stereotypes and possibilities. The former is deemed to be "evidence-based and effective" for students with disabilities, yet such claims are derived from narrow conceptions of mathematics (e.g., producing the correct answers on arithmetic problems). These claims reinforce conceptions of the discipline of mathematics as fixed with facts and procedures that must be mastered and memorized through rote performance rather than as an ever-expanding discipline where the answer to the fundamental question of what is mathematics continue to be explored (Gutiérrez, 2017).

In turn, these practices limit the practices of students with disabilities as mathematics doers and thinkers. We found endorsements of such practices in a notable number of the studies we reviewed (Griffin et al., 2013; Harris et al., 2014; Malone & Fuchs, 2014; Pape et al., 2015). Interestingly, within some of these same studies (Griffin et al., 2013; Pape et al., 2015), endorsements of stereotypical pedagogies were situated within pedagogical possibilities. For example, Pape and colleagues engaged participating teachers in supporting development of their mathematical and pedagogical understanding that would in turn position students with disabilities as mathematics doers and thinkers. This tension between pedagogical stereotypes and possibilities are problematic. In particular, in the signaling to the consumers of this research (e.g., teacher educators, prospective and practicing teachers, school leaders) who may then sustain stereotypical forms of mathematics education for students with disabilities that views them as incapable of having unique ways of constructing mathematics, who must be told exactly how to solve mathematical problems. However, other studies provide pedagogical possibilities as opportunities for future research and more just



practices.

The work with Dana (Heyd-Metzuyanim, 2013) and JF (Hostins & Jordão, 2015) shows us that there are more just explanations for the construction of disabilities in mathematics and ways to reconstruct students with disabilities as mathematics doers and thinkers. In turn, we recommend that future research and practices recognize and value students with disabilities as mathematics doers and thinkers while rejecting notions of deficiencies (Gutiérrez, 2017). Building this knowledge base and documenting these efforts will be crucial to counter other problematic phenomena in the studies that we reviewed including unjust placement decisions (Faulkner et al., 2013; Murzyn & Hughes, 2015) and stereotypical constructions of students with disabilities in mathematics (Griffin et al., 2013; Kurz et al., 2014; Harris et al., 2014; Malone & Fuchs, 2014; Pape et al., 2015) and the spaces they occupy (Bailey et al., 2015).

Lastly, the results of our analysis indicate that power is often located outside of the individuals most impacted by discriminatory practices. Positive outcomes largely depend on effective educational experiences, yet individuals with disabilities have very little say in their education regarding, for example, placement decisions into certain mathematics courses. We suggest that future research explore ways in which educators build consciousness of social forces that perpetuate ableism across all facets of mathematics education and through emancipatory forms of inquiry and practices.

## Conclusion

This research utilized a disability studies lens to explore 15 recently published journal articles. To address our research questions, we shared results of two major interrelated themes: (1) addressing teachers' mathematics understanding as valuable and (2) re/construction of disabled students, spaces, and pedagogy. We described how the outcomes of this research can help advance future work in the area of mathematics education and disability. We find advancements in socio-political research focused on concepts such as the co-construction and reconstruction of disability. In turn, we recommend continued focus on socio-political research while pursuing inquiry on power and agency. This focus will ensure improvement in the quality of opportunities for students with disabilities to be perceived as mathematics doers and thinkers, to construct mathematics knowledge alongside their peers, and to have teachers who have a deep understanding of mathematics and humanizing pedagogies. Indeed, such a commitment will contribute to positive outcomes for individuals with disabilities in and out of schools.

**Paulo Tan**, Ph.D., is an Assistant Professor of Mathematics Education in the Institute for Teacher Education at the University of Hawaii, Manoa. His research attends to inclusive mathematics education related to students with disabilities and ways to support stakeholders to advance equity and social justice.

**Rachel Lambert**, Ph.D., is an Assistant Professor in the Gervitz Graduate School of Education at UC Santa Barbara. Her research explores the intersection of mathematics

education and disability studies in education, focusing on how children come to understand themselves as particular kinds of math learners and how such identifications matter for subsequent learning.

## References

- Afamasaga-Fuata'i, K., & Sooaemalelagi, L. (2014). Student teachers' mathematics attitudes, authentic investigations and use of metacognitive tools. *Journal of Mathematics Teacher Education*, *17*, 331–368. <https://doi.org/10.1007/s10857-014-9270-y>
- Bailey, L., Nomanbhoy, A., & Tubpun, T. (2015). Inclusive education: Teacher perspectives from Malaysia. *International Journal of Inclusive Education*, *19*, 547–559. <https://doi.org/10.1080/13603116.2014.957739>
- Ball, D. L., Thames, M. H., & Phelps, G. (2008). Content knowledge for teaching: What makes it special? *Journal of Teacher Education*, *59*, 389–407. <https://doi.org/10.1177/0022487108324554>
- Clark, L. M., DePiper, J. N., Frank, T. J., Nishio, M., Campbell, P. F., Smith, T. M., ... Choi, Y. (2014). Teacher characteristics associated with mathematics teachers' beliefs and awareness of their students' mathematical dispositions. *Journal for Research in Mathematics Education*, *45*, 246–284.
- Cochran-Smith, M., & Dudley-Marling, C. (2012). Diversity in teacher education and special education the issues that divide. *Journal of Teacher Education*, *63*, 237–244.
- Faulkner, V. N., & Cain, C. R. (2013). Improving the mathematical content knowledge of general and special educators evaluating a professional development module that focuses on number sense. *Teacher Education and Special Education*, *36*, 115–131.
- Faulkner, V. N., Crossland, C. L., & Stiff, L. V. (2013). Predicting eighth-grade algebra placement for students with individualized education programs. *Exceptional Children*, *79*, 329–345.
- Gabel, S. L. (2005). *Dis/ability studies in education: Readings in theory and method*. New York: Peter Lang Publishing.
- Greenstein, S., & Baglieri, S. (2018). Imagining mathematical thinking for inclusive curriculum: A conversation. *Investigations in Mathematics Learning*, *10*(3), 133–144. <https://doi.org/10.1080/19477503.2018.1467091>
- Griffin, C. C., Jitendra, A. K., & League, M. B. (2009). Novice special educators' instructional practices, communication patterns, and content knowledge for teaching mathematics. *Teacher Education & Special Education*, *32*, 319–336.
- Griffin, C. C., League, M. B., Griffin, V. L., & Bae, J. (2013). Discourse practices in inclusive elementary mathematics classrooms. *Learning Disability Quarterly*, *36*(1), 9–20. <https://doi.org/10.1177/0731948712465188>
- Gutiérrez, R. (2013). The sociopolitical turn in mathematics education. *Journal for Research in Mathematics Education*, *44*(1), 37–68.

- Gutiérrez, R. (2017). Living mathematics: Towards a vision for the future. *Philosophy of Mathematics Education Journal*, 32.
- Harris, P. P., Pollingue, A. B., Herrington, D., & Holmes, A. (2014). Effects of training on pre-service special educators' abilities to co-teach math vocabulary in preparation for inclusion settings. *Journal of the International Association of Special Education*, 15, 94–99.
- Heyd-Metzuyanim, E. (2013). The co-construction of learning difficulties in mathematics—teacher–student interactions and their role in the development of a disabled mathematical identity. *Educational Studies in Mathematics*, 83, 341–368. <https://doi.org/10.1007/s10649-012-9457-z>
- Hinton, V., Flores, M., Burton, M., & Curtis, R. (2015). An investigation into pre-service special education teachers' mathematical skills, self-efficacy, and teaching methodology. *Issues in the Undergraduate Mathematics Preparation of School Teachers, 1*. Retrieved from <http://eric.ed.gov/?id=EJ1061104>
- Hostins, R. C. L., & Jordão, S. G. F. (2015). School inclusion policy and curricular practices: Teaching strategies for the conceptual preparation of the target public of special education. *Education Policy Analysis Archives*. <https://doi.org/10.14507/epaa.v23.1661>
- Jackson, H. G., & Neel, R. S. (2006). Observing mathematics: Do students with EBD have access to standards-based mathematics instruction? *Education and Treatment of Children*, 29, 593–614.
- Kastberg, S. E., Tyminski, A. M., & Sanchez, W. B. (2017). Reframing research on methods courses to inform mathematics teacher educators' practice. *The Mathematics Educator*, 26(1). Retrieved from <http://tme.journals.libs.uga.edu/index.php/tme/article/view/384>
- Kennedy, M. M. (2007). Defining a literature. *Educational Researcher*, 36(3), 139–147. <https://doi.org/10.3102/0013189X07299197>
- Kurz, A., Elliott, S. N., Lemons, C. J., Zigmond, N., Kloo, A., & Kettler, R. J. (2014). Assessing opportunity-to-learn for students with disabilities in general and special education classes. *Assessment for Effective Intervention*, <https://doi.org/10.1177/1534508414522685>
- Lambert, R. (2015). Constructing and resisting disability in mathematics classrooms: A case study exploring the impact of different pedagogies. *Educational Studies in Mathematics*, 89(1), 1–18. <https://doi.org/10.1007/s10649-014-9587-6>
- Lambert, R., & Tan, P. (2017). Conceptualizations of students with and without disabilities as mathematical problem solvers in educational research: A critical review. *Education Sciences*, 7(2), 51. <https://doi.org/10.3390/educsci7020051>
- Lambert, R. & Tan, P. (2016). Theorizing the research divide between special education and mathematics. In M. B. Wood, E. E. Turner, M. Civil, & J. A. Eli (Eds.), *Proceedings of the 38th annual meeting of the North American Chapter of the International Group for the Psychology of Mathematics Education* (pp. 1057–1063). Tucson, AZ:

University of Arizona.

- Linton, S. (1998). *Claiming disability: Knowledge and identity*. New York, NY: NYU Press.
- Malone, A. S., & Fuchs, L. S. (2014). Comparing the contribution of teacher versus tutor ratings of inattentive behavior in predicting mathematics achievement. *Remedial and Special Education, 35*, 378–386. <https://doi.org/10.1177/0741932514539855>
- Martin, D. B., Gholson, M. L., & Leonard, J. (2010). Mathematics as gatekeeper: Power and privilege in the production of knowledge. *Journal of Urban Mathematics Education, 3*(2), 12–24.
- Miller, S. P., & Hudson, P. J. (2007). Using evidence-based practices to build mathematics competence related to conceptual, procedural, and declarative knowledge. *Learning Disabilities Research & Practice, 22*(1), 47–57. <https://doi.org/10.1111/j.1540-5826.2007.00230.x>
- Murphy, M. R., & Marshall, K. J. (2015). Common core preparation in special education teacher education programs: Beginning the conversation. *Teacher Education and Special Education, 38*, 167–185.
- Murzyn, A., & Hughes, T. (2015). Making mathematics placement decisions for high school students with high incidence disabilities: A collective case study. *American Secondary Education, 43*(2), 44–58.
- National Council for Teachers of Mathematics (NCTM) (2014). *Principles to actions: Ensuring mathematics success for all*. Reston, VA: NCTM.
- Pape, S. J., Prosser, S. K., Griffin, C. C., Dana, N. F., Algina, J., & Bae, J. (2015). Prime online: Developing grades 3–5 teachers' content knowledge for teaching mathematics in an online professional development program. *Contemporary Issues in Technology and Teacher Education, 15*(1), 14–43.
- Peltenburg, M., van den Heuvel-Panhuizen, M., & Robitzsch, A. (2013). Special education students' strategies in solving elementary combinatorics problems. In A. M. Lindmeier & A. Heinze (Ed.), *Proceedings of the 37th Conference of the International Group for the Psychology of Mathematics Education* (Vol. 4, pp. 9–16). Kiel, Germany: PME.
- Skrtic, T. (1991). The special education paradox: Equity as the way to excellence. *Harvard Educational Review, 61*(2), 148–207. <https://doi.org/10.17763/haer.61.2.0q702751580h0617>
- Tan, P. (2017). Toward inclusive mathematics education for “inferior students with no brains:” A case study of a student with autism and his peer. *Journal of Ethnographic & Qualitative Research, 11*(3), 229–242.
- Tan, P. (2016). Developing mathematical understanding and students with emotional and behavioural disorders: A review of the literature. *Emotional and Behavioural Difficulties, 21*(4), 361–376. <https://doi.org/10.1080/13632752.2016.1201639>
- Tan, P., & Kastberg, S. (2017). Calling for research collaborations and the use of dis/ability studies in mathematics education. *Journal of Urban Mathematics Education, 10*(2).

Retrieved from <http://ed-osprey.gsu.edu/ojs/index.php/JUME/article/view/321>

- Tan, P., Lambert, R., Padilla, A., & Wieman, R. (2018). A disability studies in mathematics education review of intellectual disabilities: Directions for future inquiry and practice. *The Journal of Mathematical Behavior*. <https://doi.org/10.1016/j.jmathb.2018.09.001>
- Tan, P., & Thorius, K. K. (2018). En/countering inclusive mathematics education: A case of professional learning. *Mathematics Teacher Educator*, 6(2), 52–67.
- Valle, J., & Connor, D. (2011). *Rethinking disability: A disability studies approach to inclusive practices*. New York: McGraw-Hill.
- van Garderen, D., Scheuermann, A., Jackson, C., & Hampton, D. (2009). Supporting the collaboration of special educators and general educators to teach students who struggle with mathematics: An overview of the research. *Psychology in the Schools*, 46(1), 56–78. <https://doi.org/10.1002/pits.20354>
- Waitoller, F. R., & Artiles, A. J. (2013). A decade of professional development research for inclusive education: A critical review and notes for a research program. *Review of Educational Research*, 83, 319–356.
- Ware, L. (2005). Many possible futures, many different directions: Merging critical special education and dis/ability studies. In S. L. Gabel (Ed.), *Dis/Ability studies in education: Readings in theory and method*. (pp. 103–124) New York: Peter Lang.
- Woodward, J. (2004). Mathematics education in the United States past to present. *Journal of Learning Disabilities*, 37(1), 16–31. <https://doi.org/10.1177/00222194040370010301>