A DISABILITIES STUDIES ANALYSIS OF THE RESEARCH DIVIDE BETWEEN SPECIAL EDUCATION MATHEMATICS AND MATHEMATICS EDUCATION

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Research on the mathematical learning of children with and without disabilities is currently two distinct realms of research operating with different fundamental assumptions about learning and mathematics. In 2013, mathematics education included disability as a focus in only 1.2% of research reports. Research on the mathematical learning of children with disabilities in 2013 was overwhelmingly published in special education and psychology journals (88%). This divide perpetuates the assumption that that there exists two kinds of children who need separate mathematical pedagogies, institutions and research agendas, relegating children with disabilities to a perpetual status of non-thinkers in mathematics.

INTRODUCTION

In an analysis of mathematical educational research published between 1982 and 1998, Lubienski and Bowen found that research on disability was predominately found in special education journals, and was almost absent from mainstream mathematics journals (2000). Research on the mathematical learning of children with disabilities is still overwhelmingly published in special education and psychology journals, while disability is routinely left out of mathematics education. Mathematics education and special education mathematics operate with different fundamental assumptions about the nature of mathematics learning, teaching and research. This divide continues to re-inscribe difference for those with disabilities as math learners, creating the conception that these two groups of children are cognitively dissimilar, and thus must be studied and educated separately, with different pedagogies and methodologies in mathematics.

Mathematics instruction in special education classrooms has long been dominated by computational practice (Woodward & Montague, 2002; Parmar & Cawley, 1991). Mathematics in special education believes that children need to first master math facts and learn computational procedures before children engage in conceptual work. Reform mathematics proposes the opposite trajectory, in which children first engage in conceptual problem-solving which leads to the development of efficient strategies for computation and finally learning standard procedures. Just as each research field differently conceptualizes the process of learning mathematics, so they conceptualize learners based on their theories. Children in special education are understood as a series of deficits that affect their ability to memorize facts and replicate procedures, while. Children in mathematics education are understood as meaning makers who learn through solving problems.

Segregating children within special education appears to have negative consequences for their mathematical achievement. Students who received special education services had consistently low achievement levels in mathematics from fourth to seventh grade, while students who received English language services improved over that time period (Shin, Davison, Long, Chan, & Heistad, 2013). Controlling for other factors such as achievement, students in special education are less likely to be placed into algebra in eighth grade than their similarly performing peers (Faulkner, Crossland, & Stiff, 2013).

THEORETICAL FRAMEWORK

Children receive special education services because of a wide variety of individual variations. Within special education, children with disabilities are understood primarily through a medical model. The assumption is that these children need specialized instruction and support for both diagnosis and intervention. While this research commentary will focus on learning disabilities (LD), I do so not to privilege LD over other disabilities. All learners with disabilities deserve access to meaning-making in mathematics.

Disability Studies in Education (DSE) provides a critical perspective on special education, interrogating how schools and academic research create meaning from disability (Gabel, 2005). The social model separates impairment—differences in one's body or mind—from disability, a term that is used to understand how social processes disable those with particular impairments in particular ways (Shakespeare, 2006). Disabilities in schools are constructed on the premise that there exists a meaningful distinction between normal and abnormal learner in schools. Teachers are trained to notice difference and to name it as deficit (McDermott, Varenne & Goldman, 2006). Taking longer to learn to read, difficulty memorizing mathematical facts, or having trouble sitting still are all ways of behaving that are currently read as disability. Children who seem different are referred to special education experts who are presumed to have expertise in diagnosis and intervention that the classroom teacher does not. The disability is assumed to lie within the child, instead of within the classroom context. Yet schools and classrooms have been arranged to make certain differences visible, and to sort young people into categories like LD (McDermott et al., 2006).

LD has been broadly understood as difficulties learning in school that could not be explained by other disabilities or environmental factors. LD was originally diagnosed through a discrepancy between achievement and IQ scores, a method that has been rejected by the special education community as lacking validity and reliability (Francis et al., 2005; Stanovich, 2005). Even within the special education community, there continues to be discussion about whether or not the label of LD identities a group of students who is any different from low-achieving students (Gresham & Vellutino, 2010). A review of ten years of research in the three major LD journals noted "a failure to scientifically operationalize the LD construct"(McFarland et al., 2013). In addition, diagnosis of learning disabilities is disproportionate based on race and gender, with for example a greater proportion of African-American boys placed into the LD category (Losen & Orfield, 2002). Despite significant difficulties with the LD construct, it continues to be used to sort learners into special education.

A far more flexible vision of disabilities has emerged from the neurodiversity movement, which began with autistic self-advocates (Sinclair, 2012; Robertson & Ne'eman, 2008). These activists have redefined autism as neurodiversity rather than deficit, bringing forward ways in which autistic thinking processes benefit them. Preserving the diversity of thinkers in our society is a goal of the movement, which strongly resists the "cure" for autism. Like autism, people with learning disabilities have associated strengths, such as artistic skill and global visual-spatial processing (von Karolyi et al., 2003). Yet none of the studies in my sample investigated the mathematical strengths of learners with disabilities. Neurodiversity can be incredibly helpful to teachers, as it is centered on the educational experience of students with disabilities, focusing on the development of strengths rather than relentless remediation.

Special education research developed from experimental psychology and behaviorism (Skrtic, 1991). Behaviorism focuses on the quantification of observable behaviors. Mathematical learning is understood as mastering a sequence of discrete sub-skills, taught through teacher demonstration and student practice. Recommended pedagogy within the academic fields of special education and psychology is "explicit, systemic instruction" which "typically encompasses a step-by-step teacher demonstration for a specific type of problem along with teacher-guided and independent practice using the step-by-step procedure."(Powell, Fuchs & Fuchs, 2013, p. 41). Special education mathematics has been deeply distrustful of constructivism, known within the field as discovery learning (Woodward & Montague, 2002), which assumes that the teacher provides no guidance. This theory bears little resemblance to current constructivist curricula that require extensive experience with pedagogical content knowledge in mathematics for teachers to implement successfully, as student success depends on skilled facilitation and problem design (Carpenter et al., 2014).

METHODS

The purpose of this research is to ascertain the current state of research into the mathematical learning of students with and without disabilities. It addresses the following research questions:

) In which academic fields is the study of mathematical learning of students with disabilities published?

2) How does mathematics research for children with and without disabilities differ in terms of methodologies and participants?

3) What patterns exist within the literature on disability and mathematics? Which disabilities are included? How is mathematical learning disabilities defined?

In order to create a sample set that included as many articles as possible that were peer-reviewed, research papers, and dealt with mathematics education from the preschool level until the end of high school, I searched using descriptors and keywords in both the ERIC and JSTOR research databases for math, mathematics, numeracy, and as well as a hand search through all actively-publishing journals used in Lubienski and Bowen (2000). I identified 45 total journals that published articles on mathematics education preK-12 during the year 2013, with a sample of 259 research articles. I analyzed the title, keywords and abstract for each article, coding for kind of journal (mathematics education, general education, or psychology and related research), the methodology used (quantitative, qualitative, mixed methods, or a theoretical piece) and explicit connections to disability or special education. I also coded for terms related to equity (race, ethnicity, gender, sexuality, class or language-learner status).

After this first round through the data, I identified 36 articles that dealt both with some aspect of disability and/or special education and mathematics learning for PreK-12th grade learners in 2013. I then read the full text of these articles, coding for specific disability. I coded for whether research articles used the following discourses to understand and or describe learning in mathematics: medical, behavioral, constructivist, socio-constructivist, or socio-political. Research articles could be coded as using multiple discourses, and many did.

There are several limitations to this content analysis. My search was limited to articles published in English, and only those I found through ERIC, JSTOR, and from Lubienski & Bowen (2000). I only used the title, abstract and the keywords to code, so I undoubtably missed mentions of disability and other equity categories. I would have benefited from coauthors to discuss and hone the reliability of coding schemes.

RESULTS

I found 36 peer-reviewed research articles that dealt explicitly with disability and/or special education and mathematics in 2013. Eighty-six % of these articles (31 articles) were published in psychology or special education journals (Table 1).

Table 2. Articles on mathematics education and disability published in 2013.

	Math Education Journals (166)	Psychology or Related Fields Journals (63)	General Education Journals (30)	Total (259)
Articles on Mathematics Education and Disability	2 (1.2%)	31 (49.2%)	3 (10.0%)	36 (13.9%)

The vast majority was published outside of mathematics education (94.4%). Within mathematics education research, which published 166 articles in 2013 on PK-12 mathematics, only 2 articles mentioned disability or special education in the abstract, title, or keywords. Almost all research on mathematical learning of learners with disabilities in 2013 was published in psychology or special education journals rather than in mathematics education.

My second research question asked about the differences between mathematics research for children with and without disabilities. I compared the 36 articles that dealt explicitly with students with disabilities with the 166 articles in mathematics education. The most frequently used methodology in mathematics education research reports on PK-12 mathematics was qualitative, with 51.8% of all articles listing qualitative data collection, 6.6% listing mixed methods, and 16.2% quantitative methods only (Table 2).

Table 3. Research methods for studies focusing on children with and without disabilities.

	Mathematics education journals (166)	All studies on mathematics and disability across journal types (36)
Quantitative methods	27 (16.2%)	30 (83.3%)
Qualitative methods	86 (51.8%)	4 (11.1%)
Mixed methods	11 (6.6%)	1 (2.8%)
Theoretical	32 (19.3%)	1 (2.8%)

Note: Percentages in this table are column percentages. 16.2 % of the 166 articles in mathematics education journals used quantitative methods.

The distribution of methods that dealt with the mathematics learning of children with disabilities (in all three journal categories) were very different: 83.3% of research on the math learning of children with disabilities was quantitative only, with 11.1% of the research qualitative and 2.8% respectively for theoretical and mixed methods.

Mathematics education has focused increasing attention on teachers, reflecting decades of study into the importance of teaching practices on the learning of students. In mathematics education in 2013, teachers were the focus of 40 studies (24.1%). For children with disabilities, the focus is relentlessly on the child; only 1 out of 36 studies focused on teachers of students with disabilities. Special education mathematics has not explored topics such as the significant impact of pedagogical content knowledge on teaching and learning in mathematics (Shulman, 1986), instead viewing teachers as technicians who implement standardized interventions (Skirtic, 1995).

Finally, what patterns exist within the literature on disability and mathematics? The majority of articles in the sample (69.4%) focused on mathematical learning disabilities or mathematical difficulties. The second most researched disability was autism. The only other disabilities mentioned were deafness, intellectual disabilities, speech and language impairment, ADHD, multiple disabilities and visual impairments. While it is reasonable that mathematical learning disabilities would be a significant focus of studies, the lack of attention to other disability categories is alarming, considering the unique needs of learners who are blind, for example, in learning mathematics.

While mathematical learning disabilities have long been given less attention in the special education research literature than reading learning disabilities, interest has shifted. Between 2000 − 2010, while there were still three times as many research articles in the major LD journals on reading disabilities than math disabilities, this ratio represented an increase in studies on mathematics compared to previous counts (McFarland, Williams & Miciak, 2013). In my sample, there were several ways to name significant difficulties in mathematics: mathematical disability, dyscalculia, mathematical difficulty, and at risk for mathematical disability or difficulty. As several articles in my sample reiterate (e.g. Mazzocco et al., 2013) there is currently no consensus on how to define and diagnose MD. There is no single cognitive profile of students with mathematical learning disabilities, although there is a commonly held assumption that such a cognitive feature exists. Mazzocco (2007) estimated that 3-6% of students have significant mathematical disabilities rather than are low-achieving in mathematics.

In my sample, I could see evidence of a trend to rename *disability* into *difficulty*. Out of twenty-five articles focused on mathematical disabilities/difficulties, thirteen articles primarily named learners using mathematical disability or dyslexia, while thirteen used either mathematical difficulty or at risk of mathematical difficulty. It was common across the articles to see authors using all three terms. For both mathematical difficulties and disabilities, eligibility was determined primarily through cut-off scores on mathematics achievement tests, which ranged from 10% to 50%. Learning difficulties are a more common way to name learning differences in non-US contexts, rather than the medical term disability. In my data set, however, difficulties were also understood through medical and behavioral discourses. Mathematical difficulties are currently defined with such broad strokes that several studies in this sample defined children with MD (or at risk for MD) as those that score at or below the fortieth percentile, and even in one case the fiftieth percentile (Leh & Jitendra, 2013), on mathematics achievement tests. These children, almost half of the children in our schools, were defined by this literature as needing explicit and systematic scripted instruction, a far cry from the meaning making advocated for “normal” learners within mathematics education within Common Core Standards (2011).

Some researchers in my sample set took alternative approaches to understanding mathematical disability. Understanding disability in mathematics as co-constructed through interaction between the student and the teacher, Heyd-Metuyanim (2013) described her interaction with a student that led to the student taking up ever more rigid rule-following in mathematics, as the teacher/author offered fewer and fewer opportunities to be an agentic member of a mathematical community. Disability was located in interaction, and shifted.

CONCLUSION

Mathematics education, with strong traditions of valuing individual differences in learning, has ignored children with disabilities as math learners. The same attention to the individual processes of learning will be invaluable to better understand students who need more sustained, individualized instruction in mathematics. There have been researchers in mathematics education who have produced important work in mathematics education that includes learners with and without disabilities (e.g. Baroody and colleagues; Bottge and colleagues; Woodward and colleagues). Mathematics education needs to include learners with disabilities, without essentializing them, and without contributing to an already extensive literature of deficits. The question for students with disabilities is not what they cannot do, but what they can do.

Mathematics education would benefit from including disabled children in their research. Diversity of learners is a resource, particularly for expanding our understanding of what it means to learn mathematics. De Freitas and Sinclair (2014) posit that attending to how children with disabilities learn through touch, movement, sound, gesture and action has radical implications for how mathematics education conceptualizes learning. These new ideas will be beneficial to many more math learners, as difference and variability exist through the population and are not limited to those who are labeled disabled. Fundamentally, we need to decide if there are two different fundamentally different kinds of math learners, or simply a wide variety of children who can all be engaged in making mathematics their own.

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