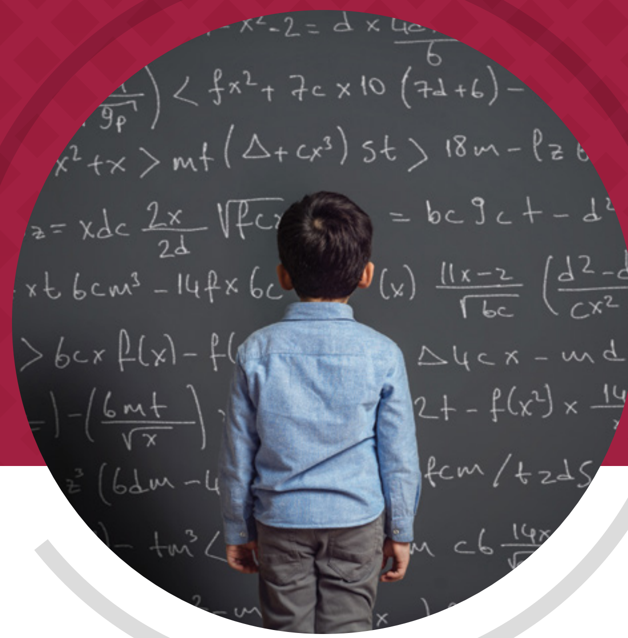
Increasing Access to Universally Designed Mathematics Classrooms

Rachel Lambert



While California Common Core State Standards in Mathematics (CA CCSSM) call for rigorous mathematics for all students, students with disabilities have not been provided equal access to instruction that meets these standards. Universal Design for Learning (UDL) is a research-based framework to develop strategic, expert learners within classroom settings that maximize engagement of a wide variety of students, including students with disabilities. This brief describes how UDL can provide the foundation of mathematics instruction that provides access to rigorous, standards-based mathematics for all students in California.

February 2020

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Policy Analysis for California Education

Introduction

Students with disabilities are currently underperforming in mathematics in California—a considerable concern for equity as mathematics achievement is a gatekeeper for high school graduation and postsecondary outcomes. Traditional approaches to disability in education have focused on a medical model of disability, locating problems within the individual deficits of students with disabilities. Yet this complex problem may be more effectively located outside individual students and within our mathematics classrooms. Are students with disabilities in California provided access to rigorous mathematics instruction that follows the California Common Core State Standards in Mathematics (CA CCSSM)? And, if not, how best to increase access to mathematics for all students?

Students with disabilities in California have historically been educated in separate special education classrooms with inconsistent access to grade-level curriculum in mathematics.[1] Increasingly, students with disabilities in California are more likely to spend the majority of their school day in general education. Yet, even when included in general education mathematics classrooms, students with disabilities still experience barriers to accessing standards-based curriculum—for example when teachers reduce the cognitive demands of instruction.[2] Simply including students with disabilities in math classrooms that are not designed for diversity will not sufficiently increase access and achievement. Universal Design for Learning (UDL) is a research-based framework to develop strategic, expert learners within classroom settings that maximizes engagement of a wide variety of students including students with disabilities. In this brief, after a discussion of research in the area of special education and mathematics, I will detail a specifically mathematical view of UDL to guide its implementation in California schools.

Research on Math and Students With Disabilities Under the Common Core State Standards

CA CCSSM are the result of decades of research on how students learn particular mathematical concepts. The standards are organized in learning progressions, shaped by research on how students develop understanding of complex topics such as numerical operations, fractions, and algebra. The Standards for Mathematical Practice (SMP) also reflect decades of research on the importance of mathematical practices—or the ways in which mathematicians and successful math learners engage in mathematical activities such as problem-solving, modeling, and proof. These standards are both an endpoint and a process; students will need guided opportunities to engage in these standards in order to reach the complex content goals of the CA CCSSM.

Currently, research on the teaching and learning of mathematics for students with disabilities is qualitatively different from research on mathematical teaching and learning for students without disabilities.[3] Mathematics education research on students without disabilities is overwhelmingly focused on constructivist and sociocultural perspectives on learning. In contrast, research in mathematics that includes students with disabilities is far more likely to be framed by a medical model, most often focused on behavioral approaches to learning such as direct instruction. While this has resulted in a significant research base of studies that demonstrate the efficacy of explicit, direct instruction in teaching mathematics procedures for students with Learning Disabilities (LD),[4] it is misleading to assume that there is sufficient evidence that inquiry mathematics is *not* effective for students with LD, or that explicit instruction is the *only* method that is evidence-based. As Gersten and colleagues write, "it is important to note that there is no evidence supporting explicit instruction as the only mode of instruction for … students [with LD]."[5] Mathematics reform and research, including the CA CCSSM, document the importance of both procedural and conceptual understanding. Existing studies document the success of students with LD with curriculum that is centered on student problem-solving using multiple representations, particularly if the classroom offers supports that deepen student participation in problem-solving and discussion.[6, 7]

When considering pedagogy in policy, I urge us to consider the *least restrictive curriculum*. Just as the law states that students with disabilities can only be placed in more restrictive or segregated settings after the Individual Education Plan (IEP) team has determined that the more inclusive setting was not successful, so all students with disabilities deserve access to the highest quality general education curriculum. As I have argued elsewhere, it is deficit thinking to assume that students with disabilities are not capable of creating their own strategies and of engaging in problem-solving.[8] Assumptions that students with disabilities are not capable of independent mathematical thinking are destructive to teachers' ability to teach those students, and to those students' understanding of themselves as mathematically capable. Within California's Multi-Tiered System of Support (MTSS) framework, then, Tier 1 instruction needs to be based on the least restrictive curricular approaches. To achieve the CA CCSSM, teachers will need to engage all students in sustained inquiry-based problem-solving in which students develop strategies and generalize knowledge.

Universal Design for Learning (UDL): A Research-Based Approach to Optimizing Classrooms for a Wide Range of Learners

UDL is a research-based approach to understanding classrooms and pedagogy grounded in the learning sciences and neuroscience.[9] UDL emerged from Universal Design, a movement in architecture and product design that sought to find elegant and effective ways to maximize the use of buildings and products. Educational spaces and curriculum can be designed to include a wide range of learners from the outset.

UDL is a particularly useful framework because it does not separate students with disabilities and assume that their fundamental needs and/or learning processes are different from those of students without disabilities. Instead, UDL is focused on learner variability, "the most consistent finding to emerge from modern learning sciences."[10] Because of the complex interplay between genetics and experience throughout development, all learners have unique brains and ways of engaging in learning. Understanding disability as variability has strong connections to neurodiversity, a social justice movement that understands differences in thinking and being in the world—such as those found in people with autism, Attention Deficit Hyperactivity Disorder (ADHD), dyslexia, and intellectual disabilities—as naturally occurring differences across the population that offer both challenges and strengths.[11] Individuals with ADHD, for example, have both a set of challenges around attention and a set of related strengths. The problem of ADHD does not reside in the individual student but in classrooms that often seem designed specifically to penalize differences in attention. Our secondary school system, in particular, demands that students pay attention in demanding and narrow ways. For instance, the ability to sustain hyper focus on projects—typical of students with ADHD—is not allowed in school because it does not fit within the structured schedules of most schools. Thus, while differences in attention exist, it is the narrow confines of our schooling system that create the disabling conditions of ADHD. Because learners are naturally diverse, UDL asks that teachers create classrooms that capitalize on that diversity, rather than continuing to build classrooms that work for only a small subset of the population.

Perhaps most importantly, UDL proponents advocate for change because "the future is in the margins"[12]—that is, people with disabilities are likely to be, just as they have been in the past, critical innovators in our society's future. Mathematics education can no longer focus on developing students into calculators; humanity has designed calculators that we keep in our pockets. Such technological innovations mean that we must focus on meaning rather than memorization; on 21st-century skills such as collaboration and problem-solving across contexts.

UDL is Based on Neuroscience and the Learning Sciences

These broad patterns in learner variability allow us to design curricula that can work for a broad range of students. Research in both neuroscience and the learning sciences has identified three broad networks of the brain that factor significantly in learning.[11] These three areas of learning form the basis of the UDL guidelines. The first network is affective, involved in how we process our emotions and affect. Researchers in UDL have focused significant attention on the critical role social and emotional processes play in learning. The second network is recognition, involved in how we recognize objects and patterns in the environment. The third network is strategic, involved in how we plan and monitor our actions, including learning. These three networks work together in the complex process of learning in content areas such as mathematics.

Common Barriers Impeding Learning That Can Be Overcome With UDL

A critical part of the UDL process is the identification of barriers that impede learning. To explore these barriers, I draw on narratives from memoirs and interviews written by people with learning disabilities about their experiences learning mathematics.

Barrier 1: Limited avenues for learning mathematics in traditional instruction

> "Like math—I could be right in the front row getting all of the information. ... It doesn't click right away in your head. I mean, you're staring at it but it's not there at that moment, while everyone else—it clicks to them real fast. After a while you're just standing there on pause, just looking at the example and it's not feeding it to your brain."
>
> SANTIAGO[13]

Mathematics classrooms have historically been dominated by auditory and textual modes of instruction, specifically lectures and textbooks. Students like Santiago are expected to simply watch teachers solve problems at the board and then replicate those procedures. Textbooks can offer access to content, but many learners, perhaps almost all students, struggle to learn mathematics simply through reading a textbook. Certain students—those with dyslexia and those with visual impairments—are significantly disadvantaged in classrooms focused on print. Lectures are particularly inaccessible to students with hearing impairments and auditory processing differences.

Barrier 2: Focus on speed and memorization

> "There was the nightmare of the multiplication tables. It wasn't the concept of multiplying that I had trouble with. It was memorizing the tables and then having to retrieve them quickly. I was not actually doing math, I was doing "rapid naming," which is a process that can create tremendous hurdles for dyslexic readers throughout their lives."
>
> LINDA TESSLER[14]

Memorization of disconnected facts is a particular difficulty for students with dyslexia, the most common subcategory of LD.[15] This makes memorization of multiplication or addition facts particularly challenging for these students. A focus on speed and memorization permeates mathematics classrooms, particularly in California, where our previous standards dictated memorization of facts and thus created the conditions for widespread timed tests. In interviews, students with dyslexia have asserted their need for additional time to complete schoolwork, and particularly their rejection of speed as a way to measure competence.[16] A focus on speed is also counterproductive for those with significantly different processing, such as students with intellectual disabilities.

Barrier 3: Limited connections to concepts

> "Soon after entering fourth grade the truth became apparent. While I could recite the numbers and the multiplication tables that I had memorized, they were only symbols with numerical names that didn't mean anything to me. I didn't understand the concepts behind them."
>
> SAMANTHA ABEEL[17]

Here, Samantha Abeel describes her experiences learning math with dyscalculia. Her situation was somewhat reversed from that of Linda Tessler: Samantha was able to memorize mathematical facts, but understanding concepts was very challenging for her. Students with other disabilities, such as intellectual disabilities, also need support to construct complex concepts in mathematics. Yet traditional mathematics classrooms, particularly special education classrooms, tend to focus more on procedures than conceptual understanding. Chanell, a young woman with a learning disability, described mathematics instruction as being told how to think, rather than being asked how to think: "In math, they don't give you a chance to do it on your own, to succeed, to see if you know how to work it out. They'll just tell you. They don't even give you a chance to think about it... . They'll find the problem all out for us."[18] A lack of agency affects students' chances to construct understanding through problem-solving—and, as Chanell suggests, sends a message that teachers do not believe that students can do the math on their own.

Barrier 4: Emotional aspects of mathematics

> "Faced with the daily onslaught of progressively more difficult mathematical concepts, I could no longer deny there was a problem. I started to shut down completely... . I began to feel less and less comfortable at school. I felt anxious that someone would find out I couldn't understand everything. I always felt the most vulnerable during the math portion of the day."
>
> SAMANTHA ABEEL

Abeel notes that perhaps the most challenging part of her difficulties in mathematics were emotional. Mathematics is a particularly emotionally challenging subject.[19] Students report that timed assessments are particularly stressful, as are teachers who move on before students understand a concept. Students also report anxiety around speaking in math class, as they perceive teachers as only valuing correct answers. Mathematics remains the only subject with a related anxiety—math anxiety—suggesting that emotions raised by traditional instruction are a powerful barrier to many students in mathematics.[20]

Universally Designing the Mathematics Classroom

How can we redesign our mathematics classrooms so that more students can experience success? UDL is a process best undertaken at the local level by collaborative groups of teachers engaging in the study of their own practices. However, understanding both the lofty goals of the CA CCSSM and common barriers for students with a variety of disabilities, I suggest some important shifts to make mathematics classrooms more accessible to all learners.

Create Safe Classroom Climates

Researchers in UDL have documented how emotions regulate all learning, and thus understanding of the emotional and relationship aspects of learning are critical to providing universal access.[21] With a rigid focus on right and wrong, mathematics classrooms can feel unsafe to students, particularly those who are positioned as less competent. Teachers can develop a safe classroom community in which students are comfortable taking mathematical risks. Students report taking more risks speaking in mathematics class when the teacher values thinking more than accuracy, and explicitly gives students permission to make mistakes. In one inclusive classroom, students and teachers chose their favorite mistake each day, based on which one best helped students learn more about the math.[22] Teachers will need to lead a shift away from valuing mathematical speed towards valuing mathematical thinking and persistence: in addition to eliminating timed tests, teachers can explicitly value thoughtfulness over speed.

Offer Relevance and Choice

A critical component to universal access is student enthusiasm and engagement. UDL tools that serve to increase engagement are flexibility, choice, and relevance. Teachers can focus mathematics class on relevant, engaging, and culturally responsive contexts as well as follow the students' lead into topics for investigation. Rather than insisting on narrow forms of engagement, teachers can provide students with choice in how they engage in mathematical problem-solving (e.g., individually, in pairs, and in groups). These changes can shift math class away from being a disengaging environment towards being an environment in which students see themselves as mathematical thinkers.

Focus on Core Ideas

In order to make math class accessible to all learners, teachers need to identify and understand the core mathematical ideas in each unit. Identifying these will assist in designing a sequence of tasks that engage students in the necessary learning to understand core ideas, which are particularly useful in adapting instruction for students with processing difficulties, intellectual disabilities, and/or limited prior knowledge of mathematics. For example, instruction in fractions should begin with "fair sharing"—the concept that fractional pieces are equal and that different fractions can be equivalent.[23] This core idea can be made accessible to students with a range of prior knowledge through problems in which students must fairly distribute items such as food. Excessive and repetitive assignments are another barrier for students. Instead of worksheets with many problems, classroom and home work should include a smaller number of problems focused on core ideas.

Put Rich, Accessible, and Collaborative Tasks at the Center

While not all work in the math classroom needs to consist of collaborative investigations, there should be some central, class-wide investigations that (a) focus on the core ideas of the mathematics unit; (b) are multi-dimensional (drawing on different strengths); and (c) allow access and sustained learning for students with varying prior knowledge of the topic (low floor–high ceiling). When such central investigations are well designed, they offer opportunities for every child in a class to be part of a collective inquiry.

Represent Concepts in Multiple Modalities

Just as multiple representations are a core feature of UDL, so representation itself is a key aspect of mathematical thinking and learning. For example, the number line is a key mathematical representation across K–12, from early numbers to Cartesian planes. Use of mathematical models can be adapted to include students with visual impairments who can experience such models through touch and sound. However, like most mathematical representations, number lines can be complex for students to learn, particularly when teachers only show these representations, expecting them to make sense immediately to all students. Research has documented how to sequence instruction to develop specific useful mathematical representations, such as the number line.[24] Students should be able to use a variety of representations to model their thinking; multiple representations can support students with memory and processing differences. All of this suggests the central role of representation in mathematical learning and how understanding representation itself as multimodal can make mathematics more accessible to all learners.

Focus on Developing Strategic, Expert Mathematicians

Both UDL and the CA CCSSM offer a vision of mathematics education as focused not on memorization and replication of procedures but on engaging in the practices of mathematicians: proof, justification, problem-solving, representation and mathematical modeling. Engaging in the practices of the SMPs can offer long-term benefits for all students, but particularly for students with disabilities who have not historically been given access to sense-making in mathematics. However, all students will need additional scaffolds to develop expertise in these practices. For example, many students have difficulties connecting multiple representations of a particular concept, such as matching an equation with its graph. The instructional routine Connecting Representations[25] provides a sequenced routine that offers guided practice in connecting representations, including language and processing supports to develop strategic expertise.

Policy Recommendations

Provide Professional Development in Common Core and UDL for All Teachers and Administrators

Additional professional development is recommended so that all teachers, including special education teachers, develop an understanding of the CA CCSSM. This professional development needs to directly address access to students with disabilities within the context of UDL. Finally, as issues of providing support for students with disabilities often intersect with structural, planning, and administrative issues, considerable effort must be made to include administrators.

Build UDL into the Definition of Quality Tier 1 Instruction Under CA MTSS Framework

Implementing UDL as core instruction for students with disabilities also needs to be contextualized within MTSS structures and policies, which tend to focus attention on Tiers 2 and 3. We need to invest in aligning Tier 1 curriculum with UDL so that more students experience the most rigorous and least restrictive curriculum.

Set IEP Goals Within a UDL Framework

One important leverage point within this conversation is the mathematics goals in students' IEPs. According to the Individuals With Disabilities Education Act (IDEA), the purpose of IEP goals is "to enable the child to be involved in and make progress in the general education curriculum."[26] However, IEP goals in mathematics tend to be overly procedural and focused on skills or procedures that are called for in earlier grades. Thus, implementing standards-based goals is not simply using content standards to provide the language of IEP goals but is also a larger process of increasing access and participation for students with disabilities in the general education curriculum, including mathematical problem-solving and discussion as called for in the Standards for Mathematical Practice.[27]

Invest in Research on the Inclusion of Students With Disabilities

We need significant investment in research focused on inclusion of students with disabilities within math classrooms. Investment should be made to understand inclusion of students with significant support needs in general education math classrooms, an area with little to no research data.

Endnotes

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Author Biography

Rachel Lambert, Ph.D., is an Assistant Professor at the Gevirtz Graduate School of Education, University of California Santa Barbara. Her scholarship focuses on students with disabilities in inclusive mathematics classrooms. She spent over 10 years as a teacher in both special and general education positions, including in California.

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Stanford Graduate School of Education
520 Galvez Mall, CERAS 401
Stanford, CA 94305-3001
Phone: (650) 724-2832
Fax: (650) 723-9931

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