Understanding and Accessing Standards-Based Mathematics for Students With Mathematics Difficulties

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Abstract
In this introduction to the special issue, the author provides a brief overview of (a) standards-based mathematics and implications for students with learning disabilities and those at risk for mathematics difficulties and (b) research on mathematics interventions/instructional practices and student outcomes. Furthermore, the author highlights how the articles in this special issue address these areas. The article concludes with a description of the purposes of this special issue.

Keywords
standards-based mathematics, students with learning disabilities and mathematics difficulties, mathematics interventions

Much effort has been invested in the last two decades on improving the mathematics achievement of U.S. students, which has led to more rigorous standards for teaching and learning mathematics. Furthermore, state and federal mandates require that all students, including the increasing numbers of students with learning disabilities (LD) who are receiving mathematics instruction in general education classrooms, have access to more challenging instructional curricula and that schools be responsible for greater student accountability.

Growing consensus regarding the need to address the achievement gap in mathematics between certain subgroups (e.g., Latino, African American, Native American students) and their higher achieving White and Asian/Pacific Islander counterparts based on National Assessment of Educational Progress data have led to several equity studies involving low-income, minority students (e.g., Clements, Sarama, Spittle, Lange, & Wolfe, 2011; Silver, Smith, & Nelson, 1995). Although these students have benefitted from standards-based mathematics instruction, its influence on the learning of students with LD and the 25% to 35% students who are at risk for mathematics difficulties (MD; Mazzocco, 2007) is less clear, given the lack of empirical attention to this topic. As a result, questions remain as to what standards-based mathematics is and how students with LD or at-risk students can access it. Specifically, these are also important issues to consider as they relate to implementing evidence-based interventions within the response to intervention (RTI) systems of service delivery.

In this introduction to the special issue, I provide a brief overview of (a) standards-based mathematics and implications for students with LD and those at risk for MD and (b) research on mathematics interventions and instructional practices and student outcomes. Furthermore, I highlight how the articles in this special issue address these areas. I conclude with a description of the purposes of this special issue.

Standards-Based Mathematics and Student at Risk for MD
As a result of the National Council of Teachers of Mathematics (1989) Curriculum and Evaluation Standards for School Mathematics (the Standards) issued in 1989, followed by the Principles and Standards for School Mathematics (Principles and Standards) in 2000, we have witnessed an increasing number of districtwide adoptions of standards-based mathematics curricula that shifted focus from rote memorization to more ambitious forms of student learning such as conceptual understanding, mathematical thinking, reasoning, and problem solving (National Research Council, 2001; Remillard, 2005). Furthermore, as

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most states began to implement the newly adopted Common Core State Standards for mathematics (2010), one characteristic of the standards is a relatively smaller number of topics covered in-depth at each grade level so that students understand the mathematics (e.g., explain a mathematical rule) to solve problems.

Key features of standards-based mathematics curricula include “active student engagement, a focus on problem solving,” and making “connections within mathematical strands as well as to real-life contexts” (Tarr et al., 2008, p. 248). Standards-based curricula include frequent group work that offers opportunities for students to talk about mathematics with peers and their teacher, use of mathematical tools (e.g., calculators, manipulative materials), and student-invented algorithms rather than traditional algorithms to solve problems. Specifically, the goal of standards-based curricula is for students to approach unknown problems by generating ideas and discussing multiple approaches to solve the problem. However, standards-based approaches for the 5% to 8% of school-aged children who experience some sort of mathematics LD may be challenging given their unique learner characteristics (Geary, 2004). For example, these students often experience working memory and long-term memory deficits, have difficulty organizing information, have limited knowledge of strategies and their use, have difficulty with basic computation and commit procedural errors, and have considerable difficulty manipulating numerical and linguistic information in mathematical word problems (Geary, 2004; Montague & Jitendra, 2006). As a result, considerable modifications may be needed for these students and students at risk for MD to participate in and benefit from small-group activities and whole-class discussions in standards-based classrooms (e.g., Baxter, Woodward, & Olson, 2001; Baxter, Woodward, Voorhies, & Wong, 2002; Woodward & Baxter, 1997).

To address the diverse needs of at-risk students, researchers have identified several approaches that provide content and pedagogical support, including sufficient practice with number combinations to increase automaticity, teaching backup (traditional) algorithms, providing strategic support for problem solving using procedural facilitators, and a greater focus on incorporating explicit instruction with standards-based mathematics (Hudson, Miller, & Butler, 2006; Sayeski & Paulsen, 2010). Three articles (Jitendra et al., 2012; Krawec et al., 2012; Leh & Jitendra, 2012) in this special issue included interventions designed to access standards-based mathematics and support student learning using different types of scaffolds (i.e., conceptual, metacognitive, procedural, and strategic). Conceptual scaffolds (e.g., hints and prompts using think alouds) help the learner focus on critical content when solving a problem, metacognitive scaffolds support the learner to self-regulate the learning process (e.g., evaluating the task), procedural scaffolds assist the learner with a variety of complex tasks (e.g., multistep word problems) by illustrating how to use the available tools (e.g., diagrams, problem-solving checklists), and strategic scaffolds make the learner aware of the different solution methods (Brush & Saye, 2001).

Research on Mathematics Interventions/Instructional Practices and Student Outcomes

What do we know about instructional practices that lead to improved mathematics outcomes for students with LD and at-risk students?

Findings from several meta-analyses of intervention research indicate that different types of interventions can lead to improvements in the mathematics achievement of students with LD and students at risk for MD (Baker, Gersten, & Lee, 2002; Gersten, Chard, et al., 2009; Kroesbergen & Van Luit, 2003; Swanson & Hoskyn, 1998; Xin & Jitendra, 1999). The interventions include instructional or curricula design approaches such as (a) providing explicit instruction to teach math concepts and procedures (Baker et al., 2002; Gersten, Chard, et al., 2009; Kroesbergen & Van Luit, 2003; Swanson & Hoskyn, 1998; Xin & Jitendra, 1999), (b) teaching students to use heuristics (Gersten, Chard, et al., 2009), (c) encouraging students to think aloud their approach in solving a problem (Gersten, Chard, et al., 2009), (d) using visual representations to solve problems (Gersten, Chard, et al., 2009; Xin & Jitendra, 1999), and (e) providing a range of examples and sequencing examples (e.g., concrete to abstract; Gersten, Chard, et al., 2009). Another promising instructional or curricular approach was related to opportunities for engaging in real-world problems (Gersten, Chard, et al., 2009). The three intervention studies (Jitendra et al., 2012; Krawec et al., 2012; Leh & Jitendra, 2012) in this special issue addressed these features to a greater or lesser degree in the design of their interventions. Furthermore, instructional materials focused on in-depth treatment of mathematical word problem solving involving whole numbers. In keeping with the U.S. Department of Education’s What Works Clearinghouse recommendations related to mathematics interventions for struggling students, instruction during the interventions in these studies was explicit and systematic, which included “providing models of proficient problem solving, verbalization of thought processes, guided practice, corrective feedback, and frequent cumulative review” (Gersten, Beckmann, et al., 2009, p. 6).

In addition, instructional practices such as providing teachers with ongoing feedback about their students’ performance using formative assessments, providing feedback only to students, and cross-age tutoring were found to be effective for students with LD (Gersten, Chard, et al., 2009) and at-risk students (Baker et al., 2002). In contrast, providing feedback with goal setting and peer-assisted learning
within a class were not effective for students with LD (Gersten, Chard, et al., 2009). Furthermore, computer-assisted instruction (CAI) was associated with improved problem-solving performance (Xin & Jitendra, 1999). One study (Leh & Jitendra, 2012) in this special issue examined the impact on mathematics word problem solving when students used a well-designed and implemented CAI problem-solving tutorial program compared with a well-designed problem-solving instruction that did not use technology. Their findings suggest that a carefully designed and implemented intervention can improve student learning regardless of the medium of instructional delivery.

What do we know from research about effective teaching practices?

Research has demonstrated that teacher instruction has a major impact on student learning (e.g., Cohen & Hill, 2001; Rowan, Correnti, & Miller, 2002). In fact, Ball, Hill, and Bass (2005) argued, “Little improvement is possible without direct attention to the practice of teaching” (p. 14). When teaching practices are aligned with standards-based curricula materials, implementation would entail (a) maintaining cognitive demand of the lesson, (c) promoting the development of conceptual understanding, (c) providing opportunities for students to make conjectures about mathematical ideas, (d) attending to student thinking and mathematical reasoning by having students explain their responses or particular strategies or representations, and (e) using students’ statements about mathematics to build class discussion (Stein & Kaufman, 2010; Tarr et al., 2008). Ironically, studies that examined the effects of standards-based mathematics curricula and instruction on student achievement have not addressed or separated the effects for students with LD or at-risk students. Griffin, League, and Griffin (2012) in this special issue used an observational tool to identify teachers’ discourse practices in inclusive elementary mathematics classrooms specifically documenting instances when teachers checked for student understanding, defined mathematical vocabulary, and provided opportunities for student-to-student interactions.

Purposes of the Special Issue

The goals of this special issue are to (a) showcase an observational tool for examining the relationship between teachers’ discourse practices and students’ mathematics learning and (b) present findings of empirical studies of the effectiveness of mathematical problem-solving intervention packages that addressed standards-based mathematics (e.g., problem solving, reasoning, representing, connecting, communicating) for students with LD or who are at risk for MD. Toward the first goal, Griffin and colleagues (2012) described a direct observation tool that was developed based on a review of the literature on mathematics classroom discourse to scaffold student learning, providing researchers and practitioners a means to evaluate mathematics teaching in inclusive general education classrooms. Toward the second goal, three empirical articles addressed mathematical problem-solving instruction. Jitendra and colleagues (2012) discussed an intervention (schema-based instruction [SBI]) study examining the impact of small-group tutoring instruction on the problem-solving performance of students at risk for MD. Their findings suggest that problem-solving strategy instruction for students with MD can be most beneficial when students have learned the requisite foundational skills (e.g., number combinations). This research also adds to the growing literature on the importance of strategy instruction (e.g., SBI) that primes the underlying problem structure using schematic representations, which is a key recommendation in the RTI literature in mathematics (Gersten, Beckmann, et al., 2009). Leh and Jitendra (2012) extended the research on SBI to show that the medium of instruction (technology) is less influential than the quality of instruction in affecting the learning of at-risk students. More specifically, the authors contrasted teacher-mediated instruction (TMI) with computer-mediated instruction (CMI), both of which incorporated critical elements of effective instruction. Leh and Jitendra ensured that the CMI condition included adequate support to use the software effectively (e.g., sufficient hardware and software, technical support), a recommendation put forth by the National Mathematics Advisory Panel (2008) report. Their findings suggest that a well-designed and implemented intervention, whether delivered by the teacher or computer, can be used to enhance students’ problem-solving skills. Given that few empirical studies of technology in mathematics for students with LD or at-risk students have controlled for the effects of instructional variables, this study represents a step forward in understanding when technology might be effective.

Krawec and colleagues (2012) discussed an intervention study that examined knowledge of math problem-solving processes following instruction using Solve It!, a cognitive strategy intervention. In effect, Krawec and colleagues showed that middle school students with LD receiving Solve It! instruction reportedly used more strategies during the different phases of problem solving compared with students receiving business-as-usual instruction, and that ability-level differences were not evident in strategy use at posttest for students in the Solve It! treatment group. To date, there has been a dearth of research on the nature of student thinking or problem-solving processes; thus, this study provides evidence of the effectiveness of Solve It! that goes beyond assessing the product using frequent and “easy-to-administer” formative assessments, such as curriculum-based measurement commonly used in special education. In sum, these three intervention studies collectively represent a step toward moving from teaching single skill and isolated tasks to more complex mathematics that
requires student thinking and application of problem-solving processes, which are reliably assessed using appropriate assessments.

To date, there has not been a special issue that focused on accessing standards-based mathematics for students with LD or at-risk students, even though several researchers in special education (e.g., Baker, Chard, Clarke, Gersten, & colleagues; Bottge & colleagues; Bryant, Bryant, & colleagues; Fuchs, Fuchs, & colleagues; Jitendra & colleagues; Montague & colleagues; Woodward & colleagues; Xin & colleagues) have conducted empirical research on mathematics interventions that integrate standards-based mathematics. Special education mathematics research has made advances in developing interventions and evaluating their effectiveness, supporting interventionists as they implement them in real-world settings, as well as using formative assessment data across a range of mathematical tasks to inform instruction. Standards-based mathematics should be central to each of these activities. Thus, I hope that the articles in this special issue will engage the profession in a discussion about accessing standards-based mathematics for students with LD and at-risk students.

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