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Chapter 11: Teaching mathematics to students with disabilities from diverse backgrounds

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Teaching Mathematics to Students with Disabilities from Diverse Backgrounds

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According to the Organization for Economic Cooperation and Development (OECD), the literacy and numeracy skills that are distributed across a population will have significant impact on economic and social outcomes. In particular, the "higher the levels of inequality in literacy and numeracy skills … the greater the inequality of distribution of income" (OECD, 2013, p. 26). However, although literacy skills are important, it has been suggested that poor mathematical skills may be more of a handicap than poor literacy skills, especially in the workplace (Butterworth, 2005; McCloskey, 2007). As McCloskey (2007) notes, "… quantitative concepts and information are involved in many facets of home, work and community life …" (p. 421). Poor quantitative skills are likely to pose significant problems in everyday life, even into adulthood (Dougherty, 2003; McCloskey, 2007).

The recognition of the importance of having adequate mathematical skills is gaining traction at local and national levels in many countries (see, e.g., OECD report, 2014, for a summary of improvements in mathematics scores by country) but, even more importantly, at the global level. For example, the United Nations Educational, Scientific and Cultural Organization (UNESCO), post-2105 education agenda in a target priority area, unlike the previous education agenda, specifically mentions the development of proficient numeracy skills as "necessary to fully participate in given society" (UNESCO, 2014, p. 26). This target is one of several targets all designed to meet the proposed overarching goal to "Ensure equitable and inclusive quality of education and lifelong learning for *all* [author's emphasis] by 2030" (UNESCO, 2014, p. 26). In this chapter, we highlight that "all" also means providing access to and opportunity for learning in mathematics to an often-overlooked group of individuals—students with disabilities (SWDs) from diverse cultural, racial, linguistic, and economic backgrounds.

Generally, students without a disability who are diverse learners, or students who have a disability only, tend to underperform in mathematics. For example, based on international data collected via the OECD Program for International Student Assessment (PISA), a less advantaged student is more likely to score

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lower on the assessment, up to the equivalent of nearly one year of schooling, compared to a peer who is more socioeconomically advantaged (OECD, 2013). Data collected in the United States of America on diverse learners, such as SWDs, English language learners (ELLs) and students of color, clearly demonstrates that these groups of learners also tend to underperform in mathematics (e.g., National Center for Education Statistics [NCES], 2013; Provasnik et al., 2012).

Of the extremely limited data available, it appears that the performance of diverse learners who also have a disability is even more concerning. Data collected on the 2013 *National Assessment of Educational Progress* (*NAEP*) examination in mathematics (given only in the United States of America), found that SWDs who are diverse learners disproportionately performed at "basic" or "below basic" levels, with percentages ranging from 90% (for grade 4 SWDs who receive a free or reduced price lunch) to 100% (for grade 12 SWDs who are ELLs) of students scoring at these combined levels (see Table 11.1). Scores at the basic level indicate only partial mastery of prerequisite knowledge and skills that are fundamental for at least proficient knowledge of key content, whereas scores at the below basic level signify an incomplete and inadequate mastery of prerequisite knowledge and skills. Consequently, a significant proportion of SWDs from diverse backgrounds do not possess adequate mathematical skills.

Table 11.1 Cross-tabulated Performance on the 2013 NAEP Exam in Mathematics for Students with Disabilities from Diverse Backgrounds

	Grade 4				**Grade 8**				**Grade 12**			
	SD		**Not SD**		**SD**		**Not SD**		**SD**		**Not SD**	
Variable	**% Below Basic**	**% At Basic**	**% Below Basic**	**% At Basic**	**% Below Basic**	**% At Basic**	**% Below Basic**	**% At Basic**	**% Below Basic**	**% At Basic**	**% Below Basic**	**% At Basic**
Ethnicity												
African American	68	27	29	50	84	14	43	41	94	5	58	34
American Indian/ Alaskan Native	65	29	26	47	77	17	35	41	—	—	38	47
Hispanic	60	32	23	49	78	18	33	44	87	11	47	41
White	35	42	6	37	57	32	12	39	71	22	21	44
SES												
F/R Lunch	57	33	23	49	76	20	34	44	87	11	48	40
No F/R Lunch	31	41	5	33	55	32	11	37	71	23	22	42
Language												
ELL	66	27	37	48	87	12	65	29	98	2	85	12
Not ELL	45	38	11	41	66	26	19	41	77	18	30	42

Note: SD = students with disabilities; SES = socio-economic status; F/R = free and/or reduced; — = reporting standards not met.

In a study that used data from the Special Education Elementary Longitudinal Study (SEELS) to explore mathematical growth trajectories by disability category, gender, race, and SES within the United States of America, Wei, Lenz, and Blackorby (2012) found that, while achievement growth in mathematics accelerates throughout elementary school, growth begins to plateau around age 13 years for all disability categories. Additionally, they found significant achievement gaps for white–black and white–Hispanic students with disabilities favoring white students. Interestingly, the white–black gap remained stable over time, while the gap between white and Hispanic students increased over time. Clearly, inequities exist, and many SWDs who are diverse learners are not developing adequate mathematical skills.

Thus, the purpose of this chapter is to review the literature in order to identify existing evidence-based instructional approaches that can be used to promote and support mathematics learning for SWDs from diverse backgrounds. In doing so, we first discuss the research available on instructional practices for SWDs from diverse backgrounds. However, because this is an area that remains under-researched, we also discuss research-based instructional practices for specific groups of diverse learners, namely SWDs, ELLs, and students of color. Within these three latter sections, we highlight the key challenges in mathematics that these students experience followed by a discussion of key instructional approaches that have been demonstrated to be effective for this group of learners. To conclude the chapter, we discuss the commonalities in the instructional strategies and the implications for practice across these groups of students. We close with recommendations for future research.

Research-based Instructional Practices for Students with Disabilities from Diverse Backgrounds

Published studies specifically focused on identifying instructional practices in mathematics that work for SWDs from diverse backgrounds are extremely limited. Although studies might include SWDs who are diverse (e.g., African American, Hispanic, low SES, etc.), findings are typically reported for all students in the study rather than disaggregated. At the time of writing this chapter, only six empirically based studies could be located. Five studies focused on SWDs who are ELLs and students of color, and one study focused on SWDs who are students from a different ethnic background. We discuss these next.

Students with Disabilities Who are English Language Learners and Students of Color

Orosco and colleagues (Orosco, 2013, 2014; Orosco, Swanson, O'Connor, & Lussier, 2013) studied how grade 2 and 3 Latino ELLs at risk for a mathematics disability solved mathematics word problems. The intervention involved:

(a) preteaching concepts and vocabulary via direct and explicit instruction (e.g., a vocabulary word with a definition and an example); (b) strategy instruction focused on five common problem-solving strategies (know, find, set-up, solve, and check for understanding); and (c) cooperative learning and/or student pairing, where students, with teacher monitoring, worked together to practice the strategy while solving word problems. In all three studies, this intervention was found to facilitate problem-solving performance for all participants.

Barrera et al. (2006) examined the effectiveness of a math think aloud (MTA) strategy with four middle school students identified with learning disabilities (LD) and limited literacy proficiency in English. The MTA involved three main strategies: (a) problem-solving instruction and task analysis strategies (explicit instruction to solve a math problem—understanding the question, identifying relevant and irrelevant information, choosing a plan to solve the problem, solving it, and checking the answer); (b) teacher "think alouds" (teacher demonstrates solving a problem using explicit explanations); and (c) student-developed glossary (student writes key content and concept words with a definition). Results demonstrated improved performance for converting improper/proper fractions or solving for an unknown for the four basic operations. When examining teacher implementation of the MTA, students' progress in mastering the MTA was not gradual. Strategy mastery often did not happen until the later stages of instruction, and although improvements were made with the content, students only achieved instructional (support still needed) as opposed to independent levels of mastery.

Shumate, Campbell-Whately, and Lo (2012) examined the effectiveness of culturally infused mathematics, specifically the use of the Sheltered Instruction Observation Protocol (SIOP) model, with grade 8 Latino students identified as having an LD to solve one-step mathematical calculations. The culturally responsive intervention (CRI) involved (a) a statement of the lesson objectives; (b) provision of typed guided notes; (c) use of examples that were culturally relevant to the students (e.g., students were real estate brokers selling the homes of Latino celebrities); and (d) use of instructional strategies and activities designed to promote learning (e.g., partner work, graphic organizers). A modification of the CRI was also implemented to include group activities in which manipulatives were provided to serve as visual cues for problem-solving, and game activities were used to promote engagement. Overall, the CRI produced higher performance gains in mathematical performance than traditional instruction; however, a functional relationship with participants' higher performance gains was found for the modified CRI condition.

Students with Disabilities who are also Students of Diverse Ethnicities

While not strictly an intervention study, Hankes, Skoning, Fast, and Mason-Williams (2013) provided professional development to teachers in using cognitively guided instruction (CGI) and CRI in an effort to become more instructionally responsive to the needs of Native American students with LD. CGI was used to plan instruction to solve mathematical story problems using a problem-solving taxonomy (e.g., joining problems, separating problems) along with intuitive problem-solving strategies while developing number sense. CRI practices specific to Native American culture were then provided and embedded in the CGI. These practices included: (a) more time to complete lessons, (b) an emphasis on solving real-life problems, (c) use of manipulatives and construction of models through hands-on problem-solving, (d) cooperative learning, and (e) conversational classroom discussion with the teacher acting as facilitator. Increased achievement on the *Wisconsin Knowledge and Concept State Exam* for grade 4–8 students was found.

Summary

Several instructional practices have been identified to improve performance in mathematics for SWDs from diverse backgrounds. These practices include variations of strategy instruction (e.g., think-alouds, step-by-step strategies for solving word problems, CGI) and CRI practices. Although this research exists, it is extremely limited in number, and, as a result, these findings need to be interpreted with caution; more research needs to be conducted to verify these practices work with SWDs from diverse backgrounds. More research, not surprisingly, has been conducted specifically on each of the subgroups (e.g., SWDs, ELLs, and students of color). This literature can provide additional insights that may prove helpful for instructing SWDs from diverse backgrounds in mathematics. Therefore, given the desire to provide practical recommendations and insights for teachers working with these students, we provide a summary of this literature next.

Instructional Practices for Diverse Students: What the Research Suggests

For this section of the chapter, we provide information about students in three subgroups (SWDs, ELLs, and students of color). First, we focus on key learning challenges in mathematics experienced by these students, and, second, we identify commonly recommended research-based instructional practices to address these challenges that they may experience. Please note that this is not an exhaustive review of the research literature, but rather an overview of significant ideas.

Students with Disabilities

For the purposes of this chapter, we focus on students with "mild" or "high incidence" disabilities, that is, students identified with an LD (including attention deficit hyperactivity disorder), mathematics disability, and/or at-risk for an LD in mathematics. Students identified specifically with a mathematics disability represent 5–8% of the K-12 student population (Bryant, 2005).

Although each student with a disability has a unique profile of challenges and strengths, a core number of key challenges have been identified in the research that may interfere with each student's development of mathematical proficiency.

Working memory/long-term memory. Recent studies have demonstrated that working memory (WM; "… a processing resource of limited capacity, involved in the preservation of information, that simultaneously processes the same or other information" [Swanson & Zheng, 2013, p. 215]) plays a significant role in predicating academic performance in mathematics (e.g., Swanson & Jerman, 2006). Difficulties with WM impact mathematical word problem-solving performance and arithmetic computation. In particular, students may have difficulty using WM to activate relevant knowledge from long-term memory (e.g., knowledge of algorithms) to facilitate solution accuracy, as well as difficulty controlling and regulating cognitive activities (e.g., attending, monitoring, inhibiting irrelevant information) that are a part of the executive system central to WM (Geary, 2013; Swanson & Zheng, 2013).

Processing speed. Several studies have found that SWDs often tend to be slower than their typically developing peers at problem-solving (e.g., Swanson & Beebe-Frankenberger, 2004). However, this does not mean that these students have a slower processing speed. Instead, these students may be slower at more basic processes such as his/her ability to encode into and retrieve numerical information from working memory (Geary, 2010, 2013; Geary, Brown, & Samaranayake, 1991).

Translation difficulties. Many SWDs have considerable difficulty translating and transforming numerical and linguistic information from mathematical word problems (Montague, Applegate, & Marquard, 1993). Successful problem-solving depends on the ability to create a representation of the problem in order to understand and solve the word problem (Mayer & Hegarty, 1996). Several studies (e.g., van Garderen & Montague, 2003; van Garderen, Scheuermann, & Jackson, 2013) have demonstrated that SWDs often have difficulty creating a representation—such as a diagram—that is of sufficient quality (e.g., depicting relevant information from the problem), which often results in poor problem-solving.

Metacognitive/strategic deficits. Substantial evidence suggests that SWDs have difficulty both selecting appropriate strategies to use and regulating their strategy use during mathematics tasks (Montague, 2007; Swanson & Jerman, 2006). Specifically, SWDs may have a limited repertoire of strategies, display immature metacognitive abilities, struggle to self-initiate problem-solving, lack enabling strategies, and struggle to self-evaluate their work (Montague, 2007).

Quantitative deficits. A substantial amount of research has focused on quantitative deficits that SWDs may experience. Particular difficulties have been noted in the areas of number knowledge, counting knowledge, and arithmetic. In number knowledge, it appears that SWDs have difficulty representing a quantity (e.g., *** = 3 = three), mapping symbols onto a representation (e.g., **3 = 5), and dealing with symbolic quantity discrimination (e.g., which is more, 18 vs. 28) (Geary, 2011, 2013; Rousselle & Noël, 2007). For counting knowledge, SWDs typically understand most basic counting principals (e.g., cardinality), but they may not detect errors when counting deviates from the standard left-to-right counting of adjacent objects (e.g., double-counting; Geary, 2013). In arithmetic, two notable difficulties have been observed: (a) difficulty with procedural competence; specifically, they commit more errors for both simple and complex arithmetic and use more immature procedures (e.g., counting all vs. counting on; Geary, 2010, 2013); and (b) basic fact retrieval errors (Geary, 2013).

Behavioral characteristics. In addition to cognitive and academic challenges that SWDs may experience, there are a number of behavioral characteristics that can impede mathematical development. Difficulties include: (a) poor organizational skills; (b) inattention resulting in problems such as carelessness, not finishing work, distractibility, and missing important information; (c) difficulty controlling or regulating behavior; (d) hyperactive behaviors such as excessive talking, difficulty waiting or taking turns, and interrupting and intruding on others; and (e) learned helplessness resulting in either reticence to try something or overreliance on others (Allsopp, Kyger, & Lovin, 2007; Montague & van Garderen, 2008).

For this section, we summarize a series of evidence-based recommendations for improving the mathematical performance of students with LD (from Gersten et al., 2009; Griffin, van Garderen, & Ulrich, 2014).

Explicit instruction. According to Gersten et al. (2009), explicit instruction is using a step-by-step instructional process when teaching students mathematical concepts and skills. Typically, these steps include: (a) identifying performance expectations via an advanced organizer, (b) using description and teacher modeling, (c) engaging in guided practice, (d) independent practice, (e) monitoring performance, and (f) providing constructive feedback and reinforcement (van Garderen, 2006).

Use of heuristics. A heuristic "is a generic approach for solving a problem;" an example is the problem-solving strategy: "Read the problem. Highlight the key words. Solve the problems. Check your work" (Gersten et al., 2009, p. 1210). Heuristics assist students with organizing information to solve a problem, and involve discourse and reflective practice (Gersten et al., 2009). Montague (2007) developed a seven-step problem-solving heuristic that also included statements and questions that the student asks while solving a problem (e.g., Step 1: Read for understanding. *Say*: Read the problem …, *Ask:* Have I read and understood the problem? *Check:* For understanding…).

Student verbalizations. Critical thinking often involves thinking aloud through one's problem-solving processes. Therefore, it is recommended that opportunities be provided for students to verbalize their thinking. This might include talking through steps taken to obtain the solution, self-instructions, selection and evaluation of a representation, etc. For SWDs, verbalizing their thoughts can be challenging. Knowing this, Baxter, Woodward, and Olson (2005) had students respond weekly to a prompt in their math journals and then to share their thoughts orally. They found that journaling promoted student verbalizations.

Visual representation. The use of visual representation (e.g., diagrams and manipulatives) has been identified as a valuable tool for helping students solve mathematical word problems (e.g., Woodward et al., 2012). Visual representations serve as tools to: (a) aid communication with others about the problem-solving process, (b) solve a problem (e.g., to understand the problem situation), (c) record information both of the problem situation itself and of ideas as the problem is being solved, (d) facilitate exploration of critical concepts of the problem being solved, and (e) monitor and evaluate progress (Stylianou, 2010).

Range and sequence of examples. Effective instruction focuses on the selection and use of a variety of examples in teaching new concepts to students. Such use may be via a specified sequence or pattern of examples (e.g., easy to difficult or concrete to abstract) or systematically varying the range of examples provided (e.g., initially teaching only proper or improper fractions before teaching them in combination). Delineating sequences of a particular problem type by teaching students to identify the problem type and structure, and using a schema-based diagram is another example (see Xin, Jitendra, & Deatline-Buchman, 2005).

Feedback to teachers on students' progress. Ongoing formative and summative assessment, along with evaluation of students' mathematical progress and growth, can assist teachers in making data-based decisions regarding students' strengths and weaknesses, allowing them to better individualize instruction to meet their students' unique needs. When teachers are provided with feedback on student progress (e.g., via consultation) and options/instructional areas to target for addressing students' needs (e.g., via skill analysis, miscue analysis, diagnostic assessment, etc.), student performance increases. For example, Allinder et al. (2000) used curriculum-based measurement (CBM) along with teacher self-monitoring in mathematics computation. Each time a teaching change was required, teachers responded to four written questions: (a) On what skill(s) has the student done well in the preceding 2 weeks? (b) On what skill(s) has the student improved compared to the previous 2-week period? (c) What skill(s) should be targeted for the coming 2-week period? (d) How will the teacher attempt to improve student performance on the targeted skill(s)? (p. 222).

Feedback to students about their performance. Providing SWDs explicit and timely feedback on their performance may positively impact student effort, motivation, and engagement. Such feedback can also provide students with a better understanding of where they were successful and where understanding broke down. This occurs when a teacher, peer, or computerized program provides feedback to students on their performance, effort, or progress, or feedback on performance or effort tied to a specific goal (e.g., Calhoon & Fuchs, 2003).

Peer-assisted math instruction. Oftentimes, SWDs require one-on-one assistance in mastering or reviewing a mathematical concept. In cross-age peer tutoring, a student from a higher-grade level tutors a student in a younger grade. However, a within-class approach might also be appropriate where a student from the same class, typically a higher-performing student, would be paired with a struggling student, where each takes turns playing the role of the tutor (e.g., Calhoon & Fuchs, 2003). Peer-assisted math instruction usually occurs only after the classroom teacher has provided instruction on the concept or skill.

English Language Learners

ELLs are students who have not yet demonstrated proficiency in English and who require instructional support "in order to fully access academic content in their classes" (National Clearinghouse for English Language Acquisition, 2008, p. 6). A diverse ELL population is growing dramatically in schools in the United States.

With over 11% of students in K-12 settings identified as ELLs (Lee & Buxton, 2013), it is important to understand some of the challenges that ELLs face in their mathematics classrooms and some of the ways their teachers can address these challenges.

Simultaneous content and language. ELLs must simultaneously learn content and academic language in a mathematics classroom, along with what it means to do mathematics and to be part of a mathematics classroom, what Gee (1996) and Moschkovich (2002) refer to as discourse practices. For example, students must learn what it means to frame conjectures, to make sense of others' mathematical work, and to question the work that they and others do. Without learning mathematics discourse, ELLs have fewer tools to participate in a way that facilitates their learning of both mathematics and academic English.

Lack of cognitively demanding work. Deficit perspectives often result in low expectations for students (Moschkovich, 2002; Razfar, Khisty, & Chval, 2011) and decreased cognitive demand of the work that ELLs do in their mathematics classrooms. Oftentimes, ELLs will work on mathematics that is stripped of all context and complexity (de Araujo, 2012) for fear that such work will be too complicated and overwhelming. For example, de Araujo (2012) found that mathematics teachers of ELLs modified mathematics tasks for students in ways that decreased the intended cognitive demand by reducing the number of words and lowering the mathematical rigor. Similarly, Roberts (2014) found that teachers modified tasks for ELLs by reducing tasks to rote procedural memorization activities.

In this section, we summarize a series of evidence based recommendations for improving the mathematical performance of students who are ELLs.

Providing cognitively demanding work. Addressing lowered expectations for ELLs requires providing access to grade-level appropriate instruction (Understanding Language, 2013). ELLs must have access to and support in completing cognitively demanding mathematics (Moschkovich, 2012), tasks that are complex, less structured, and require students to "think about, develop, use and make sense of mathematics" (Stein, Grover, & Henningsen, 1996, p. 459).

Creating a verbally rich environment. Learning content and language simultaneously means that ELLs must have the opportunity to develop those discourse practices associated with the discipline, such as learning how to frame conjectures, ask questions, and present solutions. Teachers should work to create a learning environment where students have regular opportunities to practice and participate in verbally rich environments (Khisty, McLeod, & Bertilson, 1990), supporting students in sharing, discussing, reflecting, and refining their language (Setati, 2005). ELLs need the opportunity to practice their discursive practices in a safe environment; this can be achieved when teachers provide students with opportunities to hear target language before attempting it, for example, by providing an example of a strong statement of support for students' thinking, or explaining why they thought one fraction was larger than another (Khisty & Morales, 1999).

Mathematics teachers of ELLs should also draw on and engage them in the complexity of mathematics instruction through the use of multiple modes of communication (e.g., verbal, written; Roberts, 2009), multiple mathematical representations (e.g., graphs, manipulatives), different types of texts, and different types of talk (Hakuta, Santos, & Fang, 2013). Mathematics lends itself to the use of multiple representations (e.g., graphs, tables, number sentences, manipulatives) to understand, to make sense of, and to explain mathematical ideas. Additionally, students and teachers can draw on verbal and written communication that is enhanced with visuals, including pictorial representations, gestures, and real-life objects to describe thinking, questions, and tasks (Lee & Buxton, 2013; Moschkovich, 2002, 2007). The more types of language and representations a teacher and student can use, the broader students' repertoires will become and the more tools and resources students will have to draw on to make sense of their own and others' mathematical thinking and language.

Funds of knowledge and student resources. Engaging ELLs in cognitively demanding work in a discourse-rich classroom is supported by drawing on the numerous resources and funds of knowledge that ELLs bring to mathematics classrooms (Moll, Amanti, Neff, & Gonzalez, 1992). Such resources include: home language (e.g., having a conversation with a peer—verbal or written—in the home language), prior knowledge and experiences, gestures, objects, experiences with natural phenomena, code-switching, and everyday experiences and practices (Duff, 2010; Esquinca, 2013; Goldenberg, 2008; Moschkovich, 2002; Understanding Language, 2013). For example, students might be working on a problem about riding bicycles and planning a bike trip, such as in *Connected Mathematics 2, Variables and Patterns* (Lappan, Fey, Fitzgerald, Friel, & Phillips, 2006). In such a situation, a teacher can solicit what students know about riding bicycles and what experiences they have riding bicycles. In doing so, the teacher can make connections between students' prior life experiences and the context of the problem(s). The teacher could then make connections between the mathematics and the real-life situation with which students are familiar. In a situation where students might not be familiar with an everyday experience (e.g., running at different rates), the teacher could get students to model the situation (Roberts, 2014).

One of the most fruitful ways to draw on student resources and funds of knowledge is to provide students with opportunities to discuss and interact socially (Duff, 2010; Goldenberg, 2008). In providing students with opportunities to discuss mathematics, teachers allow students to share their resources (with both classmates and the teacher) and to use each other as resources as they attack their mathematical work.

Students of Color

Students of color, such as African American, Latino/a, and Native American students, represent approximately one out of every three students in elementary and secondary schools (Griner & Stewart, 2012). By 2050, students of color are predicted to represent approximately 62% of the school-age population (NCES, 2010).

With the increase of racially diverse students in mathematics classrooms, it is important to understand the racialized challenges faced by students of color that may impede their learning of mathematics.

Achievement gap discourse. Numerous studies show a substantial gap, in some cases over two grade levels, in mathematical achievement between students of color and white students (Lubienski, 2002; Reyes & Stanic, 1988), where students of color perform more poorly than white students. An outcome of this achievement gap is discourse that perpetuates deficit thinking about students of color (Gutiérrez, 2008; Gutiérrez & Dixon-Roman, 2011), promotes a sense of learned helplessness and hopelessness among students of color in the mathematics classroom (Lubienski, 2000), and positions students of color as intellectually inferior to white students (Gutiérrez & Dixon-Roman, 2011).

Unproductive beliefs and stereotypes. Barlow and Cates (2006) suggest, "beliefs affect how teachers see their students … thereby impacting [their] instructional practices" (p. 64). A student's race is a determining factor of how a teacher will treat a student (Thompson, 2010). Unfortunately, many educators believe students of color are lazy, incapable, intellectually inferior to whites, members of gangs, and that they do not value education (Battey & Franke, 2013; Landsman, 2004; McGrady & Reynolds, 2013; Thompson, 2004, 2007). These negative beliefs affect teachers' perceptions of students of color and ultimately their instruction, leading to low expectations and poor achievement among students of color, particularly in the mathematics classroom (Milner, 2012).

Colorblind ideology. Many educators claim, "I don't see color," and do not realize they have deficit views of students of color by upholding a colorblind ideology (Battey & Franke, 2013). They refuse to acknowledge racial inequities students of color face. They contend we live in a colorblind society and argue that if a teacher is a good teacher, he/she can be a good teacher to anybody by treating everyone the same, which dismisses the need to focus on inequities in the mathematics classroom (Gay, 2000; Martin, 2007; Ullucci & Battey, 2011). However, students are typically educated under a Eurocentric paradigm, in which teachers privilege white students and reprimand students of color, negatively affecting the educational experiences of students of color and their resulting achievement (Parsons, 2005). When teachers do not focus on the inequities faced by students of color (e.g., low expectations, unchallenging mathematics instruction, and teachers' unproductive beliefs), they limit and do not challenge students of color to learn rigorous mathematics. Generally, students of color are largely placed in remedial mathematics classes and are not recommended to enroll in advanced mathematics courses. In essence, when educators assume a colorblind ideology, they are contributing to the disproportionate number of students of color who do not receive high-quality mathematics instruction.

Unqualified teachers. The National Commission on Teaching and America's Future reported that new, uncertified teachers are usually assigned to teach in high-poverty school districts containing high populations of students of color, whereas educated new teachers are hired to teach in wealthier school districts (Darling-Hammond, 1998). According to the 2003–2004 *Schools and Staffing Survey*, mathematics teachers in predominantly black and/or Hispanic high schools are less likely to teach in their certified area and field of study than teachers who teach in predominantly white schools. Students of color are often enrolled in schools that are underfunded, under resourced, and are staffed with unqualified teachers (Jackson & Wilson, 2012).

Unchallenging mathematics instruction. Teachers make daily instructional decisions on what and how to teach and to whom they will teach (Reyes & Stanic, 1988). Lubienski (2002) asserts that schools with high populations of students of color spend less time emphasizing higher-order thinking skills than schools with lower populations of students of color. Many teachers argue that a prerequisite to teaching higher-order problem-solving is a mastery of basic facts. Some teachers believe students of color are incapable of solving high-cognitive-demand mathematical problems. Consequently, teachers spend an extended amount of mathematics instruction teaching low-level skills to students of color (Lubienski, 2002). This type of instruction for students of color relies on excessive repetition and drill, rote memorization, decontextualized problems, and disconnected concepts (Battey & Franke, 2013; Davis & Martin, 2008). Added to this, is a persuasive belief that students of color learn best from direct instruction approaches rather than inquiry. As a result, many students of color are not given the opportunity to engage in critical thinking tasks (Milner, 2012).

Not only do students of color tend to be given low-level cognitive demand tasks, they are also often excluded from participating in rich, mathematical discourse (Milner, 2012). For example, Landsman (2004) found that white students were always asked challenging questions, whereas easy, less challenging questions were directed to students of color. Perez (2000) also found that mathematics teachers ask white students more challenging questions, interact more with white students, and provide white students with more analytical feedback, thus, privileging white students.

In this section, we summarize a series of evidence based recommendations for improving the mathematical performance of students of color.

Culturally relevant pedagogy. Culturally relevant pedagogy is designed to teach the "whole" child through acknowledging and addressing the child's race, language, ethnicity, and class through teaching. In order to accomplish this goal, teachers must view students of color as visible players in the mathematics classroom (Malloy, 2009) by ensuring they are fully involved in classroom tasks (e.g., participating in cooperative groups) and offering support and guidance as they grapple with challenging mathematical tasks.

It is also important that mathematics teachers take the time to know the students of color in their classes, because students of color need to receive mathematics instruction that builds on their cultural knowledge and experiences (Davis & Martin, 2008). This does not imply changing the names in mathematical word problems to align with students' cultural background, but it does mean using students' experiences to help them understand the mathematics (e.g., utilizing word problems that are culturally familiar). Thus, the mathematics teacher uses students' "identities" as contributors to the teaching and learning of mathematics.

As teachers engage in culturally relevant pedagogy, they need to reflect on and respond honestly to the following questions: (a) "Who is learning math in my classroom, and who is not and why?"; (b) "Do I allow students to contextualize their thinking when practicing and solving mathematics problems?"; and (c) "Do I look to understand students' strategies and logic when they engage in mathematical problem-solving?" (Ukopoku, 2011, p. 53).

Learning preferences. Students of color, particularly African American students, tend to be more field-dependent learners and rely less on analytic reasoning (Malloy, 1997). Analytic learners place order and structure on the world to understand it and are focused on the importance of precision, directness, and conciseness when learning mathematics (Stiff, 1990). Competition in this type of atmosphere is both acceptable and desired. However, students of color often prefer learning mathematics holistically in a cooperative, communal, collaborative learning environment (Slavin & Oickle, 1981; Stiff, 1990; Ukopoku, 2011). For example, Malloy (1997) gave middle-school African American students a problem that involved three triangular arrangements of marbles of four rows. The students were to solve for the number of marbles in the fourth and 25th arrangement.

The majority of students who successfully solved the problem used a holistic approach. They examined all the arrangements and recognized the number of marbles in the first row of each arrangement was the same as the arrangement number, and each subsequent row increased by one marble. To contrast, a student solving this problem using an analytic approach would count the total number of marbles in each arrangement and discover that the number in the succeeding arrangements increases by four, and use this knowledge to find the fourth and 25th arrangement. This suggests that teachers need to provide opportunities for students of color to solve mathematics problems holistically.

Doers and knowers of mathematics. In order for students of color to be successful doers and knowers of mathematics, teachers must access and capitalize on students' funds of knowledge and the resources they bring to the mathematics classroom (Moll et al., 1992), value students' mathematical thinking, and realize there are multiple ways to solve mathematics problems. Teachers must use worthwhile mathematical tasks that are challenging, require higher-order thinking, have multiple entry and exit points, and allow students of color to make connections (NCTM, 1991; van de Walle, Karp, & Bay-Williams, 2016). Along with cognitively demanding tasks is the need to provide opportunities for students of color to discuss and share their mathematical thinking with their peers (Ukopoku, 2011).

General Implications and Recommendations for Instruction

A central target for all learners is to develop adequate mathematics skills. To meet this target, teachers need to implement practices demonstrated to work. The purpose of this chapter was to provide a summary of evidence-based instructional practices designed to help improve mathematical understanding for SWDs from diverse backgrounds. Although limited in number, several practices were identified to work specifically with these students. Given the scarcity of research,

Table 11.2 Summary of Practices

Students with disabilities from diverse backgrounds	Students with "mild" disabilities	ELLs	Students of color
• Pre-teach concepts and vocabulary • Strategy instruction • Cooperative learning/student pairing • Explicit instruction • Think aloud/teacher demonstration • Student glossary • Culturally responsive intervention/instruction • Manipulatives • Games • Cognitively guided instruction	• Explicit instruction • Heuristics • Student verbalization • Visual representation • Range and sequence of examples • Teacher feedback • Student feedback • Peer-assisted instruction	• Develop mathematics "Discourse" • Provide cognitively demanding work • Create a verbally rich environment • Draw on funds of knowledge and student resources	• Ensure students are visible in the classroom • Eliminate deficit views • Use culturally relevant pedagogy • Draw on students' learning preferences • Provide cognitively demanding work • Draw on funds of knowledge and student resources

we expanded the discussion to provide an overview of practices designed to work with three subgroups. Table 11.2 provides an overview of the various practices identified.

Several key recommendations for instructional practice from this review can be made. First, although the research is limited, there are practices that can be applied in the classroom for SWDs from diverse backgrounds. There is no need to start "from scratch." Further, given the alarming gap in mathematics performance that continues to increase rather than decrease over time for these students (Wei et al., 2012), it is important that these practices be implemented as soon as possible and with some sense of urgency (Cartledge & Kourea, 2008).

Second, several of the practices identified (e.g., verbalization, cognitively demanding work) have been demonstrated to work with various subgroups of students. This suggests that these practices may work with SWDs from diverse backgrounds. Given the gaps in research, it may be a good idea to use practices identified to work across the subgroups for those students (e.g., use CRI for SWDs from diverse backgrounds and students of color), or to implement them with all students within the classroom. However, caution is advised. Any instructional practice implemented should be connected to student need. Additionally, some practices may not work for all students. For example, the CRI practices used in the Hankes et al. (2013) study connect specifically to practices identified to work with Native American students. These may not be appropriate for students from other cultures.

Third, the recommendations provided in this chapter do not represent every recommendation available. For this chapter, we specifically highlighted practices connected to mathematics; however, there are other general classroom and reading-based instructional suggestions and recommendations connected to the needs of these students that could be used to aid in mathematics instruction (see, e.g., Cartledge & Kourea, 2008; Ernst-Slavit & Slavit, 2007; Liasidou, 2013; Shyyan, Thurlow, & Liu, 2008; Utley, Obiakor, & Bakken, 2011). We encourage teachers to look to these resources and others for ideas.

Key Considerations for Further Research

As already noted, an important finding from this review of the research is the limited number of studies found. This is not a new finding. Many have commented on the general need and urgency for more research with this group of students (Cartledge & Kourea, 2008; McCardle, Mele-McCarthy, Cutting, Leos, & D'Emilio, 2005; Shyyan et al., 2008). We suggest this is also the case specifically related to mathematics. Thus, we offer the following suggestions for further research specific to SWDs from diverse backgrounds in mathematics.

Understanding the mathematical needs of SWDs from diverse backgrounds. It has been clearly established that, over time, SWDs from diverse backgrounds are not likely to perform well in mathematics (e.g., Wei et al., 2012). Less clear, however, are their specific challenges and strengths in mathematics. At the time of writing this chapter, no studies were located that explored this. With detailed information about these students, we may be able to target their instructional needs more effectively and efficiently.

It is important to note that we are not saying that the intervention studies reviewed were not targeted to student need; however, the rationale for the interventions are often drawn from literature on one subgroup (e.g., ELL) and another (e.g., SWDs) and combined, suggesting a dual need (e.g., language instruction combined with math strategy instruction). A dual-type of rationalizing may accurately identify students' needs; however, we may be missing out on some unique need that, if addressed, could lead to a more powerful type of intervention also eliminating the need for a dual-type of rationalization. One further point needs to be noted here; Orosco, in his studies (Orosco, 2013, 2014; Orosco et al., 2013), built in a dynamic assessment process into his intervention. This assessment enabled him to identify the level of language where students were operating and to use word problems that were linguistically modified based on their level. The use of this or a similar type of assessment may be one way to address this recommendation.

Identify more instructional practices that work. Clearly, the current research available needs to be both replicated and expanded, or new research practices need to be examined that focus on varying content areas (e.g., algebra, geometry) along with more complex levels of mathematics (e.g., multi-step word problems), grade levels (e.g., high school), and diversity groups (e.g., SWDs who are African American). This may not necessarily involve developing completely new ideas, but rather drawing from the various studies for each subgroup and implementing them with SWDs from one or more of the identified sub-groups.

Although we provide the recommendation for more research, what may need to be addressed first is the priority placed on conducting this type of research specifically for this group of students in mathematics. Put another away, is this important enough to be part of a national agenda for both research and practice? Clearly, the academic performance of these students in mathematics is abysmal as compared to the varying subgroups, including SWDs (NCES, 2013). These students have the most significant needs of all the lowest performing students and are in need of significant support in order to learn, in many cases, even basic numeracy skills. For, as noted by OECD (2013), "If large proportions of adults have low … numeracy skills, the introduction and wider diffusion of productivity-improving technologies and work organization practices can be hampered and that, in turn, will stall improvements in living standards. In other words, today's education is tomorrow's economy" (p. 26).

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