MODULE 21

COGNITIVE DISABILITIES

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Outline	Learning Goals
Cognitive Disabilities in Today's Classrooms	
• Special Education Referral and Eligibility • Planning and Placement	1 Describe how cognitive disabilities are identified and served under the Individuals with Disabilities Education Improvement Act.
Intellectual Disabilities	
• Identification of Intellectual Disabilities • ***Applications:*** Guidelines for Teachers in the General Education Classroom	2 Discuss the impairments you would expect to see in students with intellectual disabilities and the curricular approaches useful in addressing these deficits.
Specific Learning Disabilities	
• Identification of Specific Learning Disabilities • Reading Disability • Mathematics Disability	3 Explain how learning disabilities are identified using the IQ-achievement discrepancy and the response-to-intervention approach. 4 Explain the characteristic deficits you would look for in identifying students with reading and mathematics disabilities and how you would approach remediating these deficits.

Cognitive Disabilities in Today's Classrooms

1 Describe how cognitive disabilities are identified and served under the Individuals with Disabilities Education Improvement Act.

Teachers play a central role in the education of students with disabilities. They not only refer students for special education evaluations but also assist in determining the eligibility of students for special education and implement curricular modifications in the classroom. Who are the students with disabilities? Let's first look to federal special education law for an answer.

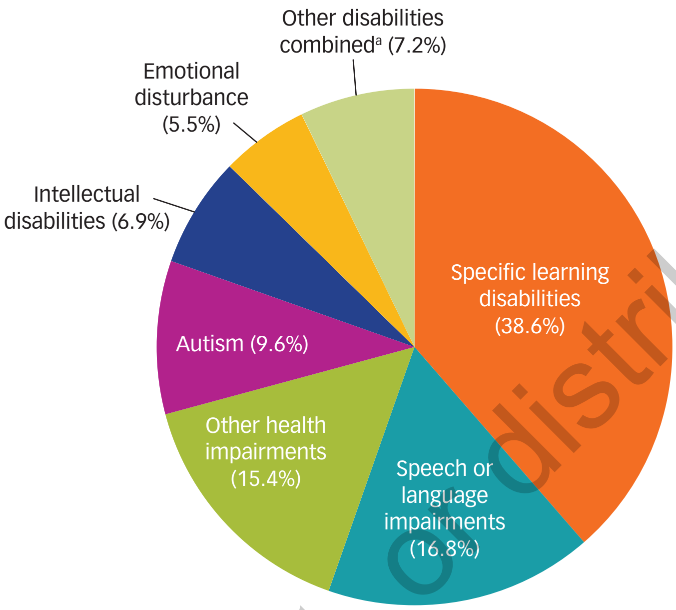
The **Individuals with Disabilities Education Improvement Act of 2004 (IDEA)**, the most recent revision of the first special education law adopted in 1975, defines a student with a disability as a child

> (i) with mental retardation, hearing impairments (including deafness), speech or language impairments, visual impairments (including blindness), serious emotional disturbance (referred to in this title as "emotional disturbance"), orthopedic impairments, autism, traumatic brain injury, other health impairments, or specific learning disabilities; and (ii) who, by reason thereof, needs special education and related services. [PL 108-446, Section 602.3(A)(i-ii)]

Students with cognitive disabilities—specific learning disabilities and intellectual disabilities (formerly called mental retardation)—together represent a large segment of the K–12 special education population, as the pie chart in Figure 21.1 illustrates (U.S. Department of Education, 2018). In this module, we discuss the learner characteristics and educational needs of students with cognitive disabilities. Other categories of disability shown in the pie chart are topics of other modules.

▼ FIGURE 21.1

An Overview of Disabilities. This pie chart shows the percentage of K–12 students with various disabilities receiving special education and related services under IDEA.



[a]*"Other* disabilities combined" includes *deaf-blindness* (less than 0.05%), *developmental delay* (2.5%), *impairment* (1.1%), *multiple disabilities* (2.1%), *orthopedic impairment* (0.6%), *traumatic brain injury* (0.4%), and *visual impairment* (0.4%).

Note: Percentage was calculated by dividing the number of students ages 6 through 21 served under *IDEA*, Part B, in the disability category by the total number of students ages 6 through 21 served under *IDEA*, Part B (6,048,882), then multiplying the result by 100.

Source: Adapted from U.S. Department of Education. (2018). *Fortieth annual report to Congress on the implementation of the Individuals with Disabilities Education Act, 2018, Vol. 1*. Office of Special Education and Rehabilitative Services, Washington, DC: U.S. Government Printing Office.

Special Education Referral and Eligibility

IDEA requires states to provide a "free" and "appropriate" public education for children with disabilities between the ages of 3 and 21. An appropriate public education involves curricular methods and modifications designed to provide educational benefit to the student. Specifically, this means special education and related services, such as speech and language therapy, counseling, physical therapy, social services, and transportation.

Determining a student's eligibility for special education and related services begins with a referral, typically by the student's teacher and sometimes by the parent. Parents must consent to the educational evaluation of the student. Once the evaluation is completed, the next step is to determine whether the student meets eligibility criteria as specified by IDEA and, if so, to develop a special education plan. Under IDEA, schools must create an **Individualized Education Plan (IEP)**, a plan outlining curricula, educational modifications, and provision of services intended to enhance or improve the student's academic, social, or behavioral skills. IEPs contain several important features:

1. The student's present levels of academic achievement and functional performance.
2. Measurable annual goals and short-term instructional objectives.

3. An explanation of how the student's progress toward annual goals will be measured and when progress will be reported to parents.
4. Any appropriate accommodations for test taking on statewide and districtwide assessments, when alternative assessments are needed, an explanation for why this assessment was selected, and why it is appropriate for the student.
5. The types of special education and related services provided to the student, how long the services will be needed, and how much of the student's education will *not* be in the general education classroom.
6. Measurable postsecondary goals related to education, training, or employment for students age 14 and older.
7. A statement of transition services needed to reach goals involving independent living, continuing education, or employment after high school for students age 16 (or younger, if appropriate).

A multidisciplinary team called the **IEP team**—consisting of the student's parents (and sometimes the student), teachers, the school psychologist, and other relevant members (e.g., speech-language pathologist, occupational therapist, reading specialist)—determines eligibility and develops and annually revises the IEP. All those involved in writing the IEP must be informed about the rights of students and their parents. Guidelines 21.1 outline these rights that educators must follow.

Keep in mind that determining a student's eligibility for special education should involve multiple modes of assessment and include standardized instruments that are culturally fair to students from ethnically diverse or lower socioeconomic backgrounds. Since the 1960s, students from culturally and linguistically diverse backgrounds have been disproportionately identified as having disabilities and placed in special education classes in elementary through high school (McKinney, Bartholomew, & Gray, 2010; Scott, Hauerwas, & Brown, 2014). Consider these examples.

- Students who are Native American, Native Hawaiian or Pacific Islander, and African American are more likely to receive special education services than are students from other ethnic groups (Harry & Klingner, 2014; Jasper & Bouck, 2013; U.S. Department of Education, 2018).
- Students from impoverished backgrounds also are more likely to be identified for special education services (Dever, Raines, Dowdy, & Hostutler, 2016; Skiba, Poloni-Staudinger, Simmons, Feggins-Azziz, & Chung, 2005).
- Students who are English Language Learners tend to be over-identified for special education services in intellectual disability, specific learning disabilities, and emotional disturbance (DeMatthews, Edwards, & Nelson, 2014; Dever et al., 2016; Sullivan, 2011).

We should be cautious *not* to interpret these data to mean that race, ethnicity, or socioeconomic status (SES) is associated with a greater risk for disabilities. Many environmental factors contribute to a child's intellectual development. For example, children from lower SES families may have lower IQs or achievement because they lack the resources that middle and upper SES families provide to promote cognitive development, such as books, computers, and high-quality preschool.

The effects of environment on intelligence: See Module 20

Planning and Placement

IDEA ensures a free and appropriate education by requiring students with disabilities to be placed in the general education classroom "to the maximum extent appropriate," known as the **least restrictive environment (LRE).** Special classes, separate schools, or other pull-out programs should be used only when the nature or severity of the disability prevents the student from functioning in the general education classroom with supplementary aids or services. LRE should not be confused with *mainstreaming* and *inclusion*, which are LRE approaches that have evolved out of different interpretations of the law over the past 4 decades.

- In **mainstreaming,** students with special needs are placed with typically achieving peers when appropriate. For example, students may spend most of their day in a special education classroom and be integrated with their peers for subjects such as music, art, and social studies and for activities such as lunch, recess, library, and field trips.
- **Inclusion**, a more recent and popular approach, refers to integrating all students within the general education classroom, even those with severe disabilities, for most or all of the school day. Students typically receive individualized instruction from the special education teacher who coteaches with the general education teacher and from paraprofessionals.

Experts continue to debate whether inclusion is the best environment for every student (Barrett, Stevenson, & Burns, 2019; Ballard & Dymond, 2017). Only about 17% of students with intellectual disabilities spend most of the day in general education classes,

▼ GUIDELINES 21.1

Rights of Students and Parents

Students' records must be kept confidential. According to the **Family Educational Rights and Privacy Act**, only school personnel with a legitimate educational interest may obtain a student's records without written consent from a parent.
Parents, or an assigned surrogate when parents are unavailable, have a right to examine all relevant records of their child and to participate in every decision related to the identification, evaluation, and placement of their child.
Parents must be included in the meetings to develop IEPs and may bring an advocate to the meetings.
Parents must approve the plans before they go into effect for the first time.
If they wish, parents also may obtain an independent educational evaluation.
Parents have the right to challenge or appeal any decision related to identification, evaluation, and placement of their child, and they are protected by due process.
Parents must receive written notices in their native language before evaluations or changes to their child's placement occur.
When the IEP meeting involves decisions related to transition (i.e., secondary and postsecondary goals), the student must be invited to attend the meetings because planning for the student's future must take into account his or her preferences and interests.
School districts are not required to assess students for determining eligibility for services in postschool environments, but they are required to facilitate students' transition from school to postsecondary education or employment (Madaus & Shaw, 2006).

Source: Adapted from Section 1415, Procedural Safeguards of the IDEA Act. Retrieved from https://sites.ed.gov/idea/statute-chapter-33/subchapter-II/1415.

while 70% of students with specific learning disabilities in elementary through high school spend most of the school day in the general education classroom (U.S. Department of Education, 2018). In any case, the decision to place students with disabilities in their LRE must be made on a case-by-case basis and in accordance with the intent of the law.

Did you ever have an IEP during your schooling? Did you know someone who had an IEP? Can you remember what services or accommodations were offered to you or to this individual?

Intellectual Disabilities

2 Discuss the impairments you would expect to see in students with intellectual disabilities and the curricular approaches useful in addressing these deficits.

Identification of Intellectual Disabilities

IDEA serves approximately 7% of students ages 6 to 21 for *intellectual disabilities*, a relatively new term that replaced the term *mental retardation* (U.S. Department of Education, 2018). The American Association on Intellectual and Developmental Disabilities (AAIDD) defines **intellectual disability** as a disability that develops before age 18 and involves significant impairments in intellectual functioning and adaptive behavior, which include conceptual, social, and practical skills (Schalock et al., 2010). Determining whether a student has an intellectual disability involves evaluating whether the student exhibits significant impairment on measures of cognitive ability and adaptive behavior.

Psychologists assess impairments in cognitive ability using individually administered IQ tests, such as the Wechsler Intelligence Scale for Children-V (Wechsler, 2014) or the Stanford-Binet Intelligence Scales-V (Roid, 2003), both of which measure a range of cognitive skills. On such tests, the typical criterion for identifying an intellectual disability is an IQ score of 70 or lower, which is 2 standard deviations below the average IQ score. This means that a student is performing significantly below his or her age group (only 2%–3% of individuals in the population obtain scores of 70 or below).

IQ tests: See Module 20

Standard deviation: See Modules 20 and 25

It is important not only to assess students' cognitive functioning with IQ tests but also to assess their everyday functioning, or adaptive behavior. *Adaptive behavior*—acting independently and in a socially responsible manner—includes conceptual, social, and practical skills (American Psychiatric Association, 2014):

- *Conceptual skills,* such as reading, writing, understanding currency, and communicating, are necessary to function in society.
- *Social skills* include using good manners, showing responsibility, following rules and societal laws, demonstrating interpersonal skills, and being neither naïve nor gullible.
- *Practical skills* comprise daily living skills and work skills, such as dressing, bathing, grooming, cooking, cleaning, shopping, managing money, working at a job, and using public transportation.

To evaluate adaptive behavior, psychologists use standardized instruments that assess the three dimensions of adaptive behavior outlined earlier. The Vineland Adaptive Behavior Scales, Third Edition (Sparrow, Cicchetti, & Saulnier, 2016), a popular instrument for this purpose, uses parent and teacher interviews to gather information about the individual's typical behaviors in areas such as communication, daily living skills, socialization, and motor skills. For example, the interviewer might ask whether a kindergartner brushes his teeth every day (daily living) and whether he can hold a pencil (motor skills).

A deficit in adaptive behavior may be identified by a significant impairment in one of the three dimensions or by a low overall score. The specific criteria for deficiency are

- a score that is 2 standard deviations below average on a standardized instrument of adaptive behavior in one of the three dimensions (conceptual, social, or practical) or
- an overall score on the instrument that is 2 standard deviations below the average, which indicates that the individual is functioning substantially below the norm.

Remember that diagnosis of an intellectual disability requires assessing both cognitive ability and adaptive functioning. As we have already stated, identification of any disability should not be based on a single assessment or instrument, and professionals should take care to use standardized instruments that are culturally fair to students from ethnically diverse or lower socioeconomic backgrounds.

APPLICATIONS

GUIDELINES FOR TEACHERS IN THE GENERAL EDUCATION CLASSROOM

When deciding how to teach students with intellectual disabilities in the general education classroom, educators must first remember that students with and without disabilities are more alike than they are different (Westwood, 2003). For example, two 10-year-old boys, one with an intellectual disability and one without, may both like sports, enjoy gym and art, and prefer to work in groups rather than independently. With this in mind, teachers should start by asking the following questions (Ashman, 1998):

- In which setting will the student learn most successfully?
- What skills need to be taught?
- What are the most effective approaches to teaching those skills?

Teachers can use several guiding principles to maximize learning opportunities for students with intellectual disabilities.

Teach using direct instruction. Direct instruction is a structured instructional method that involves teaching in small steps, providing ample opportunities for guided and independent practice, giving explicit feedback, and reteaching when necessary (Rosenshine, 1979, 1988; Rosenshine & Stevens, 1986). This method is effective when used with students with disabilities, especially for teaching basic skills (Kroesbergen & Van Luit, 2005; Turnbull, Turnbull, Shank, Smith, & Leal, 2002). However, keep in mind that skills such as reading need not be taught solely through drill and practice. For example, adolescents with intellectual disabilities improved their reading comprehension using an approach called *reciprocal teaching*, which teaches metacognitive skills that support comprehension, such as summarizing, questioning, clarifying, and predicting (Alfassi, Weiss, & Lifshitz, 2009).

Direct instruction: See Module 18

Reciprocal teaching: See Modules 11 and 12

Focus on overlearning, or practicing a skill past the point of mastery. Many students with intellectual disabilities have difficulty storing information in long-term memory, possibly due to attentional problems or lack of effective memorization strategies (Hallahan & Kauffman, 2000; Westwood, 2003). These students need extensive repetition and practice of skills, which can help them easily and automatically retrieve information from long-term memory (Westwood, 2003).

Overlearning: See Module 12

Long-term memory: See Module 10

Hands-On Learning. Hands-on learning is effective for teaching students with intellectual disabilities.
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Encourage hands-on learning. Students with intellectual disabilities typically have difficulty with abstract thinking and need concrete examples (Reddy, Ramar, & Kusama, 2000). Learning math should include not only traditional methods, such as textbooks and worksheets, but also real-life situations, such as shopping, measuring, cooking, and so on. Similarly, reading skills should be practiced in a variety of realistic contexts, such as reading instructions for a game, recipes, brochures, street signs, and newspapers.

Use cooperative learning when applicable. Cooperative learning requires heterogeneous (mixed) groups of students to work together to achieve a common goal. Teachers should adjust the curriculum content, however, to reflect the different cognitive needs and educational objectives of students with disabilities and typically achieving students. For instance, in a middle school social studies activity, typically achieving students might be learning content related to geography and history while students with disabilities are learning vocabulary or social skills from the same cooperative activity. Cooperative learning can raise the self-esteem of students with disabilities and promote positive peer relationships between students with and without disabilities (Acton & Zabartany, 1988; Johnson & Johnson, 2009; Salend & Sonnenschein, 1989).

Cooperative learning: See Modules 18 and 19

Foster generalization. Students with intellectual disabilities have difficulty generalizing what they have learned—that is, transferring newly acquired information to new contexts (Meese, 2001; Taylor, Sternberg, & Richards, 1995). Often, the teacher needs only to remind students that they have successfully performed the skill in the past. For example, when students are figuring out how much money to give the clerk at the school store, the teacher may need to remind them that they have practiced counting money in the classroom. Other examples of fostering generalization include (Mastropieri & Scruggs, 1984; Westwood, 2003)

Transfer: See Module 12

- providing immediate feedback following performance of the skill;
- practicing the skill several times (which also would encourage overlearning);
- providing reinforcement for demonstrating the skill (e.g., privileges, free time, tokens);
- reteaching the same skill in different contexts, gradually increasing the range of contexts in which to practice the newly acquired information; and
- requiring students to decide whether a particular skill or strategy could be used to solve a new problem.

Reinforcement: See Module 8

Keep in mind that transfer is difficult for *all* learners when they are acquiring new information and that the aforementioned approaches are useful for encouraging generalization in *all* students.

Think about whether you will be teaching in early childhood or elementary school, or whether you plan to teach a certain subject in middle school or high school. How would you use these guidelines in your classroom?

Specific Learning Disabilities

3 Explain how learning disabilities are identified using the IQ-achievement discrepancy and the response-to-intervention approach.

4 Explain the characteristic deficits you would look for in identifying students with reading and mathematics disabilities and how you would approach remediating these deficits.

Identification of Specific Learning Disabilities

Specific learning disabilities (LD) represent the largest special education category under IDEA (Reid & Knight, 2006; U.S. Department of Education, 2018). Refer to the pie chart in Figure 21.1. When first introduced in 1963, LD referred to students who had learning difficulties but were not eligible for special services under already existing categories such as mental retardation (MacMillan & Siperstein, 2002). Today, the exclusion of mental retardation, now called intellectual disabilities, remains a component of the definition of LD in IDEA 2004:

> The term "specific learning disability" means a disorder in one or more of the basic psychological processes involved in understanding or in using language, spoken or written, which may manifest itself in imperfect ability to listen, think, speak, read, write, spell or do mathematical calculations. Such term includes such conditions as perceptual disabilities, brain injury, minimal brain dysfunction, dyslexia, and developmental aphasia. Such term does not include a learning problem that is primarily the result of visual, hearing, or motor disabilities, of mental retardation, of emotional disturbance, or of environmental, cultural, or economic disadvantage. [PL 108-446, Section 602.30(A-C)]

For the past several decades, the primary method for determining special education eligibility for a learning disability has been the **IQ-achievement discrepancy**. This method is based on the notion that students with LD have a learning problem that is *not* due to low intelligence (the exclusion of mental retardation as a causal factor in LD in the definition). Students would be identified as learning disabled if their achievement in one or more academic areas was significantly below what would be expected from their IQ. Individually administered IQ and achievement tests, typically given by a psychologist, are used for this purpose.

Consider an example of the IQ-achievement discrepancy, shown in Table 21.1, for a 9-year-old boy suspected of having a reading disability. The boy's reading and spelling scores are two standard deviations below average, meaning that he is far below average for his age group on these skills. These skills are significantly below what we would expect from his average IQ, while his mathematics scores are average, in line with his IQ score. The boy probably

Standard deviation: See Modules 20 and 25

▼ TABLE 21.1

IQ and Achievement Scores for a 9-Year-Old Boy. These scores illustrate the IQ-achievement discrepancy. The boy's reading and spelling scores are severely discrepant from his average IQ.

Boy, age 9	
Test	Standard Scores*
WISC-V Full-Scale IQ	105
Kaufman Test of Educational Achievement II	
Spelling	70
Reading composite	68
Calculations	92
Applied problems	93

*Standard scores have an average of 100 and a standard deviation of 15. Scores below 70 (2 standard deviations below the average) are considered extremely low.

Standard score: See Module 25

would be considered eligible for special education services in reading and spelling using the discrepancy approach.

Since the adoption of the IQ-achievement discrepancy, researchers have accumulated evidence challenging the adequacy of this method on theoretical, statistical, and practical grounds (Fletcher, Lyon, Fuchs, & Barnes, 2007; Stanovich, 1991a, 1991b). Several practical problems are important to keep in mind.

- Researchers have found wide variation among states and even among districts within a state in how the IQ-achievement discrepancy is implemented (Mercer, Jordan, Allsopp, & Mercer, 1996; Vaughn, Linan-Thompson, & Hickman, 2003). For example, states differed as to the amount of discrepancy between a student's IQ and achievement performance required for eligibility (Reschly & Hosp, 2004).
- Finding a discrepancy between IQ and achievement scores does not provide instructionally useful information to help educators develop remedial plans (Aaron, Joshi, Gooden, & Bentum, 2008; Semrud-Clikeman, 2005). Collection of additional data (e.g., other tests, student work samples, etc.) is needed to determine students' strengths and weaknesses.
- Using this approach, minority students and English language learners tended to be placed in special education for LD at a higher rate than White students (Blanchett, 2006; U.S. Department of Education, 2009; Shifrer, Muller, & Callahan, 2011). The disproportionate representation may be due to a variety of factors, including standardized test bias, discrimination, and factors related to socioeconomic status (Shifrer et al., 2011).
- IQ-achievement discrepancy is considered by many to be a "wait to fail approach" in which students continue to struggle academically until the discrepancy becomes significant enough to result in eligibility (Fuchs & Fuchs, 2006; Hale, Wycoff, & Fiorello, 2011).

The limitations of the IQ-achievement discrepancy method led educators and policy makers to search for alternative approaches to identifying learning disabilities. When IDEA was revised and reauthorized in 2004, the law specified that LD identification does *not* require use of an IQ-achievement discrepancy and may involve a method called **response to intervention (RTI).**

Using RTI, educators determine whether a student responds to "scientific, research-based intervention." A major goal of RTI is to reduce the number of referrals for special education in pre-K through Grade 12 by identifying and correcting academic problems at an early stage (Al Otaiba & Fuchs, 2006; Carreker & Joshi, 2010). RTI also attempts to reduce the number of students who are incorrectly identified as having an LD, especially students from minority and linguistically diverse backgrounds who are disproportionately placed in special education (Finch, 2012). For example, students may have reading difficulties that are not due to an actual reading disability involving specific cognitive deficits (discussed next) but instead are the result of

- socioeconomic disadvantage (i.e., they have poor readiness skills due to lack of resources, non-English-speaking parents, and so on) or
- lack of appropriate instruction (i.e., they were not taught necessary reading or math skills).

RTI involves screening and monitoring of progress on academic skills for *all* students within a district and providing increasingly intensive interventions to students who perform below grade-level expectations. Currently, all 50 states use RTI as a prevention model, meaning that instruction and interventions are provided as part of general education (Zirkel & Thomas, 2010). Some states use RTI as both a general education initiative and as part of special education eligibility decisions (Hauerwas, Brown, & Scott, 2013). This means that the data collected through RTI documenting a student's continued failures to respond to increasingly intensive interventions can be used to make a referral for special education eligibility. While there is no single RTI model mandated by IDEA, the typical model has three tiers, as shown in Figure 21.2:

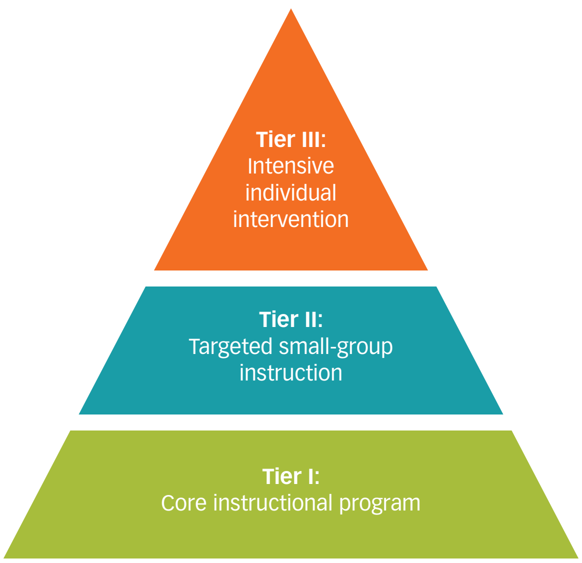
Tier 1. The preventive tier involves whole-class, general education instruction that is considered effective based on research evidence (Cakiroglu, 2015). Experts estimate that general education instruction should be effective for about 80% of students (Björn, Aro, Koponen, Fuchs, & Fuchs, 2016). In this tier, educators assess all students using screening measures to identify which students may need additional intervention.

Tier 2. The secondary intervention tier involves small-group, short-term, and intensive interventions and targets about 15% of students who were not making adequate progress in Tier 1 (Björn et al., 2016). The type of intervention (e.g., oral reading fluency, comprehension, math computations) and how often each week students receive the intervention will vary depending on students' needs. The typical duration is 10 to 20 weeks of sessions (20–45 minutes) three or four times per week (Fuchs, Fuchs, & Vaughn, 2014).

Tier 3. The tertiary intervention tier is the most intensive intervention. It is typically provided one-on-one by highly trained personnel to about 5% of students who did not respond to Tier 2 interventions (Björn et al., 2016).

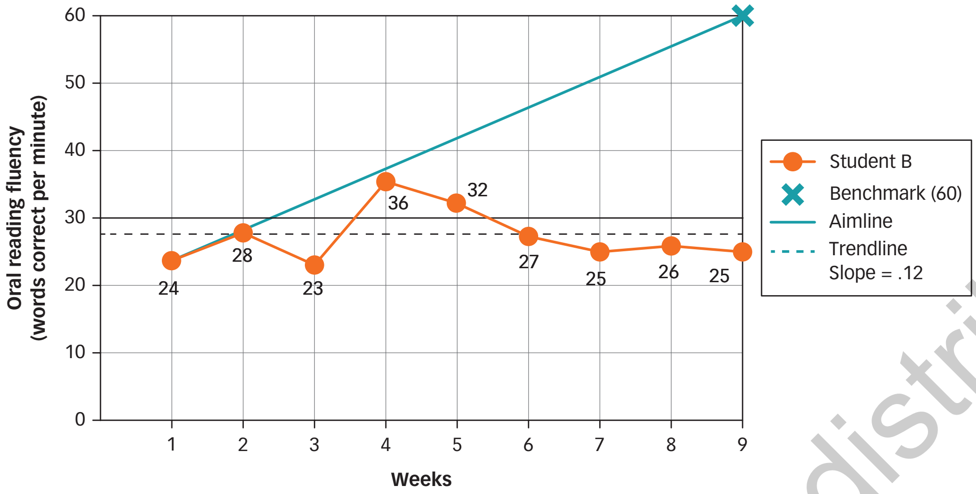
▼ FIGURE 21.2

A Three-Tiered Model of RTI. Models such as this are used by schools in all 50 states.



▼ FIGURE 21.3

Oral Reading Fluency Graph. This graph shows the performance of a student who is not responding to intervention.



Source: http://www.sde.ct.gov/sde/lib/sde/PDF/DEPS/Special/2010_Learning_Disability_Guidelines_Acc.pdf (Figure 3, p. 33).

To accurately identify a student as needing more intensive and more frequent instruction (movement to Tier 2 or Tier 3), a **dual-discrepancy method** should be used (Cates, Blum, & Swerdlik, 2011). The student's academic performance should be below average, or discrepant, compared with grade-level expectations, *and* the student should show a slow rate of improvement toward benchmarks such that the gap widens over time between the student's performance and the benchmark (Cates et al., 2011). Consider Figure 21.3, showing a student's oral reading fluency (number of words correctly read per minute). The student correctly identified 24 words per minute compared with the benchmark of 60 indicating grade-level performance, meaning that the student is below grade-level expectations. The student's performance throughout the intervention shows very little progress toward the benchmark, indicating a slow rate of learning that is not sufficient to close the gap between current performance and grade-level expectations.

Keep in mind that RTI often involves trying multiple interventions within a tier during a grade or over several grades and does *not* require a student to move through all tiers before a special education referral can be made. A student can be referred for special education evaluation at any point in the RTI process, even though in most states the process begins after Tier 3 (Berkeley, Bender, Peaster, & Saunders, 2009; Van Der Heyden & Burns, 2010). However, research suggests that students can be accurately identified for special education services at Tier 1 or Tier 2 without needing to fail to respond to multiple interventions (Al Otaiba et al., 2014; Compton et al., 2012).

As with the IQ-achievement discrepancy, RTI has its share of weaknesses. A major problem is that the assessments and interventions used in RTI, particularly for Tier 2, may not be best serving the needs of students.

- Selecting students for tiered interventions using brief screening measures may increase the possibility of identification errors—overidentifying students who do not need intervention and overlooking those who do (Fuchs & Fuchs, 2017; McAlenney & Coyne, 2015). This overidentification strains school budgets because it consumes unnecessary resources that could be used for other RTI tiers and other school programs (Fuchs & Fuchs, 2017).

- Many screening measures also do not provide information about specific skill deficits that would help develop effective interventions targeted to the individual needs of students (Ball & Christ, 2012; King & Coughlin, 2016). As a result, schools often provide generic interventions, such as oral reading or phonics worksheets in a large-group format (Fuchs & Fuchs, 2017).
- Finally, schools try to increase the cost efficiency of small-group interventions in Tier 2 by expanding group size despite research indicating that smaller groups with about a 1:3 teacher–student ratio result in better outcomes (Gersten, Jayanthi, & Dimino, 2017; King & Coughlin, 2016).

These implementation problems are exacerbated when one considers that states and districts around the country differ in many of these aspects of RTI delivery. Research has documented wide variation among states in implementation, such as the following (Beach & O'Connor, 2015; Callinan, Cunningham, & Theiler, 2013; Hauerwas et al., 2013; Mellard, McKnight, & Jordan, 2010):

- Types of assessments used for screening and progress monitoring and the different criteria for determining benchmarks and for measuring progress
- Frequency of the Tier 2 and Tier 3 interventions
- Size of the instructional groups in each tier
- Requirements for monitoring treatment fidelity (tracking how well the teachers or teacher aides are implementing particular lessons according to the guidelines provided in curriculum manuals, software, or research literature)
- Frequency of progress-monitoring assessments
- Criteria to determine responsiveness to interventions
- Timetable for when the process of determining special education eligibility begins

Reliability: See Module 25

The use of different assessments and different criteria is a problem of reliability, or consistency of assessment results and decisions that stem from the results. Because a student may be considered nonresponsive to intervention using one set of tests and criteria and responsive using a different set, the RTI method of identifying a learning disability is unreliable (Barth et al., 2008; Beach & O'Connor, 2015). As a result, RTI may result in as much or greater variation in the number of students identified as having LD compared to the variation produced by the IQ-achievement discrepancy (Fuchs & Deshler, 2007).

The variation in implementation practices among states makes it difficult to evaluate the success of RTI as an approach to reducing the number of students placed in special education for a learning disability. The percentage of students identified for special education services for LD already had been declining in the years before the adoption of RTI in 2004 and has continued to decline about 2% each year since 2002 (Cortiella & Horowitz, 2014; Zirkel, 2013). Therefore, RTI practices alone cannot account for declining enrollments in special education for students with LD (Zirkel, 2013).

Validity: See Module 25

An additional problem identified by experts is that failing to respond to an intervention in itself may not be a valid method for determining learning disabilities and therefore should not be used for special education eligibility (Fletcher, Barth, & Stuebing, 2011; Kavale, Kauffman, Bachmeier, & LeFevers, 2008; Reynolds & Shaywitz, 2009). This method only tells us that a student did not respond to educators' best attempts at intervention, but we do not know why the student failed to respond (Hale et al., 2011). This approach would identify both students who are slow learners and students with cognitive deficits indicative of a learning disability (Kavale, 2005). This method also, by itself, cannot differentiate specific learning disabilities from intellectual disabilities and emotional/behavioral disorders and may overlook students who can compensate for their learning difficulties, such as students with giftedness (Mastropieri & Scruggs, 2005; Volker, Lopata, & Cook-Cottone, 2006). Keep in mind that under IDEA, educators are still allowed to assess students' cognitive functioning and evaluate their pattern of strengths and weaknesses in academic performance as part of special education decision-making (Zirkel, 2018). However, individual states may prohibit the use of methods such as the IQ-achievement discrepancy or identifying strengths and weaknesses (Hauerwas et al., 2013).

Emotional, social, and behavioral disorders: See Module 22

Giftedness: See Module 20

A final practical problem with RTI is that it may not correct the problem of the IQ-achievement discrepancy method as a "wait to fail" approach. Critics of the discrepancy method argue that educators waited for children to fall behind in reading, math, or other academic skills until their achievement was sufficiently discrepant from their overall cognitive ability. In a similar fashion, RTI has been deemed a "watch them fail" approach (Reynolds, 2008, p. 20). To qualify for Tier 2 and 3 interventions, students need to continually score below grade level on progress monitoring measures, indicating their failure to respond to various interventions (Callinan et al., 2013). Often, students remain in Tier 2 for an entire year or several years, failing to respond to a variety of inadequate interventions (Fuchs & Fuchs, 2017; Fuchs et al., 2014). Even though students are being helped along the way, RTI may result in more students identified with a learning disability than the discrepancy method (Fuchs & Deshler, 2007). This "watch them fail" problem becomes exacerbated in schools where a majority of students score below grade level, such as schools in urban areas that serve large populations of students from lower socioeconomic backgrounds. In such schools, there may be 60% to 80% of students who perform below grade level compared to the hypothesized 20% in typical RTI models (see Tiers 2 and 3 in Figure 21.2). When demand far outweighs the staff needed for RTI, resources become strained, and all students who need intervention cannot be adequately served (Abbott & Wills, 2012; Abbott et al., 2008).

Rather than using failure to respond to identify learning disabilities, experts recommend administering tests to pinpoint the cognitive processing deficits that contribute to students' learning difficulties (Callinan et al., 2013; Hale et al., 2011). For example, research indicates that skills such as phonological awareness, word identification, decoding, and fluency, which are necessary for adequate reading development, consistently predict a student's responsiveness to intervention in RTI (Catts, Nielsen, Bridges, Liu, & Bontempo, 2015; Lam & McMaster, 2014). These are the same skills, as we see next, that are important for identifying a reading disability. Once educators identify the cognitive processing deficits that impair students' reading, math, or other academic skills, they can develop evidence-based intervention plans to help students improve their skills. Therefore, it is important for teachers to know what a reading disability or mathematics disability "looks like" to effectively plan instruction and remediate students' difficulties. Let's turn to these topics next.

Reading Disability

Students with a reading disability (RD), or dyslexia, represent only 3% to 10% of the school-age population (Compton, Miller, Elleman, & Steacy, 2014; Duff & Clarke, 2011). Yet they are the focus of much research because their difficulties are often severe and resistant to remediation using typical instructional methods. As we will see, reading disability is characterized by a deficit in phonological processing that affects the development of reading skills and ultimately reading comprehension. A **deficit** is an impairment in specific cognitive processes that affect a certain skill area, such as reading or math. A deficit suggests that students acquire skills in a *qualitatively different* way from other students and that skill impairments may not be easily remediated with conventional instruction or interventions (Stanovich, 1993). This contrasts with the notion of a **developmental delay**, in which a student acquires cognitive skills in the same way as other students but at a slower rate. This suggests that the student will catch up given proper intervention.

Characteristics. Individuals with a reading disability have a deficit in phonological processing that inhibits their ability to learn to recognize and decode words, which can affect their reading comprehension (Stanovich & Siegel, 1994; Vellutino, Fletcher, Snowling, & Scanlon, 2004). To understand RD, let's first review some important concepts in the development of skilled reading.

Phonological awareness and letter name knowledge: See Module 7

Skilled reading begins before formal reading instruction with the acquisition of two foundational skills, phonological awareness and knowledge of letter names (Adams, 1990; Wagner, Torgesen, & Rashotte, 1994). **Phonological awareness** refers to knowledge that spoken words contain smaller units of sound. For example, the word *cup* has three distinct sounds, called *phonemes*, which are the smallest units of sound that can change the meaning of a word. The words *cup* and *pup* differ in only one phoneme, the initial *c* or *p* sounds. Phonological awareness—in particular, awareness of phonemes—along with knowledge of letters help children develop the **alphabetic principle**, an awareness that printed letters are represented by sounds. The alphabetic principle allows beginning readers to acquire a strategy called **decoding**, or applying the sounds of letters or letter strings to printed words, which is "sounding out" words. This is necessary for beginning readers to acquire skill in **word recognition**, or identifying individual words in text. Skilled readers have developed word recognition and decoding skills to the point of *automaticity*, which means they can perform the skill very quickly, accurately, and with few cognitive resources such as attention and strategies (Perfetti, 1992; Stanovich, 1990). Automaticity allows a reader to use cognitive resources for understanding what is being read, as you are doing while you read this paragraph. Conversely, slow and inaccurate word recognition and decoding consume cognitive resources and lead to difficulties in reading comprehension (Perfetti, 1985; Snowling & Hulme, 2013).

Word recognition and decoding: See Module 7

Automaticity: See Module 12

Compared to typically achieving students, students with RD show deficits in phonological awareness as young children, which limits their ability to acquire efficient word recognition and decoding skills (Compton et al., 2014; Snowling & Hulme, 2013). From elementary through college level, students with RD lack automaticity of word recognition and decoding (Cisero, Royer, Marchant, & Jackson, 1997; Compton & Carlisle, 1994). They have difficulty holding a phonological representation of a word (e.g., the sounds of letters in a printed word and the name of the word) in working memory to decode it during reading. As a result, many words do not become stored in long-term memory as representations that then can be automatically retrieved—even words that students with RD have encountered frequently. Consequently, individuals with RD experience a lack of automatic word recognition and decoding that often results in a breakdown in reading comprehension (Snowling & Hulme, 2013).

Working memory and long-term memory: See Module 10

The cognitive deficits involved in RD are distinct from those involved in comprehension impairment, which affects about 5% to 10% of the school-age population (Compton et al., 2014; Snowling & Hulme, 2013). Students with comprehension impairment, also called *poor comprehenders*, have adequate phonological processing skills and can decode and spell words, but they have difficulty with reading comprehension (Duff & Clarke, 2011; Snowling & Hulme, 2013). Reading comprehension difficulties may stem from difficulties in a variety of oral language skills, such as listening comprehension, vocabulary, ability to process word meanings, ability to make inferences about the text, comprehension-monitoring strategies, and knowledge of story structure (Landi & Ryherd, 2017; Silva & Cain, 2015). Students' comprehension also may suffer because they lack prior knowledge about the world, which

Making inferences: See Module 13

is necessary for supporting their understanding of texts and their ability to make inferences while reading (Compton et al., 2014).

Teachers and school psychologists can use information about the characteristic deficits of RD and comprehension impairment to choose appropriate assessments for determining whether a student is eligible to receive special education services for an RD.

- For children in kindergarten and first grade, an evaluation should include measures of phonological awareness, letter and word recognition, and rapid naming (quickly retrieving labels for objects, letters, colors, and numbers from long-term memory).
- For older children and adolescents, an evaluation should consist of measures of word recognition, decoding, vocabulary, and listening and reading comprehension. Timed measures of word recognition and decoding are particularly important because they provide an indication of automaticity.

Applications: Remediating Reading Disability. Research studies on RD and comprehension impairment suggest different types of interventions for remediating these distinct reading problems. For students with RD, experts recommend interventions that improve the underlying cognitive deficits that contribute to difficulties in oral reading and comprehension, whereas for students with comprehension impairment, experts recommend a variety of methods to address their particular comprehension problems.

Research indicates that extensive and systematic instruction in phonics can help elementary school students with RD acquire word identification and decoding skills (Al Otaiba, Rouse, & Baker, 2018; Foorman, Francis, Winikates, Schatschneider, & Fletcher, 1997; Torgesen et al., 2001; Torgesen, Wagner, & Rashotte, 1997; Torgesen et al., 1999). **Systematic phonics instruction** focuses on teaching children to recognize and manipulate phonemes and to apply that knowledge to letter-sound correspondences. In addition to explicit instruction, students practice decoding new words to mastery. This approach tends to be more effective for students in the early elementary grades than for students in Grades 3 and higher (Suggate, 2016; Wanzek & Vaughn, 2007). **Fluency**—the ability to read text quickly, accurately, and with proper expression—is also problematic for many students with RD and is difficult to remediate in older students (Lyon, Shaywitz, & Shaywitz, 2003; Torgesen, 2005). One approach to increase fluency is **repeated reading**, which involves reading a text multiple times to reach a predetermined level of fluency or a certain amount of improvement above a student's baseline level (Ardoin, McCall, & Klubnik, 2007; Samuels, 2006). This approach can be used to improve fluency in K–12 students with RD, with the most benefit observed with students in the elementary grades (Lee & Yoon, 2017). Also, repeated reading is more effective with the assistance of an adult or more capable peer rather than a student reading alone, as well as when the student listens to the adult read the passage first followed by at least four repetitions of the passage (Kuhn & Stahl, 2003; Lee & Yoon, 2017). For optimal fluency improvement, teachers should use texts that have a high percentage of common words, many words that are easily decodable, and few multisyllabic words that are less common (Hiebert, 2003; Hiebert & Fisher, 2002; Pressley, Gaskins, & Fingeret, 2006).

Several caveats must be considered before research findings on RD can be successfully translated into educational practice:

1. Even though research suggests that systematic phonics instruction may be beneficial for students with RD, this does not mean that the same approach leads to similar levels of improvement for each student. Even the most systematic and intensive interventions used in research tend to result in 10% to 15% of students who fail to acquire adequate word recognition and decoding skills (O'Connor & Fuchs, 2013; Torgesen, 1998, 2000).

2. In research studies, children receive an extensive amount of instruction. For example, research interventions ranged from 67 hours of individual instruction to 80 hours of small-group or individual instruction (e.g., Torgesen et al., 2001; Torgesen, Wagner, Rashotte, Herron, & Lindamood, 2010). Outside of research studies, students are unlikely to receive such a considerable amount of remedial instruction. Many schools do not have the financial and personnel resources to provide sufficient time and intensity of interventions during the school day to accelerate the reading development of students with RD so that they achieve average-level skills (Torgesen et al., 2001; Torgesen et al., 2010).

Low-road transfer: See Module 12

3. Teachers should not expect mastery of letter-sound correspondences and phonemic skills to transfer automatically to improved word recognition and decoding. Studies of systematic phonics instruction by researchers have shown that this approach can improve decoding skills of students with RD, but these skills do not necessarily transfer to word recognition (Foorman et al., 1997; McCandliss, Beck, Sandak, & Perfetti, 2003; Torgesen et al., 2001; Torgesen et al., 1997). Word recognition and decoding skills must be practiced to the point of overlearning so that automaticity of word identification can support higher level reading processes such as comprehension (Cisero et al., 1997; Royer, 1997; Royer & Sinatra, 1994). Some research suggests the possibility that **automaticity training** of word recognition can improve the reading skills of students with RD (Royer, 1997). Also, systematic phonics is most effective when it is provided within a broad literacy curriculum that includes many opportunities to practice reading text (Stuebing, Barth, Cirino, Francis, & Fletcher, 2008).

4. Teachers must remember to offer opportunities for students to read rich, connected text in addition to practicing phonics (Stahl, 1998; Torgesen, 2000). Research indicates that providing simple reading material to students with RD may send the wrong message—that teachers think they are incapable of reading more challenging material and that reading is merely decoding. Also, students may expect to fail when they are given material that they have already encountered without success (Stahl, 1998). Using novel instructional materials helps circumvent this problem and motivates students by providing them with fun and interesting activities.

Research studies have found a variety of techniques to be effective in improving outcomes of students with comprehension impairment.

- Vocabulary instruction integrated within content courses, such as science or social studies, can improve reading comprehension (Clarke, Snowling, Truelove, & Hulme, 2010; Elleman, Lindo, Morphy, & Compton, 2009). Some simple classroom techniques are providing definitions and examples and nonexamples of concepts and using semantic maps (Kim, Vaughn, Wanzek, & Wei, 2004).
- Inference training has been found to improve reading comprehension (McGee & Johnson, 2003; McMaster et al., 2012; Yuill & Oakhill, 1988). Teachers can ask students to select words from the text and explain how they contribute to the overall meaning. Students can also generate questions and make causal connections or predictions about the text and then revisit their predictions to affirm or refute them after reading.
- Instruction that teaches students strategies for comprehending text have yielded positive results (Gersten, Fuchs, Williams, & Baker, 2001; National Institute of Child Health and Human Development, 2000; Rosenshine & Meister, 1994). Teachers can

improve students' reading comprehension by activating prior knowledge through previewing headings or key concepts and making predictions (Klingner, Vaughn, & Boardman, 2007; Roberts, Torgesen, Boardman, & Scammacca, 2007). Encouraging students to summarize and make connections to prior knowledge, other subjects, or real-life applications also enhances reading comprehension. *Reciprocal teaching*, a method for teaching metacognitive strategies necessary for skilled reading comprehension (questioning about the main idea, clarifying, summarizing, and predicting), can be used for this purpose. These approaches can be used with students who have comprehension impairments as well as students with RD.

Reciprocal teaching: See Modules 11 and 12

Mathematics Disability

A large proportion of students in your classroom may struggle with various aspects of mathematics. Approximately 7% of students are typically identified as having a mathematics disability (MD), and an additional 10% of students are considered to have very low achievement in math (Geary, 2011; Geary, Hoard, Nugent, & Bailey, 2012). Our understanding of MD currently is limited to arithmetic skills in elementary school (Geary, 2004). However, when working with students in middle school and high school, a teacher should know the cognitive bases of the math difficulties to better plan appropriate curricula and accommodations for students. Let's explore the characteristics of MD and how they might differ from low math achievement.

Characteristics. Research evidence indicates that MD is likely to be a heterogeneous disability and cannot be defined by classifying students into distinct categories, as once thought (Bartelet, Ansari, Vaessen, & Blomert, 2014; Geary, 2010; Peng, Wang, & Namkung, 2018). Recent research has focused on students with different profiles of cognitive abilities: those with a specific MD and those with low math achievement (Geary, 2011, 2013):

- Students with a specific MD have mathematics achievement scores below the 10th percentile for 2 consecutive years and IQ scores that are within the average range.
- Students with low math achievement also have IQ within the average range, but they have less severe problems, as indicated by below-average math achievement (percentile scores ranging between 11 and 25) over 2 or more consecutive years.

Percentile scores: See Module 25

IQ scores: See Module 20

The poor performance of both types of students is not the result of low intelligence or reading ability (Geary, 2011). Students with low achievement typically are average readers (Geary, 1993; Jordan, Hanich, & Kaplan, 2003b). Many students with an MD, but not all, also have an RD (Moll, Kunze, Neuhoff, Bruder, & Schulte-Körne, 2014). To understand MD and low achievement, researchers have focused on three areas related to the development of arithmetic skill: (1) deficits in the ability to store and retrieve facts in long-term memory, (2) delays in the development of counting and arithmetic procedures, and (3) a disruption in the development of the number sense system. Let's explore each of these skill areas.

Fact-retrieval deficit. The characteristic most consistently found in research is a **fact-retrieval deficit**, an inability to commit facts to long-term memory and automatically retrieve them (Geary, 1990; Jordan, Hanich, & Kaplan, 2003a; Jordan et al., 2003b; Mazzocco, Devlin, & McKenney, 2008). When learning arithmetic facts such as 3 + 2 = 5, students must hold number-words (e.g., the words *three* and *two*) in working memory long enough for a memory representation of the problem (3 + 2) and the answer (= 5) to be associated in

Working memory and long-term memory: See Module 10

long-term memory. For individuals with MD, many arithmetic facts do not become stored in long-term memory for automatic retrieval, even after extensive drilling (Geary, 1993, 2004). Compared to students without disabilities, students with this deficit (Chan & Dally, 2001; Geary, 2004)

- Retrieve fewer arithmetic facts from long-term memory
- Commit many more errors when using fact-retrieval as a strategy
- Overuse counting strategies (e.g., finger counting and verbal counting) rather than using retrieval
- Exhibit variability in rates of retrieval of math facts (some slower, some faster), especially compared with younger, typically achieving students

Both students with MD and students with low math achievement have difficulties learning basic arithmetic facts and retrieving them from long-term memory (Andersson, 2010; Chan & Ho, 2010, Geary, 1993; Jordan et al., 2003b). However, the origin of this deficit may be different for each type of student (Geary, 2011). Researchers are currently investigating possible sources of this deficit.

Procedural delays. Students with MD and students with low math achievement also have **procedural delays**, a lag in the development of counting procedures characterized by performance that is often similar to that of younger, typically achieving children (Geary et al., 2012). Students with this delay often use immature procedures for solving arithmetic problems. For example, children begin solving arithmetic problems by using the *counting all* strategy, which means that they begin counting from 1. For example, to solve 3 + 4, they would say "1, 2, 3, 4, 5, 6, 7" to get the answer 7. By first or second grade, typically achieving children will shift to *counting on* (also called the min strategy; Jordan & Montani, 1997; Ostad, 1998). In this strategy, the student identifies the larger addend (4) and mentally counts on from there, "5, 6, 7," to get the answer. Low-achieving students use their fingers to *count on*, but students with MD continue to use their fingers while performing *counting all* (Geary, 2011; Jordan et al., 2003a). The achievement gap represents a 1-year delay for low-achieving students and a 2- to 3-year delay for students with MD (Geary, 2011). In addition to simple arithmetic problems in the early elementary grades, older students with this delay also exhibit problems with (Geary, 1990; Geary, Hoard, Byrd-Craven, Nugent, & Numtee, 2007; Jordan et al., 2003b; Russell & Ginsburg, 1984)

- more complex arithmetic, such as 367 – 142;
- multistep problems, such as 38 × 13; and
- story problems.

Number sense. **Number sense**, or the ability to represent exact quantities or approximate magnitudes of objects, develops in young children and is important for development of counting and arithmetic skills. For example, young children develop the understanding that three dots (***) represent the quantity *3* and that six dots (******) represent a greater quantity than three dots (***). Many students with MD show severe deficits in these number sense abilities (Mazzocco, Feigenson, & Halberda, 2011; Piazza et al., 2010; Stock, Desoete, & Roeyers, 2010; Wong, Ho, & Tang, 2017). However, this deficit is *not always* found in students with MD (Iuculano, Tang, Hall, & Butterworth, 2008; Mazzocco et al., 2011; Rousselle & Noël, 2007). In contrast, students with low math achievement are less likely to have number sense problems, and when they do, they eventually catch up developmentally and are similar to typically developing students on these skills (Geary et al., 2012; Mazzocco et al., 2011). The pattern indicating a deficit for students with MD and a delay for students with low achievement may suggest that there are different mechanisms underlying the number sense difficulties of these two types of students (Geary, 2013).

Number Sense. Number sense is important for arithmetic development and may play a role in fact-retrieval deficits and procedural delays.
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Some researchers believe that number sense difficulties may be at the root of fact-retrieval deficits and procedural delays (Jordan et al., 2003a; Raghubur et al., 2009). Difficulty developing number sense may impair a child's ability to map representations (***) onto Arabic numerals (3) and number-words (three; Geary, 2010). Some children with MD and children with low achievement are slower than peers at mapping quantities onto number-words and Arabic numerals (Geary et al., 2012; Mazzocco et al., 2011; Rousselle & Noël, 2007). The difficulty in mapping may lead to problems counting and performing arithmetic. However, experts believe that there may be different mechanisms underlying the number sense deficits of children with MD and those with low achievement; this research is ongoing (Geary, 2013).

Much research is still needed to understand the underlying causes of number sense problems, procedural delays, and fact-retrieval difficulties of students with MD and low math achievement. Regardless, teachers can use knowledge regarding these characteristics to identify children who may need differentiated instruction, RTI, or referral for special education. Diagnostic evaluations by school psychologists typically include individually administered standardized achievement tests that measure a range of skills, from factual knowledge about math to mathematical calculation (from elementary through secondary level) and problem-solving. School psychologists should choose standardized tests that assess mathematical computations in a timed format to assess automaticity of fact retrieval.

In addition, school psychologists or classroom teachers can conduct informal assessments of mathematical competence. An informal assessment requires working one-on-one with students and interviewing them about their knowledge and how they arrived at answers to problems.

- For students from kindergarten through second grade, teachers can give students a variety of arithmetic problems to determine what types of counting strategies they are using (Jordan, 1995).
- For students in the upper elementary grades, teachers can conduct an error analysis (Fleischner, 1994). For example, mathematical errors sometimes involve simple misalignment of numbers while writing down partial answers. Students also may make errors due to carrying or borrowing—called procedural bugs (Brown & Burton, 1978). Consider the following problems, indicating that the student lacks knowledge of carrying and does not understand place value.

$$\begin{array}{r} 93 \\ +57 \\ \hline 1410 \end{array} \qquad \begin{array}{r} 46 \\ +39 \\ \hline 715 \end{array}$$

Applications: Remediating Math Disability. To effectively remediate mathematics disability, interventions need to target the specific deficits that students exhibit in contrast to a one-size-fits-all approach (Geary, 2011). Depending on students' difficulties, teachers may focus interventions on number sense, counting strategies, or encouraging automatic fact retrieval.

Differentiated instruction:
See Module 18

To improve students' number sense, teachers can use two free, research-based online games—*The Number Race* (Wilson, Revkin, Cohen, Cohen, & Dehaene, 2006) and *GraphoGame-Maths*—that were developed to target difficulties representing the magnitudes of number sets and manipulating them. Both games are computer adaptive, meaning that they adjust the difficulty level to make trials easier if the student shows a pattern of incorrect responses or more challenging if the student makes many correct responses.

- *The Number Race* teaches children to judge approximate magnitudes. Users are shown two arrays of dots and are told to select the larger array. The program starts with large differences between two sets (e.g., 9 vs. 4 dots) and progresses to smaller differences over time (9 vs. 8 dots) as the child gains mastery. The game can be used with kindergarteners and as a remedial intervention for children ages 4 to 8 who have an MD (Kroeger, Brown, & O'Brien, 2012; Price & Ansari, 2013).
- *GraphoGame-Maths* teaches children to compare exact quantities of small sets that can be counted, and focuses on mapping the quantities to number-words (Butterworth, 2005; Price & Ansari, 2013).

Research indicates that the computer programs improve number sense, but benefits do not transfer to counting and arithmetic (Räsänen, Salminen, Wilson, Aunio, & Dehaene, 2009; Wilson, Dehaene, Dubois, & Fayol, 2009). To improve counting and the ability to compare magnitudes of numerals (is 9 bigger than 5?)—skills that can enhance arithmetic computation—research suggests simple activities such as playing number line games and board games (Kucian et al., 2011; Siegler & Ramani, 2009).

For students who use immature counting strategies, teachers can focus on ways to help them shift to more mature strategies. Students who rely on the *counting all* strategy might practice the *counting on* strategy with their fingers or with manipulatives (objects used for counting; Garnett, 1992). Using manipulatives facilitates students' understanding of mathematical principles (Gersten et al., 2009). Students also may practice identifying the larger addend and using the commutative property (e.g., $5 + 4 = 4 + 5$).

To encourage automatic fact retrieval, teachers should remind their students to ask themselves "Do I know this one?" For example, when faced with the problem 6 + 8, students should first ask whether this is a known problem that they can directly retrieve from memory, rather than relying on a counting strategy. Overreliance on counting strategies impedes the development of direct fact retrieval.

Teachers also can introduce shortcut strategies to help students develop fact-retrieval skill (Jordan et al., 2003b; National Research Council, 2001; Robinson, Menchetti, & Torgesen, 2002). For example, if students know $3 + 3 = 6$, they can derive the answer to $3 + 4$. Another shortcut is the commutative property ($3 + 4 = 4 + 3$). Shortcut strategies link similar problems to facilitate storage of facts in long-term memory—and thus direct retrieval. Table 21.2 provides two different ways to organize instruction for students with MD. Even though the approaches differ, the intent is the same—reducing the load on working memory in solving arithmetic problems and allowing sufficient practice with calculations so that facts are committed to memory.

Working memory:
See Module 10

Some experts argue against rote memorization of arithmetic facts because it places a heavy load on working memory—a weakness in many children with MD (Geary, 1994).

▼ TABLE 21.2

Ways to Organize Number Facts Instruction for Students With Math Disabilities

Approach	Instructional Sequence	Example
Garnett (1992)	+1 principle and	2 + 1, 3 + 1, etc.
	+0 principle	2 + 0, 3 + 0, etc.
	Ties	5 + 5, 6 + 6, etc.
	Ties + 1	5 + 6, 6 + 7, etc.
	Ties + 2	5 + 7, 6 + 8, etc.
	+10 number facts	1 + 10, 2 + 10, 3 + 10, etc.
	+9 number facts	6 + 9 is one less than 6 + 10
	Remaining facts	2 + 5, 2 + 6, 2 + 7, 2 + 8
		3 + 6, 3 + 7, 3 + 8
		4 + 7, 4 + 8
		5 + 8
Thornton and Toohey (1985)	Count-ons	+1, +2, +3 facts
	+0 principle	2 + 0, 3 + 0, 4 + 0, etc.
	Doubles (i.e., ties)	5 + 5, 6 + 6, etc.
	10 sums	6 + 4, 7 + 3, etc.
	+9s	4 + 9, 9 + 3, etc.
	Near doubles	4 + 5, 3 + 4, etc.
	Remaining facts	7 + 5, 8 + 4, 8 + 5, 8 + 6

However, other researchers have found success in remediating the fact-retrieval deficit by using rote drill, or more specifically, automaticity training. In one study involving an at-home intervention for students with MD, 6 weeks of nightly practice involving speeded retrieval of addition, subtraction, and multiplication facts improved the speed and accuracy of fact retrieval (Royer & Tronsky, 1998). The speeded practice forces students to abandon their less efficient counting strategies and use fact retrieval instead. In the classroom, teachers can use a method called Detect-Practice-Repair (DPR; Poncy, Skinner, & O'Mara, 2006). This approach has several stages (Axtell, McCallum, & Bell, 2009; Poncy et al., 2006):

- A timed assessment to identify the math facts that are not yet automatic
- Multiple repetitions of these facts in sets of five in which students cover the math fact (3 + 2 = 5), copy it from memory, and then compare their result to the example
- A timed assessment and graphing of scores to show progress

DPR has several advantages over traditional classroom methods. Most classroom approaches use a combination of known and unknown facts, which wastes instructional time because much of the practice is on material the student already knows (Axtell et al., 2009; Poncy, Skinner, & Axtell, 2010). DPR reduces the amount of material students need to practice. Additionally, DPR can be implemented as a classwide intervention, can be used to differentiate Tier 1 instruction, and requires little effort from teachers (Parkhurst et al., 2010; Poncy et al., 2010). Research indicates that this method uses very little instructional time and improves the fact-retrieval skills of elementary and middle school students with very low performance in math (Axtell et al., 2009; Parkhurst et al., 2010; Poncy, Fontenelle, & Skinner, 2013; Poncy et al., 2010; Poncy et al., 2006). Teachers can readily implement this technique using simple technology of PowerPoint slides and a timer app on any mobile phone (Musti-Rao & Plati, 2015).

Regardless of the method chosen to increase the fluency of arithmetic facts, keep in mind a few research-based principles that will improve the effectiveness of the intervention. *Distributed practice*, spacing the practice of sets of arithmetic problems over the school day, is more effective than practicing all the sets in one sitting, called *massed practice* (Schutte et al., 2015). The benefit of arithmetic retrieval practice can be further enhanced if completed over multiple days, as in the automaticity training research we discussed earlier (Royer & Tronsky, 1998). Also, providing immediate accuracy feedback on students' answers to the arithmetic problems can enhance the effectiveness of the fact-retrieval intervention (Duhon, House, Hastings, Poncy, & Solomon, 2015).

Distributed and massed practice: See Module 10

> The research and practical applications regarding reading and mathematics disabilities focus on elementary school students. How might middle school and high school teachers assist their students who have been identified with reading or mathematics disabilities?

SUMMARY

1. **Describe how cognitive disabilities are identified and served under the Individuals with Disabilities Education Improvement Act.** Students with intellectual disabilities and learning disabilities are eligible for special education and related services under IDEA as specified by the law. Students undergo a diagnostic evaluation by a school psychologist after parents give consent. Based on the evaluation results, a multidisciplinary team determines whether the student is eligible for special education. IDEA requires the development of an educational plan and placement of the student in the least restrictive environment.

2. **Discuss the impairments you would expect to see in students with intellectual disabilities and the curricular approaches useful in addressing these deficits.** Individuals with intellectual disabilities have a significant deficiency in intelligence and one or more areas of adaptive behavior (conceptual, social, and practical behavior). Diagnosis is made based on a score that is two standard deviations or more below the average on a standardized IQ test and on a standardized measure of adaptive behavior. Teachers can use direct instruction and cooperative learning methods, encourage hands-on learning, focus on repetition of knowledge and skills, and foster generalization of skills to a variety of contexts.

3. **Explain how learning disabilities are identified using the IQ-achievement discrepancy and the response-to-intervention approach.** Learning disabilities may be identified using an IQ-achievement discrepancy, where a student's achievement in one or more achievement areas is significantly below what would be expected from his or her IQ. Learning disabilities also may be identified using a response-to-intervention approach, in which students are referred for evaluation if they were identified as at risk and failed to respond to increasingly intensive research-based interventions.

4. **Explain the characteristic deficits you would look for in identifying students with reading and mathematics disabilities and how you would approach remediating these deficits.** Students with reading disability experience a lack of automaticity of word recognition and decoding, which in turn impairs reading comprehension. Students with mathematics disability have a fact-retrieval deficit, experiencing great difficulty storing and retrieving math facts from long-term memory even after extensive drilling. They may also experience extreme procedural delays in counting strategies and deficits in number sense. Systematic phonics may be used successfully with some students who have reading disability, while interventions that encourage development of number sense, more mature counting strategies, and automaticity of fact retrieval may be effective for students with mathematics disability.

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CASE STUDIES: REFLECT AND EVALUATE

Early Childhood: Letter *P* Day

These questions refer to the case study on page 406.

1. The case study does not specify what disability, if any, Teran has. Based on the information given in the case, how likely is it that Teran has an intellectual disability? What additional information would you need to be certain?
2. Describe conceptual, practical, and social skills that you would expect to find among kindergartners. What difficulties in these areas would you expect to see in a kindergartner with an intellectual disability?
3. Jillian appears to be somewhat advanced in literacy skills. What difficulties would you expect to see in a kindergartner who may be at risk for later reading disability?
4. Consistent with the response-to-intervention approach to identifying learning disabilities, what type of instruction and activities in language arts does Mrs. Cahill need to provide to document that research-based approaches have been tried with students having academic difficulties? Evaluate whether Mrs. Cahill's language arts activities are consistent with the response-to-intervention approach.
5. Using the guidelines discussed in the module, describe what specific types of skills or strategies Mrs. Cahill should focus on in math instruction to document that research-based approaches have been tried with students having academic difficulties.

Elementary School: Cheetahs, Lions, and Leopards

These questions refer to the case study on page 408.

1. Assume that Travis also has an intellectual disability. Speculate on the possible deficits in conceptual behavior, social skills, and practical skills that Travis may experience in the classroom.
2. If Travis has deficits in adaptive behavior but not intellectual abilities, could he be considered to have an intellectual disability? Why or why not?
3. Provide Mrs. Fratelli with specific suggestions for teaching Travis. Do these suggestions differ from recommendations you would make for teaching a nondisabled student?
4. Evaluate whether Marcela could have a specific reading disability based on the characteristic deficits of reading disability. Based on the IQ-achievement discrepancy, describe the IQ and achievement test results you would expect to find if she has a reading disability.
5. Assume that Marcela does have a specific reading disability. What recommendations would you give Mrs. Fratelli for helping Marcela improve her reading skills?

Middle School: Math Troubles

These questions refer to the case study on page 410.

1. Like Lindsey, Jessica also seems to struggle in math. Which student would you consider to have a *deficit* and which student a *delay?* Why?
2. Jessica does not have any identified disabilities. What characteristics would you look for if you suspected that she has an intellectual disability?
3. Based on the definition of intellectual disabilities discussed in the module, is it likely for Jessica to be identified with an intellectual disability as a 12-year-old?
4. Assume that Lindsey has a math disability. What types of interventions and/or services would you expect to see on her IEP? How might these differ if she were in fourth grade?
5. If Lindsey has a math disability, what strategies or teaching methods can Miss Barton use to help Lindsey succeed in math? If Jessica has an intellectual disability, how can Miss Barton address her specific cognitive needs? Is there any overlap of the teaching strategies Miss Barton would use for a math disability and those she would use for an intellectual disability?

High School: Noon Supervised Study

These questions refer to the case study on page 412.

1. Why would you expect to find few students with intellectual disabilities in a ninth-grade history class? Discuss the issue of least restrictive environment.
2. A student with a mild intellectual disability who is highly functioning is assigned to Mr. Hardy's history class. He has an IQ of 68 and a significant deficit in social skills but fewer problems with conceptual and practical skills. Discuss potential modifications Mr. Hardy may need to make to address this student's specific academic needs.
3. What characteristic reading deficits would you expect Anthony to show? How might these affect his performance in history class?
4. Discuss how Anthony's ethnicity may have played a role in his being identified as eligible for special education. How might the response-to-intervention approach prevent students from being incorrectly identified for special education?
5. At the high school level, Anthony is unlikely to receive remedial intervention in reading. Brainstorm ways Mr. Hardy can help Anthony read and understand the text in history class.

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