Figure 14.1: Example of a Solution Algorithm for Finding Equivalent Fractions

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
<th>Algorithm</th>
</tr>
</thead>
<tbody>
<tr>
<td>1: Read</td>
<td>Pupil reads problem to him or herself.</td>
<td>( \frac{9}{17} ) ( \div ) ( \frac{17}{102} )</td>
</tr>
<tr>
<td>2: Plan</td>
<td>Pupil describes general process to him or herself.</td>
<td>( \frac{9}{17} ) ( \div ) ( \frac{17}{102} )</td>
</tr>
<tr>
<td>3: Rewrite</td>
<td>Pupil rewrites problem, providing space for work.</td>
<td>( \frac{9}{17} ) ( \div ) ( \frac{17}{102} )</td>
</tr>
<tr>
<td>4: Identify known part</td>
<td>Pupil identifies part of equivalence for which numbers are known.</td>
<td>( \frac{9}{17} ) ( \div ) ( \frac{17}{102} )</td>
</tr>
<tr>
<td>5: Solve known part</td>
<td>Pupil uses prior knowledge to solve for missing numerator.</td>
<td>( \frac{9}{17} ) ( \div ) ( \frac{17}{102} )</td>
</tr>
<tr>
<td>6: Substitute</td>
<td>Pupil uses information derived in Step 5 to complete fraction in equation.</td>
<td>( \frac{9}{17} ) ( \div ) ( \frac{17}{102} )</td>
</tr>
</tbody>
</table>


with learners with disabilities (see Johnston, Whitman, & Johnson, 1981; Whitman & Johnston, 1983). Specific types of self-instruction that have been tested have also shown some promise. For example, the teacher can have students read math problems aloud (self-verbalization) before writing their answers, or they can ask students to circle the operation sign (e.g., +) and name it before attempting to solve arithmetic problems (Parsons, 1972).

More general self-regulation training also has had beneficial effects on students’ performances in arithmetic (Miller, Butler, & Lee, 1998). For example, having ado-

Demonstrating Mastery of the CEC Standards

Search the Internet for three free math software programs teachers can use in teaching math to their students. If you cannot locate any on the Internet, go to a school in your area and ask if you can review some of the math software programs they use. Design an evaluation tool based on (1) what research says about effective math instruction, and (2) the Today’s Technology Box (pages 476–477). After designing your evaluation tool and choosing three math software programs, evaluate each program (using your tool) as to its effectiveness and usefulness. Write up this information in a brief summative report. This information will be valuable to you as a teacher. Questions to think about as you progress:

- What are the necessary factors in math instruction to improve student performance that are supported by research?
- How can math instruction and curriculum encourage student independence and personal empowerment?
- What assistive technologies can be used to support the mathematical needs of individuals with learning disabilities in terms of instruction and assessment?
- How important is efficient guided practice and ongoing analysis of the individual’s learning progress to the instruction and curriculum process?
- Why should special education professionals seek to keep current with evidence-based best practices; what is available as resources for them to use with their students?
How does mathematical knowledge develop normally?
- Normally developing children learn many arithmetic operations and mathematical concepts before reaching school age. This is called informal knowledge.
- Researchers are using the term number sense to describe a conceptual structure critical for mathematical learning.
- During the school year, a student's knowledge of arithmetic operations and mathematical concepts changes gradually, partially because of aging and partially because of instruction. This is more formal knowledge.
- Generally, children progress from using more primitive strategies to using more sophisticated and efficient strategies to solve problems.
- Instruction in schools often does not match the progression from primitive to sophisticated strategies.

What mathematics problems do students with learning disabilities experience?
- About 6 to 7% of all students have problems learning arithmetic skills. Many students with learning disabilities have individual education program goals in math.
- Some students with learning disabilities have problems in both arithmetic and reading.
- Students with learning disabilities in arithmetic and mathematics may have difficulty with computation, problem solving, or both.
- For some students with learning disabilities in arithmetic and mathematics, problems are mitigated when tasks are not timed.
- When solving computational problems, students with difficulties in arithmetic make more mistakes in giving simple answers in various areas of arithmetic and sometimes recall facts more slowly than their peers.
- Students with learning disabilities also make mistakes in applying strategies or procedures, choosing inefficient strategies, and poorly using those they choose.

How are mathematics abilities assessed?
- Skills and deficits in arithmetic and mathematics are best assessed by using both tests and less formal, direct measurement methods, such as performance samples.
- Comprehensive tests of arithmetic and mathematics performance may be used to assess general ability (grade level).
- Teachers often use specific tests for more specific arithmetic and mathematics skill areas such as computation in each of the major areas (e.g., addition) and problem solving (e.g., word problems).
- Teachers can perform an error analysis, or analyze student's mistakes, to determine what to teach.
- Teachers need to be able to assess progress in arithmetic and mathematics skills and usually do so by devising informal inventories (e.g., probes to assess speed and accuracy in computation).

What interventions help students with mathematics difficulties?
- Choices of instructional methods should be based on whether the methods are effective.
- There are benefits to teaching children both fundamental computational skills (adding, subtracting, etc.) and problem-solving skills (e.g., how to think through a problem clearly, set up a strategy for solving it, execute that plan, and monitor its completion).
- Debates continue with respect to how calculators should be used. Computer software can provide the practice opportunities many students with learning disabilities need.
- Specific teaching techniques that have research support are modeling, explicitly teaching students to use strategies, reinforcing responses, and self-instruction.

REFLECTIONS ON THE CASES
1. How would you address Shannon's difficulties in mathematics?
2. How would you monitor Shannon's progress in mathematics?
3. How would you respond to Mr. Ireland's concern about the use of calculators?
how they are doing. Self-teaching also encourages students to compete against themselves rather than compare themselves to others. Teachers can use an overhead projector to guide students while they are working on the sheets. In order for students to get a visual picture of their growth, students should also chart their progress on a graph. Typically, students will have three graphs on a page—one for speed (total number completed), one for accuracy (total/number correct), and one for accuracy (total/number correct). The data should be plotted along the x-axis and the number (correct or total) along the y-axis. Connecting the dots will give students a clear picture of their progress.

**Additional Resources**


Minute math drills grades 1-2 and Minute math drills grades 3-6. Available online at www.moodles.com/

**Number Sense—Creating a Mental Number Line**

*What is it?*

Number sense is a person's comfort level with numbers. Although difficult to define, number sense is easily spotted by a teacher. Students who invent solutions to story problems, are not dependent on following the teacher's taught algorithm, or are comfortable using strategies for simple arithmetic, such as bridging ten, have a strong sense of numbers and how they relate (Gersten & Chard, 1999).

Students with learning disabilities have difficulty developing number sense on their own and frequently require specific activities designed to support the development of number sense. By teaching students strategies for basic arithmetic, such as bridging ten, or by having them engage in other number-line activities, teachers can foster the development of this critical ability. By age 6, students should have developed a schema for counting and comparing whole numbers (Fuchs, Fuchs, & Karns, 2001). Researchers have found that the mental number line is a critical concept for solving addition and subtraction problems (Gersten & Chard, 1999).

*Bridging Ten*

When applying the bridging ten strategy, the student looks at the first addend and decides, "What number do I need to add to this number to get 10?" The student then determines what is left from the second addend once the "bridge-to-ten number" is subtracted. The remaining numbers are added to 10 for the solution.

For example, a student solving the problem 7 + 6 would go about the problem in this way: 7 + 3 = 10; 6 + 3 = 9; therefore, 10 + 3 = 13. For many students, computing the problem in this way is an easier way for them to "see the problem." It is their sense of numbers that allows them to add, subtract, and basically rearrange the quantities in order to solve the problem.

*How to implement it*

To assist in the development of students' mental number line, provide students with number line activities. Gersten and Chard (1999) recommend that teachers begin with a vertical number line (similar to a thermometer). The vertical number line reinforces the concept that greater numbers are higher and smaller numbers are lower. Once students are comfortable with the vertical number line, teachers can move to traditional number lines or to serpentine-shape Candyland number lines. Students should be given multiple opportunities to problem solve using these various representations.

**Activity 1: Creating a Thermometer Number Line (grades K–1)**

1. Create a vertical number line (thermometer) and add demarcations for 20 numbers.
2. With your students, label the bottom demarcation 1 and the top demarcation 20.
3. Ask your students a series of questions relating to the number line:
   a. Where do you think the 10 should be placed? Why?
   b. Where should we place the 2?
   c. Is 18 more than 10? If so, would it go above or below the 10?
4. Continue to ask questions, using contrasting terms like more and less, above and below, and higher and lower.
5. To extend the activity, you can ask students more challenging questions such as "How many spaces are there between the 10 and 12?" or "How much more is 8 than 7?" or "How many fewer is 2 than 5?"
6. For each of these activities, students can physically place the numbers on the number line or touch the number line to count out spaces.

**Activity 2: Find the Missing Number (Adding and Subtracting) (grades 2–4)**

1. Create a series of number lines 0 through 20.
2. Leave one number blank on each number line.
3. Have each student (or student pairs) create sentences whose answer is the missing number.
4. For example, if the missing number is 15, one pair may create the number sentence 10 + 5 = 15. They can then physically demonstrate this using their number line. Other examples could include: 8 + 7 = 15, 16—1 = 15, or 1 + 14 = 15.

**Additional Resources**


Source: Kristin L. Sayaki