Math Disabilities—Rx for Diagnosis and Remediation

By Desmond Rice

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Within the past decade, teachers have become much more aware of the needs of learning-disabled students, especially in the area of reading. However, the learning-disabled student with problems in mathematics has received sparse, or at best, inadequate assistance.

Because many texts on the subject differentiate between arithmetic and mathematics, let us note their differences. *Arithmetic* involves functions that are usually concrete in nature; its symbols are usually just a step away from manipulative activities. *Mathematics,* on the other hand, is abstract and does not necessarily deal with concrete concepts. For our purposes, we will use the term *math* to include both arithmetic and mathematics.

A person capable of performing the computational skills required to solve a problem may not do so because he or she cannot understand the wording of the problem. Conversely, the student may have adequate abstraction skills but get the problem wrong because his or her computational skills are inadequate.

Getting Started. Teachers need to determine (1) Does the student actually have an academic disability in math or in reality a general learning disability? (2) Exactly what does the student do that indicates a problem? (3) What factors —physical, psychological, or environmental—might contribute to the difficulty?[1] (4) Is there a discrepancy between the student's performance in math as compared with his or her overall school performance? If so, how wide is the discrepancy?

Diagnostic Strategies

The effectiveness of a diagnostic tool is limited not only by the tool itself, but also by factors surrounding its use. Keeping this in mind, let us look at some of the strategies available.

Initially, there are three strategies that one could use for diagnosis. As a classroom teacher, you might do the following:

- devise your own informal math diagnostic tool.
- use an informal diagnostic tool already prepared.
- use a standard norm/criterion-referenced test.

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Informal Diagnostic Tools

Your own informal math diagnostic tool might contain the following elements:

1. A means to check whether the student understands what he or she is supposed to do or find out in math. This may be done by checking over assignments given and analyzing work turned in for correction.
2. The four basic operations (addition, subtraction, multiplication, and division).
3. Exercises that highlight the student's ability to read and write numbers.
4. Computation to check the student's understanding of whole numbers and fractions.
5. Problems requiring measurement of time, space, and quantity.

If you wish to use or modify an informal test already prepared by someone else, Mann and Suiter's book, *The Handbook in Diagnostic Teaching: A Learning Disabilities Approach*[2] has a very complete section on diagnosis of arithmetic problems, including the skills required at each grade level. Reisman's book, *A Guide to the Diagnostic Teaching of Arithmetic*[3] also offers invaluable information. His error analysis chart may be of particular help to the classroom teacher.

Faas has developed a series of 27 informal questions that a teacher might wish to use for diagnostic purposes. Here is a sample:

1. Can the student write the numerals?
2. Can the student count meaningfully using cardinal numbers (1, 2, 3, 4, and so on) and ordinal numbers (1st, 2nd, 3rd, 4th, and so on)?
3. Can the student identify circles, squares, triangles, and other geometric shapes?
4. Can the student identify the tallest or shortest member of a group of objects?
5. Does the student understand the one-to-one correspondence that exists between a number and a specific quantity of objects?
6. Can the student perform the operations involved in subtraction?
7. Can the student solve problems involving carrying and regrouping?
8. Does the student understand the meaning of process signs (+, −, ×, ÷, =)?
9. Can the student tell time?
10. Does the student understand the use of measurements of length, volume, and weight correctly?
11. Does the student understand the value of money and count change correctly?
12. Can the student read well enough to successfully answer story problems?[4]

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> *The learning disabled student with problems in mathematics has received sparse, or at best, inadequate assistance.*

Formal Diagnostic Tests

Formal diagnostic tools in mathematics are not as plentiful as those in the area of reading.[5] However, norm/criterion-referenced tools fit into two categories. The first group of tests includes those that would be used primarily to get an overall picture of the discrepancy between math performance and performance in other subject areas. Examples of this *general type of test* are these:

1. *Wide Range Achievement Test (WRAT).* This in an individually administered test that has a section on math. Level 1 may be used with students up to age 11; Level 2 is for those aged 12 and up. Teachers should not count on this test for an accurate diagnosis of math disabilities.[6]
2. *Peabody Individual Achievement Test (PIAT).* This individually administered test provides a bit more information to identify strengths and weaknesses by means of grade/age equivalents, percentile ranks, and standard scores. Like the WRAT, this is a good screening test, but not especially good for diagnosis.[7]

More specific tests include the following:

1. *Karner Preschool Math Inventory (KPMI).* This is an individual test covering more than 150 quantitative concepts requiring the preschool student to respond either verbally or by pointing. It takes about 20 minutes to administer.[8]
2. *Boehm Test of Basic Concepts (BTBC).* This test may be used to screen groups in grades K-2. It surveys students' understanding of directionality, quantity, size, and space. Despite its limitations, it seems to be an effective tool for identifying high-risk kindergarten students.[9]

3. *KeyMath Diagnostic Arithmetic Test.* This individual test requires about 30-40 minutes. It includes 14 subtests categorized into three major areas including content, operations, and applications. Though designed for use primarily in preschool through grade 6, recent studies have found this test to be useful in identifying problems of the secondary level learning-disabled student. This test is said to be grade-referenced rather than norm-referenced, and does not give age/grade equivalents.[10] It gets an A+ for its inclusion of behavioral objectives for each test item, which enhances its practical and remedial function. If the person evaluating the test is using the standard scores, it is suggested that one standard deviation cut-off might be appropriate in identifying the learning disabled.

4. *The Woodcock-Johnson Psycho-Educational Battery* math subtest is an individually administered test of achievement. Like the KeyMath test, it is very useful in identifying students with learning disabilities in math.[11]

5. Two widely used group tests—the *Iowa Test of Basic Skills (ITBS)* and the *California Achievement Test (CAT)*[12]—have math subtests graded for appropriate levels. Both of these tests seem to include sufficient information about a particular student's performance on each objective. When dealing with large groups, benefits of these two tests could outweigh the advantages of the KeyMath test mentioned above because of their ability—among other things—to show intra- and inter-student discrepancies.

6. *Mathematics Concepts Inventory* is a criterion-referenced test recommended as a screening device especially for learning-disabled adolescents, though it was constructed for individuals 18 months to 13 years of age. It is useful in determining areas of strength and weakness of each student.[13]

Materials and Methods for Remediation

Having identified the student who has a learning disability in mathematics, the next step is to set in motion the Rx for remediation. While in some instances the teacher may have little trouble prescribing and implementing appropriate remediation, in many cases the problem will be one of knowing where to start. Keeping in mind the risk of oversimplifying a complex issue, I would like to suggest that remediation be examined from two vantage points. First, we will look at some activities that might correspond to the developmental level in mathematical skills of the student; then we will suggest activities that may help to remediate the more general effects of LD correlates.

While in some instances the teacher may have little trouble prescribing and implementing appropriate remediation, in many cases the problem will be one of knowing where to start.

Activities corresponding to the mathematical developmental stage of the student progress through three levels.[14] The mastery of lower-level skill should precede the inclusion of higher-level activities.

Manipulative State

At this stage the student can deal only with the here and now, with things that can be touched and moved. The child at this level should be encouraged to put things together and take them apart to familiarize himself or herself with addition and subtraction before going on to study symbols.[15]

Grouping and sorting objects according to shape, color, and quantity help to develop the idea of set and one-to-one correspondence. The idea of space can be taught by having the student fill an empty milk carton with sand and then pouring a similar carton of sand into a larger flat box and asking the child which holds more.

Activities should be introduced involving directionality by the use of such games as "Simon Says," in which terms such as *left, right,*

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that by taking sticks like 3 and 4 and putting them side by side, the student gets all the multiples of ¾. (See Illustration No. 3.)

Rewards

Whenever I have students who work slowly or fail to turn in their assignments, I give them reduced assignments in a folder. Each day they complete the required problems I give them 10 points until they have accumulated 100 points. At that time they receive a previously agreed upon reward, such as a sticker, free day, or a pencil. I have found that stickers are an excellent source of motivation and cost little compared to the results they accomplish. Sometimes I enlist parental help in providing some of the rewards if there is a need for more tangible reinforcement. Often a student needs these added incentives for only a few months.

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I have found that file-folder activities are my best resource since they can easily be stored and pulled out for individual students who are having difficulty with a specific math concept. (See Illustration No. 4.)

Listed below are some sources for materials I have found to be practical and easy to use. You can develop similar resource materials yourself. It is not necessary to do this all at once. Choose one math concept with which your students are having difficulty and develop resources to enrich your instruction. Soon you will have a vast supply of materials from which to choose just the activity needed to motivate your students. □

Resources

Centers Galore
1411 Mill Street
Education Center
Greensboro, NC 27408

Good Apple, Inc.
Box 299
Carthage, IL 62321

Mathematics in Michigan
Volume XIX, No. 5
(June, 1980)

Solving Problems Kids Care About (1981)
Goodyear Publishing Co. Inc.
1640 Fifth St.
Santa Monica, CA 90401

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before, after, between, up, and *down* are employed.

Numbers can be matched with their word equivalents (*1* with *one*).

Telling time can be taught by showing the actual times for class activities on a large clock with moveable hands. At noon the teacher tells the student that lunch time begins at 12:00 and ends at 12:30, showing where the hands of the clock will be at both times and explaining that this period is 30 minutes. The teacher then compares this length of time with that of some activity that takes less time, thus helping to develop a sense of passage of time.

Before ever learning fractions, the student can be given cardboard or flannel shapes, with directions to cut the shapes in halves, quarters, and so on; afterward, the student is told to reassemble the shapes.[16]

Other helpful manipulative materials include Montessori materials, Cuisenaire rods, and other items mentioned in the box.[17]

Concrete Activities

The observant teacher may find that the student does fine at the manipulative level, but needs help at the next level, which requires the student to deal with concepts rather than objects. At this level, figures and numbers are used to perform basic computations.

Unlike the reading teacher, who spends so much time training students to read from left to right, the math teacher must constantly reverse this instruction by giving exercises progressing from right to left. In some cases this difference may need to be pointed out.

The student should be taught that symbols such as + mean the same as *to add,* and that multiplication is really a quick way of adding sets of numbers. Although the mind of the young elementary student is still very stimulus bound, he or she can recognize that symbols allow for greater freedom of thinking. Therefore, activities involving the use of tables can be speeded up if one memorizes the times tables. Time-lines of the day's activities, use of graph paper for scaled drawings, or reference to a checkerboard or tiled floor to represent a city block help develop spatial skills.

Even if a student has learned his or her times tables, he or she may not understand the concept of "carrying over" or "borrowing" when dealing with two- or three-digit numbers. If this is a problem, the student may need to practice with activities at the manipulative stage before returning to the concrete stage.

Abstract Stage

Gearheart describes this as the stage where the student is removed "from the world of real objects to hypothesize, and to relate mental operations to one another without concrete reference."[18] At this stage, students should have the greatest freedom of thinking, using their computational skills only as a means of problem solving.

The student may have adequate abstraction skills but get the problem wrong because his or her computational skills are inadequate.

One means of helping students attain this stage is to have them explain out loud what they are doing and why. If they have turned in an assignment in which several problems are wrong, they can be asked to go over the paper orally with the teacher, explaining each written step. Students who have problems at this level often omit steps because they do not seem to realize their significance or importance. Little harm will be done if the teacher initially insists on having these steps included in the child's written work until it is clear that the student thoroughly understands the operation.

Alley and Deshler[19] have adapted a ten-step procedure for helping the learning-disabled adolescent solve word problems. A summary of each follows:

1. The student is made aware of a clearly defined problem.
2. Goals are set to solve the problem.
3. Words that lend themselves to quantitative terms in the problem are underlined.
4. The appropriate formulae, rules, and algorithms are identified and selected to use in solving the problem.
5. Numerical values are fitted into the formula or law used.
6. The number sentences are then written.
7. The mathematical procedures

Materials for Remediation

Cuisenaire Rods	abacus
geometric shapes	thermometers
clocks	clock replicas
calendar	scale rulers
fraction parts	chips (discs) for counting
calculators	measuring cups
containers of different liquid measures	menus
squared material	compass
protractor	place value chart
scale rulers (varying size)	ads and sales circulars
number line	pocket charts
train and bus schedules	

are selected.

8. Calculations are done.

9. The solutions are written in quantitative math language.

10. The quantitative solution is translated back into the semantic context of the original word problem.

The source for several successful instructional strategies for problem solving in the elementary grades are listed in footnote 20 at the end of the article.

Activities to Remediate LD Correlates[21]

A classroom teacher can use a number of strategies to help a student who has other learning disabilities that affect his or her functioning in mathematics skills. The chart below is meant ot stimulate your mind in providing help in these areas.

In conclusion, some points to remember:

1. Anticipate and design mathematics lessons to provide for different learning styles.
2. Enrich your lessons to motivate students to complete the required objectives. Make sure that materials and media are available to facilitate this.
3. Remember that not all objectives for every unit need to be met by every student.
4. Carefully monitor progress to ensure that growth is, in fact, occurring.

The Rx for remediation for each student will be effective only if it meets the child's special needs in mathematics. Consequently, the skillful teacher will evaluate each child carefully to achieve early diagnosis and rapid implementation of remediation techniques. □

If the student has	Try This
memory problems	
visual	give a motor/color clue, color process signs; give problems orally.
auditory	stress visual representations; show on board what you explain.
concentration problems	
guessing answers	give a few examples/problems at one time; encourage "thinking" time rather than speed.
doesn't complete work	give fewer items; use cardboard window to concentrate on one item.
repetition writing numbers	structure assignment to discourage repetition; write number once.
repeating a computation	alternate computational operations or type of response.
visual-motor problems	
writing	keep writing to a minimum; avoid copying problems from the board/book; use a number stamp for answers.
erasing	though only a minor problem, show students how to erase neatly—this reassures them that mistakes can be undone.
visual-spatial problems	
maintaining columns	use ruled paper with lines arranged vertically; use heavy colored lines to help place values.

FOOTNOTES

[1] Samuel A. Kirk and James J. Gallagher, *Educating Exceptional Children,* 4th edition (Boston: Houghton Mifflin Co., 1983), p. 385.

[2] Philip H. Mann and Patricia Suiter, *Handbook in Diagnostic Teaching: A Learning Disabilities Approach* (Boston: Allyn & Bacon, Inc., 1974).

[3] Fredricka K. Reisman, *A Guide to the Diagnostic Teaching of Arithmetic* (Columbus, Ohio: Charles E. Merrill Publishing Co., 1972).

[4] Larry A. Faas, *Children With Learning Problems: A Handbook for Teachers* (Boston: Houghton Mifflin Co., 1980), pp. 261-308.

[5] August J. Mauser, *Assessing the Learning Disabled: Selected Instruments,* 2nd ed. (San Rafael, Calif.: Academic Therapy Publications, 1977), pp. 77-79.

[6] Oscar K. Buros, Ed., *Seventh Mental Measurement Yearbook* (Highland Park, New Jersey: Gryphon Press, 1978); Joseph F. Jastak, Sidney W. Bijou, and Sarah F. Jastak, *Wide Range Achievement Test* (Wilmington, Delaware: Jastak Associates, Inc., 1978).

[7] Lloyd Dunn and Frederick C. Markwardt, Jr., *Peabody Individual Achievement Test* (Circle Pines, Minn.: American Guidance Service, 1970); Buros, *Op. cit.*

[8] R. E. Karner, *Karner Preschool Math Inventory* (Boston: Teaching Resources Corporation, 1976).

[9] M. C. Beech, "Concurrent Validity of the Boehm Test of Basic Concepts," *Learning Disabilities Quarterly,* 4:1 (July, 1981), pp. 53-60; A. E. Boehm, *Boehm Test of Basic Concepts* (New York: Psychological Corporation, 1970).

[10] Michael J. Breen, Joanne Lehman, and Mary Carlson, "Achievement Correlates of the Woodcock-Johnson Reading and Mathematics Subtests, KeyMath, and Woodcock Reading in an Elementary Aged Learning Disabled Population," *Journal of Learning Disabilities,* 17:5 (May, 1984), pp. 258-261.

[11] Richard W. Woodcock and M. B. Johnson, *Woodcock-Johnson Psycho-Educational Battery* (Boston: Teaching Resources Corp., 1977); Price, *Op. cit.*

[12] *California Achievement Test,* Forms C and D (Monterey, California: CTB-McGraw Hill, 1978); *Iowa Test of Basic Skills,* Form 7 (Chicago: The Riverside Publishing Co., 1979).

[13] J. F. Cawley, "An Instructional Design in Mathematics," in *Teaching the Learning-Disabled Adolescent,* L. Mann, L. Goodman, and J. Lee Wiederhold, ed. (Boston: Houghton Mifflin Co., 1978).

[14] Bill R. Gearheart, *Teaching the Learning Disabled: A Combined Task-Process Approach* (St. Louis: The C. V. Mosby Co., 1976), pp. 119-121.

[15] Bill R. Gearheart and Mel W. Weishahn, *The Exceptional Child in the Regular Classroom* (St. Louis: Times Mirror/Mosby College Publishing, 1984), pp. 231-232.

[16] Larry Faas, *Learning Disabilities: A Competency Based Approach,* 2nd ed. (Boston: Houghton Mifflin Co., 1981), pp. 383-401; Gearheart and Weishahn, *Op. cit.*

[17] Ernest Siegel and Ruth F. Gold, *Educating the Learning Disabled* (New York: Macmillan Publishing Co., Inc., 1982), pp. 237-258.

[18] Gearheart, *Op. cit.*

[19] Gordon Alley and Donald Deshler, *Teaching the Learning Disabled Adolescent: Strategies and Methods* (Denver: Love Publishing Co., 1979), pp. 163, 164.

[20] Craig Darch, Doug Carnine, and Russell Gersten, "Explicit Instruction in Mathematics Problem Solving," *Journal of Educational Research,* 77:6 (July/August, 1984), pp. 351-359.

[21] Gearheart, *Op. cit.*