

Preparing Teachers to Teach Mathematics to Students with Learning Disabilities

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In the US there has been a dramatic increase in the mathematics expectations for students with learning disabilities (LD). This paper describes how the University of Alabama has endeavored to meet this challenge by incorporating into its elementary and secondary education courses activities to help prepare teachers to teach mathematics to students with LD.

Introduction

In the US, more and more students with learning disabilities (LD) are now being included in the general education classroom (a process known as “inclusion”) (Kavale, 2002). The inclusion movement requires that instruction within the general education classroom be adapted to fit the needs of students with LD (Gartner & Lipsky, 1987; Will, 1986). Concurrent with the growth of inclusion, many US students are now required to pass a high school algebra and geometry course as well as a graduation exam to receive a high school diploma. However, this poses a significant challenge for students with LD particularly since students age 9 – 14 with LD often show very little progress in their mathematical abilities leading up to high school. On average, students with LD progress one year for each two years in school, usually reaching a plateau around seventh grade. (Cawley & Miller, 1989) Unfortunately, many general education mathematics teachers are unprepared to adequately meet the needs of students with LD in their classrooms (Daane, Beirne-Smith, & Latham, 2000; D’Alonzo, Giordano, & Vanleeuwen, 1997). This paper describes how the University of Alabama has endeavored to meet this challenge by incorporating into its elementary and secondary education courses activities to help prepare teachers to teach mathematics to students with LD.

What do mathematics teachers need to know about LD?

In preparing future teachers to teach mathematics to students with LD, it is important that they understand how LD is defined and how it affects students learning of mathematics. In this case, an information-processing model is used (Sliva, 2004). Students are also taught how to recognize the symptoms of LD and strategies that have been shown to be effective in teaching mathematics to students with LD.

Defining LD in Mathematics

Having a learning disability in mathematics is often referred to as *Dyscalculia*. Although definitions of dyscalculia vary, the Diagnostic and Statistical Manual of Mental Disorders (4th Edition, American Psychiatric Association) states that the *Diagnostic Criteria for Mathematics Disorder* (or dyscalculia) includes:

- Mathematical ability, as measured by individually administered standardized tests, is substantially below that expected given the person’s chronological age, measured intelligence, and age-appropriate education.
- The math difficulties significantly interfere with academic achievement or activities of daily living that require mathematical ability.
- If a sensory deficit is present, the difficulties in mathematics ability are in excess of those usually associated with it.

It is estimated that the prevalence of Dyscalculia in the general population is 5-8%. (Adler, 2001) Although dyscalculia implies a specific learning difficulty in mathematics, this does not mean that students with dyscalculia will have problems with all areas of mathematics.

Information-Processing

One of the most important aspects of teaching mathematics to students with LD is to have a model of how the mind works. The most common model used in understanding the thinking of students with LD is *Information-Processing* (Swanson, 1987). As Sliva (2004) notes, “the information processing model is an attempt to describe how sensory input is perceived, transformed, reduced, elaborated, stored, retrieved,

and used ... A primary focus of this approach is on memory (the storage and retrieval of information).” (p. 16)

With respect to the information processing model, teachers should understand deficiencies in the following areas: (a) visual-spatial, (b) auditory, (c) motor, (d) memory, and (e) attention. Language, cognition / metacognition, and maintaining a positive attitude also affect the success of students with LD. (Sliva, 2004)

Visual-Spatial Processing

This involves difficulties with how visual or spatial information is interpreted or processed by the brain. A few of the common problems students may experience with visual-spatial processing difficulties include confusing right from left and top from bottom, difficulty writing in a straight line across paper, not noticing differences in size and shape of symbols (e.g., fractions, exponents), problems with sequencing and organizing information, mixing up different part of tasks, copying symbols down incorrectly, and reversing digits.

Auditory Processing

This involves an individual’s ability to analyze, interpret and process information obtained through the ear. It does not apply to what is received by the eardrum or to deafness or being hard of hearing. Difficulties can include hearing a pattern incorrectly, deciphering numbers spoken such as thirty and thirteen, or the inability to count in a sequence.

Motor Processing

This involves the ability to use and coordinate large and small body muscles in order to move and manipulate objects. Students with motor skill difficulties have problems writing in small places because they tend to write rather large, have difficulty cutting and pasting, pace, neatness, and copying.

Memory

This involves the ability to store and remember information. A student with an LD may have difficulty placing information in short term memory and retrieving it from long term memory. This can lead to students being able to understand a new task in class, but be unable to remember how to do the task once s/he leaves class, forget steps in algorithms such as long division, have a hard time solving multi-step word problems, or have difficulty recalling which of multiple meanings that might exist for a mathematics term or symbol.

Attention Deficits

Students with attention deficits generally have developmentally inappropriate levels of inattention. Students may give the impression that they are not listening or have not heard what has been said, turn in work that is often messy and performed carelessly and impulsively. These students also have difficulty with paying attention to steps in algorithms or problem solving.

Students with learning disabilities in mathematics can also have problems in language, cognition / metacognition, and maintaining a positive attitude.

Language Disabilities

Language disabilities can affect learning mathematics by making it difficult to complete such tasks as rapid oral drills or explaining why a problem is solved in a certain manner. Similarly, students can have difficulty relating words to meaning, understanding mathematical concepts such as first and greater than, with words that have multiple meanings (sum, times, difference), following directions, and solving word problems.

Cognition and Metacognition

Cognition involves the ability to comprehend what is seen and heard including inferring information from social cues and body language. Metacognition emphasizes self-awareness of how one approaches a task in order to plan and monitor progress. (Garafalo & Lester, 1985) Students with LD can have difficulty in identifying and selecting appropriate strategies, organizing information, monitoring problem-solving processes, evaluating problems for accuracy, and generalizing strategies to appropriate situations.

Maintaining a Positive Attitude Toward Mathematics

In addition to the above, students with LD often have difficulty maintaining a positive attitude. This is important since one’s attitude toward mathematics can greatly affect one’s ability to learn mathematics

successfully (McLeod, 1988). Students who develop negative attitudes toward mathematics need positive encouragement and opportunities to experience success.

Other Common Symptoms of LD in Mathematics

The following are additional symptoms students with Dyscalculia might exhibit. It is unlikely that a student will have all of these symptoms; and, it is likely that many students will have some of these problems even if they do not have an LD.

- Difficulty connecting a mathematical idea with a real-world representation
- Poor long term memory; will know math facts one day, not remember the next
- Trouble organizing things in a logical way
- Trouble recognizing groups and patterns
- Trouble comparing and contrasting
- Not familiar with mathematics vocabulary
- Difficulty with measuring things
- Avoiding games that require strategy
- Trouble with the concept of time: is often late, doesn't remember schedules, can't approximate how long a task will take, confused on past/future events
- Difficulty estimating
- Difficulty learning mathematics concepts beyond basic facts
- Difficulty finding different approaches to solving a problem
- Trouble with visualizing patterns
- Problems identifying critical information needed in problem solving
- Good with general mathematics concepts, but frustrated when specific computation or organization skills need to be used.
- Poor sense of direction, confusion on left/right orientation

Strategies for Teaching Students with LD

In many cases, students with LD in mathematics will not have difficulty with all areas of information processing. In some cases, a student will do fine with visual processing, but have difficulty with auditory processing; or a student may excel in memory, but not motor skills. Therefore, when teaching students with LD, it is important to identify a student's strengths and weaknesses and understand how s/he learns best. Also, while some instructional strategies have been found to be effective for students with LD, research has shown that many of these instructional strategies are successful for all students, regardless of whether or not they have an LD (Vergason & Anderegg, 1991; Friend & Cook, 1992).

The following are a few strategies that can be used depending on a student's area of difficulty.

Visual Processing Strategies: Provide tests and handouts that are uncluttered and have extra writing space below each problem; use larger fonts; use color; provide lined or graph paper; use manipulatives or pictorial representations of concepts to help students visually understand mathematical ideas.

Auditory Processing Strategies: Tape class lectures so students can hear them again at home; stress and use appropriate vocabulary consistently; use a slower rate of speech and use changes in tone and pitch to keep students interested.

Motor Processing Strategies: Assess the student orally if a lack of motor skills interferes with an accurate assessment of the student's knowledge; provide photocopies of class notes or tape-record the lecture; use graph or lined paper to help students organize their writing.

Memory Strategies: To aid in short-term memory, use rehearsal, chunking, and elaboration. For aid in long-term memory, use manipulatives, multiple representations, and mnemonics; also, use graphic organizers or concept maps to visually illustrate mathematical connections, to organize information, and to tie new knowledge to previously stored information.

Attention Deficit Strategies: Seat students away from distractions; maintain more frequent eye contact; use clear, consistent classroom routines and transitions; provide a structured environment with few distractions

Additional Instructional Strategies for Students with LD

Other general instructional strategies that are successful for teaching mathematics to students with LD include:

- Assign students to solve problems in small groups in order to encourage discussion
- Model for students a step-by-step strategy they can use to complete an exercise or assignment
- Use probing questions (e.g., “Can you explain to me how you solved that problem?” “Is your answer reasonable given that question?”)
- Use real-world (authentic) applications that connect mathematics to students’ interests
- When introducing a new mathematics concept, teach students how to use organizing strategies (e.g. diagrams, charts, tables)
- Seat students in preferential locations in the classroom (e.g., a student with auditory or visual processing difficulties to the front of the room or nearer to the teacher)
- Give rubrics to students before an assignment to help them evaluate their own work
- Provide student with more time on quizzes, tests, and assignments
- Teach students note-taking strategies
- Provide specific verbal or written feedback to students on their academic progress
- Encourage students to explain verbally or in writing the strategies they used when solving a problem
- Simplify directions on assignments / lectures and provide directions both verbally and visually
- Reduce the number of assigned problems
- Use rhythm, music, acting out, writing, and drawing to help learn math facts
- Allow calculator use for basic operations so the student can focus on problem solving
- Explicitly teach problem solving strategies
- Use analogies and metaphors
- Break down tasks into smaller, more manageable parts

Field Experiences and Additional Activities for Prospective Teachers

In addition to learning the information above, it is important that prospective teachers have opportunities to interact with students with LD. Therefore, students are assigned field experiences where they perform activities that specifically focus on students with LD. Some of these include:

- Interviewing general and special education teachers about their experiences teaching students with LD.
- Conduct and analyze clinical interviews of students with LD
- Observe and analyze mathematics lessons focusing on the experiences of students with LD
- Teach a lesson with particular attention to meeting the needs of students with LD
- Write a case study of a student with LD documenting their experiences as a mathematics student (including shadowing a student with LD for an entire school day)

Students are also required to develop lessons that are accessible to students with LD; redesign activities and tests taking into account a student’s disability; analyze the work of students with LD and identify the mathematical difficulties they are having; discuss strategies that can be used to accommodate the needs of a particular student or modify lessons / activities for a student. To help facilitate the experiences described above, the professional development materials developed by Sliva (2004) and Brodesky, Gross, McTigue, and Tierney (2004) are used.

Summary

Teaching mathematics to students with LD poses a significant challenge. The University of Alabama has responded to this challenge by incorporating into its elementary and secondary mathematics program activities and experiences to help future teachers of mathematics teach students with LD. The approach is based on the believe that by becoming more aware of how specific disabilities interfere with learning mathematics, by learning to use instructional strategies that can mitigate these difficulties, and by having greater experience teaching students with LD early in their career, mathematics teachers can improve their ability to teach students with LD.

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