# Reaching All Students through Effective Mathematics Instruction

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SPED 644

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December 4, 2005

Mathematics is a subject that is seen by some as too difficult. Many people get overwhelmed by the numbers, variables, operations, formulas, and concepts that make up this content area. There are even some individuals who suffer from math anxiety, meaning that the task of completing a math assignment or taking a test in this area may cause them to become anxious or stressed. Despite the problems that many people face in dealing with math, it can not be disputed that it is an important subject area. This can be linked to the fact that there are standards being set by states for students to be able to show through the use of a standardized test that they have obtained the math skills required for a specific subject or grade level.

In 1989, the National Council of Teachers of Mathematics (NCTM) set standards which caused much controversy with general and special educators (Woodward & Montague, 2002). These standards stated that all students' math skills and levels of understanding needed to be increased as well as their ability to be able to participate in discussions about math as they were engaged in solving challenging problems. With these standards in mind, teachers were to engage students in thought-provoking conversations about math that required them to think in new

ways. However, the major problem with these standards was they did not seem to take into account how teachers were to help students with varying and diverse needs meet the high standards set at the national level. There seemed to be no attention given to individuals with disabilities in the setting of these standards (Woodward & Montague, 2002).

In response to this trend, most states, by 2001, had developed new standards in terms of the content or curriculum in mathematics (Woodward & Montague, 2002). Yet, there is still work to be done in terms of mathematics instruction that meets the needs of all students. With the push for the inclusion of students with disabilities in the general education classroom, it is becoming increasingly important that effective instruction is being provided. The purpose of this review is to address the revisions that are necessary in current mathematics instruction, as well as the importance of instruction that meets the needs of all students. Strategies that will be helpful to students experiencing difficulties in math will also be discussed.

## Revisions Needed in Current Math Instruction

According to Woodward and Montague (2002), there are six principles that must be addressed when discussing revising instruction in mathematics: 1) all students should

be held to the same expectations and be provided with instructional support; 2) the curriculum should be articulated and coordinated in a clear, precise manner; 3) teaching should be done in an effective way showing an understanding of what students know while still providing them with opportunities to be challenged; 4) teachers need to think about how students actively acquire and build their math knowledge; 5) useful and supportive assessments should be used; and 6) teachers need to come up with ways to use technology in math instruction (Woodward & Montague, 2002). As the National Council of Teachers of Mathematics stated, in 1989, it is crucial for teachers to find tasks that allow students "to explore, to guess, and even to make and correct errors so they can gain confidence in their ability to solve complex problems" (Bottge, 1999, p. 81). It is the job of the teacher to help students with understanding the key ideas and concepts that are the foundation of mathematics, instead of just focusing on simply having them memorize rules and procedures (Butler, Beckingham, & Lauscher, 2005).

Teachers need to realize that "mathematics is not only taught because it is useful. It should be a source of delight and wonder, offering pupils intellectual excitement

and an appreciation of its essential creativity" (Cross, 2004, p. 4). However, Bottge (1999), noted that many teachers hold the following beliefs: 1) math is a subject composed of rules that need to be remembered; 2) algorithms have to be used to solve computation problems; 3) there is always only one right answer; and 4) a person has to be a genius to use mathematics (Bottge, 1999). There is a definite need for many teachers to re-examine the methods they are using to teach math to students, especially those with disabilities (Woodward & Montague, 2002).

Some believe the goal in mathematics instruction should be for learners to acquire an understanding of math by constructing it on their own instead of just getting it directly from the teacher (Woodward & Montague, 2002). Many special education researchers have noted that, while traditional approaches to instruction, such as direct instruction, are useful in teaching content that is factual, it may not be as effective in teaching students reasoning and problem-solving skills. However, those in defense of direct instruction have stated that it is the best method of instruction for students with disabilities. Others argue that both direct instruction and the constructivist approach can be useful to these students

(Woodward & Montague, 2002).

Whether direct instruction or the constructivist approach is used, it has been found that most special education classes focus on teaching students the traditional algorithms for doing the four basic operations (Woodward & Montague, 2002). Unfortunately many students learn these rules without any real understanding of what they mean. Therefore spending vast amounts of time on this type of instruction, where the focus is on computational drill and practice, may not be useful for students with disabilities. Teachers should instead spend time instructing students on how to use the calculator in an efficient manner; this in turn would provide more time to be spent working with these students in the areas of problem-solving and analysis, rather than drill and practice (Woodward & Montague, 2002).

In their review of research, Fuchs and Fuchs (2005) discussed studies done that made observations of the instruction of basic facts and one-step word problems at the first or second grade level. According to the studies, instruction at either of these levels cannot be said to prepare students for real-world mathematical problem-solving. The emphasis on basic facts and one-step word

problems at this level can be linked to the belief that skills in math are sequenced in a hierarchy, meaning that one must master those skills seen as fundamental before they can be taught to solve real-world mathematical problems that are more complex. This type of thinking leaves many students with disabilities behind because many reach this stage in the sequence too late in their school years or never reach it at all, because they never sufficiently master the necessary fundamental skills (Fuchs & Fuchs, 2005). Yet many teachers will not teach content that is difficult, and often more relevant, until students have been able to master material that is easier. They also tend to make the mistake of focusing on the weaknesses of the students instead of their strengths (Bottge, 1999).

In an attempt to combat this problem in math instruction, the Center on Accelerating Student Learning (CASL) (Fuchs & Fuchs, 2005) has set the goal to begin to give all students instruction in solving real-life math problems in the third grade, even those who may not have mastered the prerequisite skills. CASL centers on three themes: 1) developing all students' ability to apply their knowledge of what they have been taught in order to solve new problems; 2) keeping interventions feasible through the

use of manuals with scripts so that they can be used by all teachers; and 3) addressing the varying needs of students with disabilities by using many components of instruction (Fuchs & Fuchs, 2005). It is important to realize that in order for teachers to use the work from CASL in an appropriate manner, they will need to come to terms with their perceptions of their students and their abilities, their knowledge of how people learn, and their thoughts of mathematics and its purpose in the lives of their students. As stated by Lingard:

> I don't expect, and I don't want, all children to find mathematics an engrossing study, one that they want to devote themselves to either in school or in their lives. Only a few will find mathematics seductive enough to sustain a long term engagement. But I would hope that all children could experience at a few moments in their career...the power and excitement of mathematics...so that at the end of their formal education they at least know what it is like and whether it is an activity that has a place in their future (cited in Cross, 2004, p. 6).

## Importance of Effective Mathematics Instruction

So what is the best way to use math instruction time

with students? According to Ball (2005), "it is clearly important for all students to be provided with appropriate opportunities to learn to think mathematically and to be able to demonstrate their understanding of mathematical concepts" (p. 1). Therefore, time should be spent focusing on more than simply teaching students to perform basic calculations. Teachers need to prepare students of all abilities for the workplace and in becoming critical thinkers by using their higher order thinking skills (Ball, 2005).

Students experience difficulties in math for many different reasons. In today's schools, although five percent of children have some sort of disability in mathematics, this subject has been researched far less than reading disabilities. Thus, more research is necessary because math is such a critical life skill in terms of being successful in school, on the job, and managing income (Fuchs & Fuchs, 2005). Research has found that students with learning disabilities have attitudes that are more negative towards mathematics, which may lead to difficulties in this area (Butler et al., 2005). However, it is the job of the teacher to help students gain confidence in their skills by using material that is

motivational; this will in turn aid them in being able to use their math knowledge in an effective manner (Ball, 2005). As Ball (2005) states, "it is how students are taught mathematics rather than what they are taught that is the key to helping young people develop into adults who are interested in, confident about, and competent at mathematics" (p. 1).

All students, no matter what their level of ability, need to be able to solve the types of problems related to math that they will inevitably face in the community and in future job settings. There is evidence to show that the math skills of children in America, in terms of being able to solve problems, are far from adequate (Bottge, 1999). For example, a study done in 1992 by the National Assessment of Educational Progress, found that only approximately 59% of students in the twelfth grade could solve problems that required more than the computing of whole numbers (cited in Bottge, 1999). Students with disabilities have been found to have skills that are even less adequate. Sixteen to seventeen year olds with learning disabilities have been found to only be at the fifth grade level in the areas of computing and application, and the perform two grades below what is expected for them to be

able to do (Bottge, 1999).

It should be noted that math disabilities are often comorbid with disabilities in reading and attention deficit/hyperactivity disorder (ADHD). Students with math difficulties that are not identified early may not acquire the skills necessary to be successful on assessments or in their classes. Those found early could receive intensive instruction to improve their basic arithmetic and number sense skills (e.g., being able to count, discriminate between different quantities) and also other areas of number sense could be addressed as well such as, determining place values, rounding numbers, and being able to decide if an answer is reasonable (Bryant, 2005).

According to Fuchs and Fuchs (2001), math difficulties could be prevented and students could be provided intervention at three levels: primary, secondary, and tertiary. At the primary level, instruction would be used that was beneficial to all students. The secondary level would address necessary adaptations and their feasibility, and the tertiary level would provide intense and individualized instruction, and include any needed resources. It is important to realize that this type of intervention would be similar to the response to

intervention model that is used to aid those students with reading difficulties at an early age (Fuchs & Fuchs, 2001).

Students with disabilities should be provided instruction in solving real-life math problems because research has found that those from eight to nine can benefit from this type of instruction, even if they do not have good fundamental math skills (Fuchs & Fuchs, 2005). These students need to have a strong foundation in problem-solving rules, but this does not mean it is a skill that has to be mastered before they receive this type of instruction. Research has also found that students need to be taught how to make connections between new problems and those they have solved before; linking the components of instruction has been found to be beneficial as well. In terms of whole-class and small-group instruction, it has been noted that there is value in both; but in small-group instruction teachers can better monitor student behavior and learning (Fuchs & Fuchs, 2005).

**Strategies to Aid Students with Math Difficulties**

According to Furner, Yahya, and Duffy (2005), there are twenty strategies that have proven to be the most effective in meeting the needs of all students (See Table 1). These strategies provide students experiencing

difficulties in mathematics a means to learn vocabulary, apply problems to their every day lives, solve problems, and to make concepts easier (Furner et al., 2005).

Another strategy that teachers can use to assist students with mathematics instruction is Strategic Content Learning (SCL), which is an instructional model that has been shown to be effective in promoting self-regulated learning (Butler et al., 2005). One principle behind SCL is that self-regulated learning should be included in the curriculum being taught instead of making it separate. Also, teachers need to realize that the way students interpret information has a major impact on what they learn; and students need to be guided in constructing their own meaning in concepts. It is critical that "teachers act as facilitators of students' active problem-solving not just as providers of information" (Butler et al., 2005, p. 160).

Students should realize that their learning and solving of problems is in pursuit of a goal, whether it is to be able to solve a specific type of problem or to apply a novel concept (Butler et al., 2005).

Strategic questions are a significant aspect of the principles of SCL because they are "used intentionally for

assessment purposes and/or to mediate student learning" (Butler et al., 2005, p. 161). With strategic questions, students may be asked the meaning of a concept or to discuss how to solve a particular problem. These questions can also be used in aiding students in self-regulating their learning. Students may ask themselves how well a specific problem-solving strategy is working or what they would do differently to solve the problem. Teachers should guide students through the process of self-regulation through the use of cues until they are ready to be more independent (Butler et al., 2005).

One study (Butler et al., 2005) looked at how SCL could be used to promote self-regulated learning with eighth grade math students. It was determined that when self-regulated learning was included into math lessons, students did better. However, teachers need to provide support that is explicit and systematic to students so that they are able to complete class work successfully. Research also found that the principles of Strategic Content Learning could be used to meet the individual needs of students because it allows for the "co-construction of strategies with individual students targeting their specific learning needs" (Butler et al., 2005, p. 171).

## Discussion

As one can tell, it is essential that students are provided with effective mathematics instruction that meets their needs. Teachers need to move beyond simply teaching facts, and focus more attention on problem-solving. It is essential that students know how to deal with the real-life problems that involve mathematics that they will come across in their daily lives. Thus, teachers need to start as early as elementary school in teaching students how to approach these types of problems and provide them with strategies.

### *Recommendations*

As a high school special education teacher that teaches math, I have found that my students are more successful when they are provided with specific strategies to use for solving problems. I have taught my students how to self-regulate their learning and I have seen major improvements from the beginning of the school year. My students have gone from being unsure of how to solve math problems and lacking confidence in themselves, to being able to use their prior knowledge to solve new problems and having confidence in their abilities.

I credit the improvement that I have seen in my

students to my use of material that they are able to apply to their daily lives and the fact that I always teach new material in terms of what they have already learned. Also, it has been vital to me that my students learn how to use the calculator in an effective manner. Yet, I strongly believe that my students have been helped the most through my use of lessons that are interesting and provide opportunities for all of my students to experience success, because it has eased much of their anxiety towards mathematics. In my opinion, this is the most beneficial to students because as they become more comfortable with math, they are able to become better problem-solvers.

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Table 1: **Twenty Strategies to Aid Students with Math Difficulties**

1) Incorporate manipulatives and hands-on activities into vocabulary instruction.

2) Link math problems and vocabulary to what students already know and their background.

3) Apply problems to situations that students experience in their daily lives. (Examples: using restaurant menus, coupons, or advertisements to teach students specific problem-solving skills)

4) Use manipulatives in a concrete manner so easier for students to move towards more abstract problems.

5) Encourage students to draw pictures for visual representations of word problems, and to help them process the information in a problem before providing a response verbally.

6) Use computer or cooperative learning activities to allow students with disabilities to work with those without disabilities.

7) Use think-aloud techniques with students which allow them to explain orally their solving of word problems.

8) Students can create their own word problems for review activities.

9) Use directions that are clear, concise and explain them fully, being sure to emphasize key terms.

10) Make students aware of the steps needed to solve a problem and encourage their use. (Steps in the problem-solving process: read the problem and figure out what
needs to be done, determine the strategy necessary to solve the problem, use the strategy, and check answer)

Table 1

11) Be aware that math notations may not be universal to all. (Example: student with a visual perception problem may not be able to tell the difference between a comma and a decimal)

12) Form cooperative learning groups that are heterogeneous.

13) Make connections to other subject areas when teaching math.

14) Make connections to the culture of students.

15) Teach students to rewrite problems using terms that are less complex.

16) Use Total Physical Response (TPR) to make math concepts more concrete. (Example of TPR: teaching the term median, which means the middle number in a set of data, by having the students line up in order from shortest to tallest and having them determine who the median is, or the person in the middle)

17) Students can create word bank charts that can be put up in the classroom.

18) Make use of the Internet and math software.

19) Use children's books that teach math in the context of the story, these books may help reduce math anxiety as well.

20) Incorporate different learning styles (auditory, visual, and kinesthetic) into lessons.

Note:

Adapted from Furner, J. M., Yahya, N., & Duffy, M. L. (2005). Teach mathematics: Strategies to reach all students. *Intervention in School and Clinic, 41*(1), 16-23.