TEACHING MATHEMATICS TO STUDENTS WITH LEARNING DISABILITIES: A REVIEW OF LITRATURE

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Abstract

The purpose of this study was to review and synthesize available literature to draw a comprehensive picture of what is necessary to teach mathematics to students with learning disabilities. A systematic search was conducted through 5 computerized databases (Academic Search Complete, ERIC, Education Research Complete, and Primary Search) The descriptors used were “teaching mathematics to students with learning disabilities”, and “effective mathematics instruction and learning disabilities”. Only documents that were available in full text from the databases were included. The next step in the selection process involved a search through the reference list of the obtained articles. This review of literature found that there are four important factors in determining success in mathematics for students with learning disabilities (LD). They are: teacher training, teacher attitudes/perceptions, use of effective strategies, use of assistive technologies, and the application of an effective curriculum. Studies indicated that teachers are inadequately prepared to teach students with learning disabilities, especially in math. The use of effective strategies is especially important to students with LD. Use of strategies is even more important than using drill and practice and mediated instruction strategies. The curriculums that most students with LD are exposed to are ineffective because little emphasis is put on the everyday application of mathematics in their lives. A comprehensive approach that addresses teacher deficiencies and closes the gap between research and practice is necessary to address the problems faced by students with LD. Well trained teachers will have the knowledge and skills to employ effective strategies, use assistive technologies, and have positive

attitudes towards their students. The implementation of an effective mathematics curriculum that is relevant to students' lives and emphasizes problem solving will help students with learning disabilities acquire the mathematics skills necessary for them to be successful.

Introduction

According to Geary (2004), about 5% to 8% of students are identified as having mathematical disabilities. Students with LD are plagued with numerous problems. Not surprisingly, they are often lagging behind their non-challenged peers. Cawley & Miller (as cited in Butler, Frances, Kit-hung, Lee, Miller & Peterson, 1998) found that students with disabilities progressed about one year for every two years they attended school. They also found that 12th grade students with learning disabilities performed at around a high fifth grade level. Despite the clear challenges faced by these students, Ginsburg, (as cited in Paulsen, 2005) found that their was relatively little research on mathematics disability (MD) when compared to reading disability .This, according to Rivera-Batiz (as cited in Paulsen, 2005) is regrettable because "…mathematics competence contributes to gainful employment, income, and work productivity…" (Paulsen, 2005 p.21). The importance of proficiency in mathematics, especially for students with disabilities, cannot be overstated. This review of literature found the following factors to be important in determining success in mathematics for students with disabilities. They are: teacher training, teacher attitudes/ perceptions, use of effective strategies, use of assistive technology, and application of an effective curriculum.

Teacher training

According to the U.S. Department of Education, to be considered highly qualified under No Child Left Behind (NCLB), teachers must have a bachelor's degree, full state certification,

and prove that they know each subject they teach. It is assumed that teachers who meet the requirements of NCLB have the knowledge and skill to implement validated practices in their classrooms. This is not always the case. DeSimone & Parmar (2006) found that in-service teachers had little understanding of the mathematics learning needs of students with learning disabilities. Teachers felt that teacher education programs and professional development training was inadequate in preparing them to teach students with LD in inclusive mathematics classrooms. Fusco (as cited in Cawly & Parmar, 1997) found that special education pre-service programs spent a disproportionate amount of time preparing teachers to teach reading compared to time devoted to mathematics instruction. In a survey of syllabi of 250 courses in special education pre-service programs, Fusco found that on average, only 0.57 sessions per semester were devoted to mathematics instruction methods compared to 6.36 class sessions per semester for methods of teaching reading. Paulsen (2005) stated that there was a gap between research and practice in special education. To close this gap, Paulsen argued that teachers should be provided with explicit instruction on the strategies and practices they should implement in their classrooms. Using the Council for Exceptional Children (CEC) Division of Learning Disabilities and Knowledge in math, Cawly and Parmar (1997) identified six principles that math teachers should develop in order to be effective. They are: 1) modeling good mathematics teaching; 2) knowledge of mathematics; 3) knowing students as learners of mathematics; 4) knowing mathematics pedagogy; 5) developing as a teacher of mathematics; and 6) teacher's role in professional development. Paulsen used these six principles together with the four validated teaching practices of explicit instruction, effective teaching behaviors, curriculum-based measurements, and concrete-representational-abstract method to teach first grade students at risk of failing in math and to model effective practices to pre-service teachers. Achievement gains

were noted for the first grade students and pre-service teachers felt they had obtained knowledge that they could put to use in their classrooms.

Teacher attitudes

Cochran (as cited in Parmar & DeSimone, 2006) argued that with the increased implementation of inclusion, all teachers are in fact special education teachers. General educators' beliefs on inclusion and their perceptions of students with disabilities could influence their students' achievement. Kochlar, West, & Taymans (as cited in Parmar & DeSimone, 2006) reported that one of the three negative barriers to inclusive education was the negative beliefs and feelings teachers had about students with LD. McLesky, Waldron, So, Swanson, and Loveland (as cited in DeSimone & Parmar, 2006) found that elementary school teachers with no experience in inclusion showed more negative attitudes to students with LD and less desire to collaborate with special education teachers than teachers with more experience in inclusion. Janney, Snell, Beers, and Raynes (as cited in DeSimone & Parmar, 2006) concluded that the more experience teachers had with inclusion, the more positive were their attitudes. In a study to research kindergarten teachers perceptions of children's success when labeled as developmentally delayed compared to peers who are not labeled, Talbert, Prater & Zimmerman (1988) found no significant statistical difference between labeled and unlabelled students in terms of predicted success. Unfortunately, though necessary in special education, such labeling, could lead to negative associations. Bryan & pearl, 1981 and Graham & Dwyer, 1987 (as cited in Prater, Talbert, & Zimmerman, 1988) reported that teachers lowered their expectations of students who had been labeled.

Effective strategies

Fuchs & Owen, (2002) concluded that when elementary-age students with mild disabilities are taught a strategy to solve math word problems, their performance on process and product was better than that of students who received conventional instruction. In addition, their study showed that an emphasis on transfer skills and peer mediation improved student performance. Isaacs & Carol, 1999, and Steinberg, 1985 (as cited in Tournaki, 2003) found that teaching different strategies to children helped them learn and retain not only higher order concepts and problems, but also basic mathematics facts. Automaticity in basic facts is considered important for further development in math. Tournaki (2003) stated that automaticity is taught either through drill and practice or the direct teaching of a strategy. Though Ashcraft (as cited in Tournaki, 2003) found that it was beneficial to teach basic facts to student with LD using drill and practice, Garnett, & Fleischner (as cited in Tournaki, 2003) found that students with LD did not automatize computational skills at an age appropriate rate when drill and practice was utilized. Tournaki argues that when students are taught strategies, they are provided with procedural knowledge that can be used to solve problems. In Tournaki's study, the minimum addend strategy (where the student counts up from the larger addend the number of units specified by the smaller addend) was taught to students with and without LD and compared to students with and without LD taught using drill and practice. Tournaki found that students with LD improved significantly only in the strategy condition compared to the control and drill and practice conditions. The general education students improved significantly in both the strategy and drill and practice conditions compared to the control group. Tournaki, however, found that only students in the strategy condition became significantly more accurate in transfer tasks. This was true for both students with and without LD.

According to Jerman & Swanson (2006), cognitive mechanisms such as memory and monitoring processes influence the learning of math. Swanson & Saez (as cited in Montague, 2007) contend that students with LD display considerable memory, attention and self-regulation problems which have a significant negative impact on their performance in reading and math. Montague (2007) found that students with LD are extremely poor at self regulation. She argued that self regulation must be explicitly taught to these students. This helps them monitor and control their cognitive abilities as they learn challenging tasks such as problem solving. Kroesberger & Van Luit (2003) concluded that self regulation strategies were more successful for teaching math problems solving than mediated instruction strategies such as peer tutoring. DiGangi, Maag, & Reid, (1993) studied the effects of self monitoring on task behavior, academic productivity, and academic accuracy with six elementary students with learning disabilities. Students were taught how to record the specific self-monitoring goal and were cued by a taped tone to record results for the number of problems completed, number of problems completed correctly, and on task behavior. DiGangi et al. (1993) found that self monitoring increased both the accuracy and the number of problems completed for fourth grade students. Dunlap & Dunlap (1989) evaluated the effectiveness of a self monitoring package with three students with LD experiencing problems in subtracting. The self monitoring package consisted of an individualized self monitoring checklist based on the types of mistakes the students made while working out subtraction problems. The checklists were prepared after an error analysis of the student's work. One of the students' in the study had the following checklist to help him with problems involving regrouping:

Regrouping

1) I underlined all the top numbers that are smaller than the bottom.

2) I started in the one's place and crossed out the number to the left of the underlined number and made it one less.

I put a " 1" in front of the underlined number.

Regrouping over zero

1) I underlined all the top numbers that are smaller than the bottom.

2) I passed the 0, crossed out the first number to the left of the 0 and made it one less.

3) I put a " 1" in front of the 0.

4) I crossed out the "10." and made it a "9."

5) I put a " 1" in front of the underlined number.

(Dunlap & Dunlap, 1989, p. 311)

Dunlap & Dunlap found that the self monitoring procedures led to immediate gains. Students were able to maintain their performance levels when the monitoring checklist was replaced by a reward system. Carran, Rosenberg, & Wood (1993) trained three elementary students with mathematics LD in self-instruction. The students then tape-recorded the instructions in their own voice and used the recording to complete math computations. Carran, Rosenberg, & Wood found that as a result, the students were able to complete more problems with increased accuracy. According to Montague (2007), students can develop schemas for certain problems. Jitendra el al., 1998, (as cited in Montague, 2007) describes a schema-based strategy in which students are taught a universal rule to help them choose the correct operation to solve the problem. Students are taught that when the total (whole) is not known, then the parts must be added. If the total is known, then the students must subtract to find the missing part. Jitendra's model has been used successfully to teach elementary school students to choose

between addition and subtraction to solve problems. Deatline-Buchman, Jitendra, & Xin (2005) compared the effects of schema-based instruction to those of general study instruction (which involved activities such as drawing pictures) on the mathematical problems solving abilities of 22 middle school students. They found that the schema-based instruction group significantly outperformed the general study instruction group on immediate and delayed posttests and transfer tests. Deatline-Buchman et al. (2005) stated that schema-based instruction emphasized conceptual understanding, facilitated higher order thinking, and was an "effective and feasible option for teachers" (Deatline-Buchman, Jitendra, & Xin 2005, p.191)

Smith & Wisniewski, (2002) evaluated the effectiveness of touch math, a series that stressed the use of manipulatives. According to Smith & Wisniewski, many students with disabilities have trouble using manipulatives because they forget how many they had counted by the time they are ready to transfer the answer to their worksheet. With touch math, students did not have to leave their worksheets to record answers. Students were taught that every number, one through nine had touch points that corresponded to the digit's value. Scoot (as cited in Smith & Wisniewski, 2002) stated that touch math used three modalities: visual, kinesthetic, and auditory. According to Bullock (as cited in Smith & Wisniewski, 2002), when teachers employ strategies for all learning styles, students are able to learn via their dominant modality while strengthening the others. Smith & Wisniewski found that all students using touch math improved considerably in both speed and accuracy as measured by pre and post-tests.

Montague, Morgan, & Warger (2000) described Solve It!, a research based instructional program designed to help students having difficulty in mathematics to solve word problems. Solve It! Helped students learn to understand mathematical problems, analyze information, develop logical plans to problem solve, and evaluate solutions. According to the authors, Solve

It! Provided teachers with proven instructional techniques that helped their students acquire and effectively utilize cognitive processes and self regulation. Montague et al. (2000) concluded that the program was successful for students with mathematical LD and could therefore be used in inclusive, general education, and special education classrooms.

Application of an effective curriculum

Most mathematics instruction is designed to prepare students for college. Wagner, Blackorby, Cameto, Hebbler, & Newman (as cited in Basset, Cronnin, Koppel, & Patton, 1997) found that only 18.1 % of youth with LD go on to college. Because most students with disabilities are not college bound, Basset, Cronnin, Koppel, & Patton, (1997) argued that the mathematics instruction provided to students with LD should put a greater emphasis on everyday practical applications of mathematics in the lives of students. Wagner et al (as cited in Basset, et al., 1997) explored the math related life skills of young adults out of school for up to two years. They found that only 8.1 % had a checking account or a credit card in their own name. Clearly, this showed that most students with LD are not being prepared with the life skills they will need as adults. Basset et al. reported that a significant number of students with LD found the instruction they received irrelevant to their daily lives and as a result dropped out of school. They stressed that it was critical that educators found ways to include life skills math topics in the curricula of students with LD. Basset et al. emphasized that this could be done by spending a significant amount of instruction time on real life problem solving. Jones, Langral, & Thornton (1997) reported that the curriculum, assessment, and professional teaching standards of the National Council of Teachers of Mathematics (NCTM) called for a shift in mathematics instruction for all students toward higher level mathematical reasoning and problem solving. Jones et al. (1997) found that the common practice in special education classrooms was to

narrowly focus on computation. This, they noted, went against NCTM standards. Montague, Morgan, & Warger (2000) argued that the traditional mathematics curriculum "is based on rote acquisition of declarative and procedural knowledge with little regard for developing conceptual and strategic knowledge in students. (Montague, Morgan, & Warger, 2000 p. 110). Jones et al. stated that a broader curriculum could be implemented by using problem driven instruction that emphasized number sense and estimation, data analysis, spatial sense and geometric thinking, patterns and relationships, and the supportive use of assistive technology.

Assistive technology

Assistive technology can be used to support students with LD in their areas of weakness. Goldman & Pellegrino (as cited in Babbit & Miller, 1996) found that extended practice with computers increased automaticity in basic math tasks for children with learning disabilities. Okolo (as cited in Babbit & Miller, 1996) found that simple drill and practice software programs and computer game formats were both effective in building acquisition and fluency skills. Bottge & Hasselbring (as cited in Babbit & Miller, 1996) compared the ability of two adolescent groups with learning disabilities to produce solutions to a contextualized problem after being taught problem solving under the conditions of standard word problems and anchored instruction on videodisc. According to Babbit & Miller, anchored instruction involved bringing real-life problem solving via computer videodiscs to the classroom and teaching students to solve complex multiple step problems. The anchored instruction was integrated with effective teacher guidance. Babbit & Miller found that both groups improved in their word problem solving abilities, though students in the contextualized problem group who used anchored instruction did significantly better in post-tests and transfer tasks.

Conclusion

Proficiency in mathematics is a major determinant of a student's future success. A comprehensive approach is necessary to address the many problems students with LD face in our education system. As stated earlier, both pre-service and in-service teachers have little understanding of the mathematical learning needs of students with LD. They reported feeling unprepared to teach students with LD in inclusive mathematics classrooms. A disproportionate amount of time is spent preparing pre-service teachers to teach reading compared to the amount of time spent on preparing them to teach math. Well trained teachers who are aware of validated mathematics practices could help close the gap between educational research and instructional practices in the classroom. They would have the knowledge and skill to employ effective practices such as self regulation/self monitoring strategies, schema-based strategies, use of manipulatives in programs such as Solve It!, and effective use of assistive technologies in their classrooms. Successful teacher training would also eliminate negative perceptions about students with LD. The implementation of an effective mathematics curriculum that is relevant to students' lives and emphasizes problem solving will help students with LD acquire the math skills necessary to help them find gainful employment and lead productive, independent lives.

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