



EFFECTIVE MATHEMATIC INSTRUCTION STRATEGIES FOR STUDENTS WITH LEARNING DISABILITIES MATHEMATIC DIFFICULTIES

Research Assistant Dr. Onur Emre Kocaoz

Aksaray University, Faculty of Education, Department of Special Education, Aksaray/ Turkey

onurkocaoz@aksaray.edu.tr

Abstract

The impact of mathematic difficulties level varied for each individual from mild to severe. Having math difficulties potentially impact the individual's school, work, and personal life. To close the mathematic performance gap between students with and without LD requires accounting for students' learning needs in order to maximize the use of effective mathematic instructional strategies. The purpose of this paper is to provide an overview of effective math interventions on the mathematical word problem-solving skills for students with LD

Key Words: Learning disabilities, mathematic, computer-assisted instruction

Introduction

Over the last decade the importance of mathematics for students with and without disabilities has been emphasized by federal laws concerning high school graduation and college preparedness in science, technology, engineering, and mathematics (STEM) (U.S. Government Accountability Office, 2005). The shift to student-centered models and the passage of laws, such as The Individuals with Disabilities Education Act (IDEA, 2004) and No Child Left Behind (NCLB, 2002) are prompting more school districts to provide scientific based practices into the process of teaching in order to increase student comprehension of mathematics, reading, and science.

Statistics generated by the U.S. Department of Education in 2008 demonstrate that 2.5 million students between the ages of 3 and 21 have been indicated as a having learning disabilities. Approximately 5% of the all students have learning disabilities (Aud et al., 2011). This number demonstrated that students with learning disabilities are the most common group among those who need special education. Many students with learning disabilities (LDs) struggle more in many subjects compared to those without disabilities. Geary (2004) found that 5 to 9% percent of LD students have a mathematic learning disability (MLD). Interestingly, even if the prevalence of reading disabilities and mathematic disabilities are similar, students with MLD are underrepresented in the special education area (Leong & Jerred, 2001; Mazzocco & Myers, 2003).

A recent report of National Assessment of Educational Progress found that the performance of only 40% of fourth-grade public school students were at or above the proficient level, whereas the performance of only 34% of eighth-grade public school students were at or above the proficient level (National Center for Educational Statistics, 2011). Research shows that students with MLD have problems with: a) number facts, b) computation, c) knowledge transfer, d) the language of math, and e) spatial organization (Garnett, 1998). Hence, students with reading disabilities or difficulties are very likely to have difficulty in mathematic word problem solving (Fuchs & Fuchs, 2002).

Students with LD in either elementary school or middle school have a greater difficulty solving mathematic problems because several steps and skills are required. (Fuchs et al., 2008; Parmar, Cawley, & Frazita, 1996). Further, the importance of math problem solving skills for K-12 students with and without disabilities was noted by the National Council of Teachers of Mathematics (NCTM) in 2013. Nevertheless, the deficiency of mathematic-problem solving skills of students with MLD or at risk is

greater than their peers without MLD (Montague & Applegate, 1993). Parmar et al. (1996) showed that students with LD are one or two grade levels below their peers. To close the mathematic performance gap between students with and without LD requires accounting for students' learning needs in order to maximize the use of effective mathematic instructional strategies. The purpose of this paper is to provide an overview of effective math interventions on the mathematical word problem-solving skills for students with LD.

Effective Mathematic Instruction Strategies

Numerous instruction strategies are common for teaching math problem solving skills, such as explicit/systematic instruction and computer-assisted instruction (CAI). Twenty-six research studies, which have investigated the effectiveness and variety of instructional methods, such as explicit systematic instruction, direct instruction, and visual representations, to increase the mathematic performance of students with disabilities, have been reviewed by the National Mathematics Advisory Panel (2008). According to the findings, explicit systematic instruction is the most effective strategy for teaching computation and mathematic word problem solving for students with LD.

Kroesbergen and Luit (2003) conducted a meta-synthesis of empirical research on mathematic intervention in elementary schools. They included 58 original reports of empirical research on math intervention published between 1985 and 2000. The study of Kroesbergen and Luit in 2003 involved 13 interventions for *preparatory arithmetic*, 31 for *basic facts*, and 17 for *problem solving*. The 58 reports included 2,509 students with MLDs. Kroesbergen and Luit (2003) concluded that both self-instruction and explicit instruction are the most effective methods in teaching math problem solving.

Explicit -systematic instruction

Explicit systematic instruction requires direct explanation of concepts or skills that targeted to teaching. Student- teacher interaction, modeling the target skills, guiding the instruction, and providing immediate feedback are the fundamental components of the explicit systematic instruction (Archer & Hughes, 2011; Jitendra, Griffl, Gardill, Bhat, & Riley, 1998; Tournaki, 2003). According to the National Mathematics Advisory Panel (2008), these components lead to build the foundational skills and conceptual knowledge for students with mathematic difficulties. In the process of explicit systematic instruction, the teacher clearly explains all steps which are needed and establish learning goals. Assessing students' previous knowledge is another important aspect of this instruction method to connect targeted skills in the learning sequence. The teacher demonstrates all steps of new skill/concept by modeling and provides opportunities to determine if the students can perform the targeted skills correctly. Students are actively participating in the learning although the instruction and practices are guided by teacher. Researcher suggested that explicit systematic instruction in the math teaching need to be used frequently.

Wilson and Sindelar (1991) designed a study to explore the effectiveness of explicit instructional strategy teaching and sequential instruction on student mathematical word problem solving skill (e.g., addition and subtraction word problems). There are 62 students who are participated to this study. The result of the investigation indicated that students who assigned either *strategy plus sequence* or *strategy only* performed higher than students from *sequence only* group.

Jitendra et al. (1998) conducted a study to compare two instructional strategies (explicit schema-based strategy and traditional basal strategy) on math word problem skills. There are 34 students with mild

disability or math difficulties at elementary school level participated. Randomized trial research design was employed. The result of posttest, delayed posttest, and generalization test showed that students who were assigned to explicit schema-based strategy group significantly performed higher than students from basal curriculum

Computer-assisted instruction

Both policy-makers and education researchers view integration technology in education as an important component in equipping next-generation students. Computer-assisted instruction (CAI) has been demonstrated in many research studies as an effective method to teach mathematic word problem skills for students with disabilities. Enhancing personalized learning, the use of visualization, more practicing opportunities, and quick feedback are well-known features for teaching math with this instructional strategy (Hannafin & Foshay, 2008; Miles, 2000; Xin & Jitendra, 1999).

Xin and Jitendra (1999) found CAI the most effective instructional strategies for teaching math word problems to students with learning problems. There is a large number of math applications and software available to use for teaching math content for students with and without disabilities. In general, most students and teachers perceive the use of iPads as likely to engage and motivate most students. More empirical research, however, is needed to determine the popular device's effectiveness on teaching and learning across a range of grades and subjects.

Nordness and Haverkost (2013) designed a research study to examine CAI by using portable devices, i.e., iPods with Math Magic application, on subtraction skill three elementary aged students with LD and Behavior Disorder (BD). The students' subtraction scores obtained from curriculum-based assessments were higher compared to their previous assessment results. While there is an improvement by 17% on their subtraction score via CAI, two limitations of this study are its small size (N=3) and the lack of comparison with other instructional methods or different types of technological devices.

O'Malley et al. (2013) investigated whether the use of iPads enhanced the basic math fluency of ten students with special needs. A single subject design (ABABA) was applied to measure the effectiveness of intervention. In a baseline phase, the students were assigned to solve twenty math problems by traditional methods, and in an intervention phase, the students used iPads. Four important findings emerged. First, the intervention impacted basic math fluency positively, based on class-wide assessment. Second, when asked about the use of iPads in math instruction, teachers perceived their use as beneficial in terms of enhancing student engagement and interest in the course topic and content. Third, teachers demonstrated their willingness to use iPads as an instructional tool for math. Fourth, O'Malley et al. (2013) showed that single subject design could be applied to indicate evidence based practice for students with special needs. In conclusion, there was a significant difference ($p < .05$) in the mathematic class-wide test score between the baseline and intervention phase. O'Malley et al. (2013) concluded that iPads as instructional tools were an effective way to enhance the basic math skill rate of students with disabilities. A few drawbacks from the teachers' perceptions were: the need for technical support, and their own lack of enough technical knowledge about using iPads as instructional tools.

Cihak and Bowlin (2009) examined the use of video modeling (VM) instruction by tablet computers on geometry skill of three high school students with LD. They used a multiple design to measure the effectiveness of VM intervention in geometry instruction. Before the test was assigned, the use of VM was allowed to show the students the problem-solving steps needed. The findings of this study suggested that



the three students improved their geometry skill ($M=94$). Moreover, after the intervention was withdrawn, the students maintained their improvement on a geometry test by a mean of 86. The teachers, who were asked to give their perspective on the use of VM in their instruction, pointed out that having flexibility for creating a particular video by considering students' specific needs, was another advantage. In addition, both the teacher and the three students reported that the technology was an innovative way to help them understand mathematical content. Cihak and Bowlin (2009) concluded that the integration of portable computers into geometry instruction enhanced the students' math computing skills and facilitated their learning by providing "increased opportunities for students to watch, listen, and interact with the instructional content" (p. 26). The authors noted a few limitations of this study including the difficulty of generalizing from the small sample size. They also noted that since the intervention occurred in a special education office rather than a classroom, examining the effectiveness of VM for students with disabilities in a classroom needed further investigation.

Discussion

The impact of mathematic difficulties level varied for each individual from mild to severe. Having math difficulties potentially impact the individual's school, work, and personal life (Little, 2009). However, student with mathematical difficulties can demonstrate a greater improvement by implementing scientific based practices into instruction. The importance providing effective instructional strategies for student with and without mathematical difficulty has been underlined by several researchers. In this paper, two scientific based practices; explicit -systematic instruction and computer-assisted instruction overviewed and discussed.

While each of these practices has different strengths and key features, a classroom teacher can implement the most appropriate practice when on his/her students' unique needs are identified. Little and Delisio (2015) summarized the practical aspects of explicit -systematic instruction in math teaching for students with math learning difficulties. These aspects are: a) maximizing the impact of instructional time, b) having low cost, c) combining with other instructional approaches easily if needed, d) implementing with large procures fidelity, and e) using either small or whole class format.

The benefits of the use of education technology have been discussed in studies of its effectiveness on learning (Berson & Balyta, 2004; Bjerede & Bondi, 2012; Saine, 2012). Computer-assisted instruction (e.g., Laptop, iPad, mobile technology) can be integrated into math teaching practices to meet the student needs. A number of different types of technological learning devices, such as computer, Ipad touch, laptops, smart phone and iPads have been widely used as instructional tools to facilitate learning with a focus on engagement, interactive learning, increasing students' conceptual understanding and differentiation, immediate feedback, and personalized learning (Bouck, Bassette, Taber-Doughty, Flanagan, & Szwed, 2009; Henderson & Yeow, 2012; O'Malley et al., 2013; Russell, Bebell, Cowan, & Corbelli, 2003;).

Despite the potential for mobile learning to become an alternative model of teaching, experts continue to debate its overall impact on learning. A large number of schools, districts, and states provided iPads soon after their release by Apple in April 2010 (Apple, 2013). It is clear that more empirical research is needed on the device's effectiveness for teaching and learning across a range of grades and subjects. Researchers have noted that adaption technology in education, teachers having adequate knowledge/skills to implement a technology initiative in a school or classroom, accessibility of technology, willingness or resistance to the use of educational technological devices and technology cost are some of the important



Turkish International Journal of Special Education and Guidance & Counseling 2016, volume 5, issue 1

factors which determine whether this practice would be used in today's classroom (Bjerede, & Bondi, 2012; Henderson & Yeow, 2012; Saine, 2012)

References

- Apple, (2013). *Apple Awarded 30 million ipad deal from La unified school districts*. Retrieved from <http://www.apple.com/pr/library/2013/06/19Apple-Awarded-30-Million-iPad-Deal-From-LA-Unified-School-District.html>
- Archer, A. L., & Hughes, C. A. (2011). *Explicit instruction: Effective and efficient teaching*. New York, NY: Guilford Press
- Aud, S., Hussar, W., Kena, G., Bianco, K., Frohlich, L., Kemp, J., Tahan, K. (2011). *The Condition of Education 2011* (NCES 2011-033). U.S. Department of Education, National Center for Education Statistics. Washington, DC: U.S. Government Printing Office
- Berson, M. J., & Balyta, P. (2004). Technological thinking and practice in the social studies: Transcending the tumultuous adolescence of reform. *Journal of Computing in Teacher Education*, 20(4), 141-150.
- Bjerede, M. & Bondi, T. (2012). Learning is personal: Stories of android tablet use in the 5th grade. Retrieved from <http://www.learninguntethered.com/wp-content/uploads/2012/08/Learning-is-Personal.pdf>
- Bouck, E. C., Bassette, L., Taber-Doughty, T., Flanagan, S. M., & Szwed, K. (2009). Pentop computers as tools for teaching multiplication to students with mild intellectual disabilities. *Education & Training in Developmental Disabilities*, 44(3), 367-380.
- Cihak, D. F., & Bowlin, T. (2009). Using video modeling via handheld computers to improve geometry skills for high school students with learning disabilities. *Journal of Special Education Technology*, 24(4), 17-29.
- Fuchs, L. S., & Fuchs, D. (2002). Mathematical problem-solving profiles of students with mathematics disabilities with and without comorbid reading disabilities. *Journal of Learning Disabilities*, 35, 564-574.
- Fuchs, L. S., Seethaler, P. M., Powell, S. R., Fuchs, D., Hamlett, C. L., & Fletcher, J. M. (2008). Effects of preventative tutoring on the mathematical problem solving of third-grade students with math and reading difficulties. *Exceptional Children*, 74, 155-173.
- Individuals with Disabilities Education Act. (2004). *Regulations: Part 300/A/300. 8/* Retrieved from <http://idea.ed.gov/explore/view/p/root,regs,300,A,300%252E8>
- Garnett, K. (1998). Math learning disabilities. Retrieved from http://www.ldonline.org/article/Math_Learning_Disabilities
- Jitendra, A. K., Griffin, C. C., McGoey, K., Gardill, M. C., Bhat, P., & Riley, T. (1998). Effects of mathematical word problem solving by students at risk or with mild disabilities. *The Journal of Educational Research*, 91(6), 345-355.
- Geary, D. C. (2004). Mathematics and learning disabilities. *Journal of Learning Disabilities*, 37, 4-15.
- Hannafin, R. D., & Foshay, W. R. (2008, April). Computer-based instruction's (CBI) rediscovered role in K-12: An evaluation case study of one high school's use of CBI to improve pass rates on high-stakes tests. *Educational Technology Research & Development*, 56(2), 147-160.
- Henderson, S., & Yeow, J. (2012). iPad in education: A case study of iPad adoption and use in a primary school. In *System Science (HICSS), 2012 45th Hawaii International Conference on* (pp. 78-87). IEEE
- Kroesbergen, E. H., & Van Luit, J. E. H. (2003). Mathematics interventions for children with special educational needs. *Remedial and Special Education*, 24(2), 97-114.
- Leong, C. K., & Jerred, W. D. (2001). Effects of consistency and adequacy of language information on understanding elementary mathematics word problems. *Annals of Dyslexia*, 51(1), 275-298.
- Little, M. E. (2009). Teaching mathematics: Issues and solutions. *Teaching Exceptional Children Plus*, 6(1), 1-15.
- Little, M. E., & Delisio L. (2015). Current Practice Alerts: A focus on Explicit Instruction in Mathematics. Council for Exceptional Children's Division for Learning Disabilities and Division for Research. Retrieved from http://s3.amazonaws.com/cmi-teaching-ld/alerts/27/uploaded_files/original_DLD_Alert23_rev1.pdf?1438596491
- Mazzocco, M. M. M., & Myers, G. F. (2003). Complexities in identifying and defining mathematics learning disability in the primary school-age years. *Annals of Dyslexia*, 53, 218-253.



Turkish International Journal of Special Education and Guidance & Counseling 2016, volume 5, issue 1

Miles, C. (2000). Developmental mathematics traditions and alternatives: An interview with Bob Hackworth. *Journal of Developmental Education*, 23(3), 20-23.

Montague, M., & Applegate, B. (1993). Middle school students' mathematical problem solving: An analysis of think-aloud protocols. *Learning Disability Quarterly*, 16(1), 19-32.

National Center for Educational Statistics. (2011). *The Nation's Report Card: Mathematics 2011*. Washington DC: U.S. Department of Education. Retrieved from <http://nces.ed.gov/nationsreportcard/pdf/main2011/2012458.pdf>

National Council of Teachers of Mathematics. (2013). *Common core mathematics*. Bloomington, IN: Solution Tree Press.

National Mathematics Advisory Panel. (2008). *Foundations for success: The final report of the National Mathematics Advisory Panel*. Retrieved from <http://www.ed.gov/about/bdscomm/list/mathpanel/report/final-report.pdf>

No Child Left Behind Act (NCLB) of 2001, Pub.L. No. 107-110, 20 U.S.C. § 1000 *et seq.* (2002).

Nordness, P. D., Haverkost, A., & Volberding, A. (2011). An examination of hand-held computer-assisted instruction on subtraction skills for second grade students with learning and behavioral disabilities. *Journal of Special Education Technology*, 26(4), 15-24.

O'Malley, P., Jenkins, S., Wesley, B., Donehower, C., Rabuck, D. & Lewis, M. E. B. (2013). Effectiveness of using ipads to build math fluency, *Online Submission*. Retrieved from <http://files.eric.ed.gov/fulltext/ED541158.pdf>.

Parmar, R. S., Cawley, J. F., & Frazita, R. R. (1996). Word problem-solving by students with and without mild disabilities. *Exceptional Children*, 62, 415-429.

Russell, M., Bebell, D., Cowan, J., & Corbelli, M. (2003). An AlphaSmart for each student: Do teaching and learning change with full access to word processors? *Computers and Composition*, 20, 51-76.

Saine, P. (2012). iPods, iPads, and the smartboard: transforming literacy instruction and student learning. *The Nera Journal*. 47(2), 74-79.

Tournaki, N. (2003). The differential effects of teaching addition through strategy instruction versus drill and practice to students with and without learning disabilities. *Journal of Learning Disabilities*, 36(5), 449-458.

U.S. Government Accountability Office. (2005). *Federal science, technology, engineering, and mathematics programs and related trends* [GAO-06-114]. Retrieved from <http://www.gao.gov/new.items/d06114.pdf>

Verschaffel, L., Greer, B., & De Corte, E. (2000). *Making sense of word problems*. Swets and Zeitlinger: Lisse.

Wilson, C. L. & Sindelar, P. T. (1991). Direct instruction in math word problems: Students with learning disabilities. *Exceptional Children*, 57, 512-518

Xin, Y. P., & Jitendra, A. K. (1999). The effects of instruction in solving mathematical word problems for students with learning problems a meta-analysis. *The Journal of Special Education*, 32(4), 207-225.