Integrating Reform Math Instruction in the Special Education Classroom

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Abstract: Over the past twenty years, the goals of mathematics education have evolved. While procedural knowledge remains important, there is now a greater emphasis on reasoning, problem-solving, and discourse. The direct instruction approach, commonly used for students with learning disabilities, has not kept pace with these new expectations and does not adequately develop the conceptual knowledge and reasoning skills emphasized by the Common Core State Standards for Mathematics. By combining the reform-math approach, which is preferred in general education, with direct instruction, students with learning disabilities can achieve deeper understanding and improved generalization of their math skills, leading to holistic development. This paper will provide information on improved learning outcomes for students with learning disabilities when these two approaches are integrated.

Introduction

"The person who does the thinking, does the learning." This quote from a math teacher I recently worked with has stayed with me. While it seems obvious that teachers should encourage students to think about their thinking, this is not happening in all classrooms. Despite the math reform movement and a commitment to equity in education, the disparity in math instruction between students with learning disabilities and their peers without learning disabilities persists. In a typical special education classroom, students with learning disabilities have fewer opportunities to develop their reasoning skills. This is primarily due to the choice of instructional methods. The direct instruction approach, favored in special education classrooms, limits students' growth, and widens the divide between students with learning disabilities and their typical peers.

Why Math Matters to Students with Learning Disabilities

Conceptual understanding of mathematics lays the foundation for quantitative reasoning (QR). QR is the ability to apply basic mathematical concepts and skills to solve real-world problems. Failure to develop these skills will create shortcomings that will affect the student academically, professionally, and personally. More broadly, failure to develop quantitative reasoning has societal implications.

Beyond academic benefit, QR proficiency has everyday life applications including understanding nutritional information, budgeting, understanding terms of loans, interpreting medical results and cooking. Additionally, QR prepares students for the jobs of the future. With the evolution of technology, there is a high demand for workers with strong logic and analytical thinking. Currently, there is limited participation of students with learning disabilities in the science, technology, engineering, and math (STEM) fields, with limited time spent problem-solving and discourse potentially to blame (Lambert & Sugita, 2016). Improving student participation in

mathematical discussion and problem-solving can open doors to a new career path, which can empower a student to live more independently.

Furthermore, students with better developed QR skills will be better equipped to understand charts, graphs, and other data. As adults, they will also be better able to discern the validity of information, which will result in improved judgement and decision making. Implementing instructional practices that develop students' ability to apply and generalize math concepts will not only positively impact their lives, but also improve their contributions to society.

Two Instructional Practices

Direct instruction and reform math instruction, as shown in Table 1, are two favored instructional methods. In the special education mathematics classroom, where much instructional time is dedicated to algorithmic instruction, the method of choice is direct instruction. In the general education classroom where the focus is on peer interaction and creative problem-solving, the chosen method is reform math instruction. Highlighting this discrepancy, students in special education spend 70% of their time on algorithmic instruction, compared to just 30% in general education (Wilson & Hunt, 2022). While the direct instruction approach is effective in developing procedural understanding, it is less effective in developing critical thinking, creative problem-solving, and collaborative skills. By integrating reform mathematics instruction, which is based on the National Council of Teachers of Mathematics' Principles and Standards of School Mathematics (NCTM 2000), students with learning disabilities will have the same opportunities as their general education peers to develop a deeper conceptual understanding of mathematical concepts. The failure to integrate these practices in the special education classroom will result in limited opportunities for these students personally and professionally, especially in STEM fields.

Table 1
Comparison of Mathematics Instructional Approaches

Characteristic	Direct Instruction	Reform Math Instruction
Learning Theory	Behavioral Learning Theory: Teacher-Directed Example: worksheets, drills	Constructivist Theory: Student-Centered Example: student collaboration with peers, sharing ideas and reflecting on their learning and the strategies they used
Objectives	Mastery of skills, procedural understanding	Problem-solving, real-world applications, conceptual understanding
Teacher Role	Authority of learning; teacher explicitly teaches concepts, step by step	Facilitator of learning; the teacher guides the students and encourages discussion

Characteristic	Direct Instruction	Reform Math Instruction
Student Role	Students receive explicit instruction from teacher with student participation during guided and independent practice; limited opportunity for creative reasoning	Active participants in constructing learning through experiences; student-centered; creative problem-solvers
Discussion/Discourse	Work is mostly independent, with students verbalizing teacher-modeled ideas	Discourse encouraged in this collaborative classroom; students communicate and justify ideas
Methodology	Algorithmic instruction; learning outcomes performance-based; worksheets, independent work	Less time devoted to algorithmic instruction; project-based assessments; collaborative projects

Direct Instruction

Students with disabilities are traditionally taught using the direct instruction method based on the behavioral learning theory. In this approach, procedures are broken down into steps, with new steps not introduced until the student has achieved mastery. A concern with this approach is that students spend so much time working to achieve mastery that they have less time to dedicate to higher-order thinking and problem-solving activities. Another drawback of this teacher-centered model is that it gives the teacher the main voice, requiring students to conform to their teacher's reasoning, which leads to students verbalizing their teacher's reasoning, instead of their own (Wilson & Hunt, 2022).

The NCTM listed productive and unproductive beliefs about teaching and learning mathematics in their publication, Principles to Actions: Ensuring Mathematical Success for All (2014). Unproductive beliefs included characteristics of direct instruction such as: students should practice procedures and memorize math facts, all students should use the same algorithms, math should be taught sequentially with no progression until a concept is mastered, and an effective teacher guides students through problem-solving step by step. In contrast, productive beliefs more closely resembled reform math principles and included focusing on conceptual understanding, introducing students to a wide range of strategies, and teachers acting as a guide while the students' role is to construct their own understanding of mathematics through discourse.

Reform Math Instruction

In the early 90's the National Council of Teachers of Mathematics (NCTM) advocated for a change in mathematics instruction. In their publication, Principles and Standards for School Mathematics (2000), they outlined key elements of mathematics instruction, and standards. This publication not only influenced the reform math instructional approach, but it also influenced today's Common Core State Standards for Mathematics (CCSSM). This reform called for an increase in instruction that developed students' real-world problem-solving skills, while de-emphasizing algorithmic instruction. It also encouraged collaborative problem-solving which would

help deepen students' conceptual understanding and facilitate the generalization of their math skills. By engaging in collaboration, which is a principle of mathematics reform, students must explain their thinking and justify their methods through participation in discourse. This process not only fosters a deeper understanding of the content, but also contributes to student confidence, motivation, flexibility, and creativity (Bottge et al., 2007).

Integration

To grasp mathematical concepts, students must demonstrate tenacity in solving problems, actively engage in discussions, and apply quantitative reasoning (Lambert & Sugita, 2016). In one mixed-methods study, the authors developed a reform math instructional approach, Enhanced Anchored Instruction (EAI), to address the deficits in problem-solving skills in learners with disabilities. This method integrates technology, problem-based learning, and real-world contexts to make learning more meaningful and effective. Lessons are presented to students within a story or real-life situation using interactive software that has scaffolding built into it. This scaffolding addresses the students with learning disabilities' need for repetition to effectively grasp more challenging concepts. Students collaborate to find solutions to authentic problems, and instructors provide skill instruction as needed. The study, which was implemented in special education classrooms, found that students benefited from this type of instruction, and not only improved their problem-solving performance, but also retained skills that were taught (Bottge et al., 2007). The study found that teachers in special education classrooms are effectively able to instruct students in a way that aligns with NCTM standards (Bottge et al., 2007).

Another study looked at the impact of the Explicit Inquiry Routine (EIR) on students with disabilities. EIR integrates elements of direct instruction with inquiry-based learning. Beyond accurately solving one-variable equations, the goal was for students to express their thinking. The method involved explicit sequencing, moving from simple to complex problems. By beginning with simple equations, the students were able to establish the necessary background knowledge that enabled them to move on to more complex problems. After explicit instruction, students were guided through inquiry where they would explore ideas more deeply. Additionally, students' learning of mathematical procedures was scaffolded using the Concrete-Representational-Abstract (C-R-A) model (Scheuermann et al., 2009). The researchers concluded that the EIR method increased student scores on a word problem assessment, and that students not only retained these learned skills, but were also able to generalize these skills as evidenced in being able to solve textbook problems (Scheuermann et al., 2009). The results of this study demonstrate that combining direct instruction and reform math instruction can create an approach that is not only effective, but also aligns with the practices recommended by NCTM (2000), giving the students the opportunity to develop reasoning skills.

As a result of these innovative approaches, students with learning disabilities were able to engage in math learning in ways that resembled their peers. In both studies, the balanced approach of combining traditional direct instruction with math reform was effective in not only improving performance and retention, but also in generalizing new concepts.

Challenges

Wanting to improve math learning for students with learning disabilities is not a simple matter. There are challenges that educators face such as the lack of available research, lack of student readiness, and teacher knowledge.

One challenge educators face in closing the divide between students with disabilities and their peers without disabilities is the lack of research on the subject (Lambert & Sugita, 2016). Lambert & Sugita (2016) argue that we cannot assume that students with learning disabilities cannot meet the new math standards, but we also cannot assume that teaching students with disabilities using general education methods is effective either. What we need is to learn more about how to support these students to increase their math achievement through research proven methodologies.

The lack of alignment in teaching practices between the general education and the special education classroom presents another challenge. Students with learning disabilities may not be well-prepared to be successful with a more balanced instructional approach. They will have deficits in conceptual understanding and may have memory issues that affect their recall. To overcome this challenge, they will need instruction that combines both development of basic skills and problem-solving (Bottge et al., 2007).

In general education, student achievement has been found to correlate with the knowledge of their teacher (Hill, Rowan & Ball, 2005, as cited in Bottge et al., 2007). Teacher preparedness is another challenge that students with disabilities face. Their special education teachers may not be as well-versed in mathematics as content teachers. Special education teacher programs usually only include one math instruction course, and some programs may include none. Furthermore, this limited training does not prepare teachers to understand cognitive diversity, which refers to the various ways students with learning disabilities think. Having a better grasp of neurodiversity and how it affects mathematical thinking would help teachers better adapt their instruction, improving math outcomes for students with learning disabilities (Hunt et al., 2021).

Conclusion

Despite the challenges, we know that the different instructional approaches used in special education and the general education classroom develop different skills in the students. The objectives of math education have changed; it is no longer sufficient to merely remember formulas and calculations. As the world advances with technological innovations, student learning must evolve accordingly. Direct instruction has a place in special education, however for students with learning disabilities to reach their fullest potential, it should be integrated with the reform math approach. While students should learn procedures, they should also engage in discourse and problem-solving like their peers.

"Mathematics is a universal, utilitarian subject—so much a part of modern life that anyone who wishes to be a fully participating member of society must know basic mathematics" (Kilpatrick et al., 2001, p.15). This statement highlights the issue that we face today. By failing to integrate reform math instruction into special

education classrooms, we neglect to prepare our students for active participation in society. Integrating reform mathematics into our long-favored method of direct instruction is not merely a choice; it is a moral obligation.

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About the Author

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