Teaching to the Standards in Math:
A Literacy-Based Approach
for Students with Significant Cognitive Disabilities

Katherine Trela
Bree Jimenez
Diane M. Browder
University of North Carolina at Charlotte

"All students, regardless of their personal characteristics, backgrounds, or physical challenges must have opportunities- and support to learn-mathematics. Equity does not mean that every student should receive identical instruction; instead, it demands that reasonable and appropriate accommodations be made as needed to promote access and attainment for all students."

(National Council of Teachers of Mathematics, 2002)

Studies conducted under the Reading, Writing, Math, and Science for students with significant cognitive disabilities grant (OSEP Grant H324M030003) have responded to the need to develop models of accessing the general curriculum emphasizing three components: (a) standards-based IEPs, (b) connection to grade level general curriculum, and (c) strategies to teach basic academic skills to students with significant disabilities. Specific to making math accessible to students with significant cognitive disabilities, the team conducted a comprehensive literature review using the National Council of Teachers of Mathematics (NCTM) core areas of math to investigate current practices in teaching math to this population of students. Findings from this review identified geometry, algebra, and problem solving as areas in need of evidence-based instruction in order for students with significant disabilities to gain access to NCTM math standards. Based on these findings, the research team developed interventions to teach academics aligned with general education curriculum to students with significant cognitive disabilities, with a focus on secondary level content and performance standards.

In the 2005-06 school year, the use of story-based lessons combined with a task analysis and graphic organizer to teach students with significant disabilities to solve a one variable algebraic equation was piloted in five classrooms, with ten students with significant cognitive disabilities (i.e., students with measured IQ <55). Teachers were trained using a ten step task analysis to guide students through the story, identify and organize facts on a graphic organizer, and solve the problem. Upon completion of the pilot study, teachers indicated that the materials were useful and effective tools to deliver lessons directly aligned with secondary math content (e.g., algebra). In addition, students who participated in the study increased number of independent correct responses on a ten item task analysis from pre to post test. At the pilot's concluding focus group session, each teacher presented a video to show how they implemented the math lesson. These videos showed that teachers delivered instruction

consistently from one site to another, with some teachers modifying only to support unique physical, learning, or sensory needs of the students. A general education high school math department chair attended and assisted in developing the content of future units to include: (a) introduction to and use of the coordinate plane in geometry, (b) identifying numbers in sequence when counting money or using a linear measurement tool, (c) organizing data and creating graphs to describe data, and (d) expanding on the algebra unit to include subtraction.

Using feedback from the pilot study, the team designed four units of study for the following (2006-07) school year using task analytic instruction, story-based lessons, and a graphic organizer to implement instruction directly aligned to secondary math standards. These materials were then validated by a faculty member from the middle- secondary education math department at University of North Carolina at Charlotte (UNCC) and a high school math teacher from the cooperating school district. Together, these experts agreed that the unit lessons and supporting materials addressed critical functions of math standards for middle and high school math courses, including: (a) problem solving in algebra, (b) spatial reasoning in geometry, (c) solving problems with real numbers in measurement (d) interpreting information displayed on a bar graph in data analysis.

Method
Participants
A total of 10 teachers participated in the study. Teachers responded to a survey during the previous spring semester to participate in this research. The average number of years in teaching was six, with all teachers holding certification in the state to teach special education. Teachers were randomly assigned to either the experimental (five received math training) group or the control (five received science training). Student participation was yoked to their teacher's assignments, with 17 students in the math group and 21 students in the science group.

Setting
All training took place on a university campus, where teachers attended three workshops throughout the school year to be trained in teaching the separate units. Lesson implementation took place in self-contained classrooms for students with autism or students with intellectual disabilities.

Design
A pretest- posttest with random assignment to groups design was used to examine the effect of training teachers in task analytic instruction on students' achievement in math skills aligned to secondary general education curriculum standards.

Materials
All adapted story-based problems, graphic organizers, and lesson plan task analyses were developed by the researchers and given to teachers at their training workshop.
The test of math skills was developed by researchers and validated by a university math education expert and used in pre and post-testing.

Procedure

Pretest. In August, 2007, researchers pre-tested students in the control and experimental groups.

Training. When pre-testing was finished, math teachers attended a one day workshop to be trained in the use of the Algebra task analysis, story-based lessons, and graphic organizer. A lesson from the basic unit was demonstrated, and then teachers role-played the lesson with a partner. Researchers checked fidelity of lesson implementation before teachers left the workshop, working with teachers to clarify wording or presentation of materials. Teachers were also shown a sample of the challenge lessons, but encouraged to work toward mastery on the basic unit stories. Mastery tests for each unit (versions of the test of math skills) were provided so that teachers could periodically review previously taught skills with their students.

Teachers in the control (science) group attended a separate training to implement inquiry-based science instruction.

Lesson Implementation. Teachers implemented lessons in the basic unit in their classroom over a period of 3-4 weeks after the workshop. Most teachers spent a week on mastering one story, and then moved on to the next story. As students became more proficient with the problem solving strategy for the unit, less time was spent between new stories. Researchers checked for procedural reliability on at least one story-based lesson in each unit.

Post-test. After the third workshop in January, 2007, teachers were trained to implement the final two units. In April, researchers returned to all classrooms to post-test students in the experimental and control groups.

Results

Cohen's d, or the standardized mean difference (Gravetter & Wallnau, 2004, p. 350), is used here to report the power of the intervention's effects on student achievement from pre to post-test in comparison to the control group on each subtest. To illustrate, an effect size of .20 indicates that the strength of the intervention was small, while .50 is moderate, and .80 is strong. Effect sizes over 1.00 indicate a strong intervention.

What is the effect of teacher training in task analytic instruction on student achievement on test of math skills?

Overall, students in the math training group showed gains in each area of the test of math skills. The intervention effect for teacher training in geometry lesson implementation was strong (d=1.29), as was the training to deliver measurement lessons (d=1.29). Similar results were found for training in algebra lesson implementation (d=1.70) and training to deliver instruction in data analysis (d=1.01).

How will teachers perceive the training in lesson implementation?

On a teacher intervention rating survey, teachers responded to statements about the training on a Likert scale from 1 (strongly disagree) to 4 (strongly agree). Overall, teachers

found the training to be fair and practical to implement. Comments from the teachers indicate that the training has given them a better understanding of how to address secondary academic standards in their students' individual education plans (IEP).

Discussion

As American schools continue to respond to accountability mandates of NCLB and IDEA legislation, special education services need to strengthen their focus on supporting all students' progress toward general education curriculum standards. However, recent reviews of literature have shown that little research exists to guide instructional practices in reading, writing, math, and science for students with significant disabilities, especially students in secondary settings (Browder et al, 2006; Browder et al, 2008; Courtade, 2006; Spooner et al., 2007). Based on implications from results of these literature reviews, research with middle and high school students with significant cognitive disabilities has shown increased participation and achievement toward secondary general education curriculum standards in science, math, and reading (Browder, Jimenez, & Courtade, 2007; Browder, Trela & Jimenez, 2007; Courtade, 2007). This line of research implements instructional practices that are grounded in general education research (i.e., inquiry-based science, literacy-based math, NRP components of effective reading instruction) and special education research (i.e., systematic prompting, time delay, self-monitoring, adapted text). Teaching to the Standards in Math provides teachers with a template to begin the work of providing access and supporting progress in mathematics to all students.