The article that focuses on the teaching of mathematical fluency and higher order learning is aimed at enhancing the learning of children with disabilities in kindergarten through Grade 3. This involves identifying instructional practices that accelerate the learning of children with disabilities in curricular areas.

CASL (Center on Accelerating Student Learning) focuses on accelerating reading, math, and writing development in grades K-3. The Directors of CASL are Lynn and Doug Fuchs of Vanderbilt University. CASL research sites are also located at Columbia University (Joanna Williams) and the University of Maryland (Steve Graham and Karen Harris).

REACH (Research Institute to Accelerate Content Based Learning in Grades 4-8) exposes interventions that reflect high expectations, content, and support for students. The Director of REACH is Catherine Cobb Moroeco at Education Development Center in New ton, MA.

Research partners include the University of Michigan (Arulmarie Palincsarand Shirley Magnusson), the University of Delaware (Ralph Ferretti, Charles MacArthur and Cynthia Okolo), and the University of Puget Sound (John Woodward).

The Institute for Academic Access (IAA) is conducting research to develop instructional methods and materials to provide students with authentic access to the high school general curriculum. The Institute Directors are Don Deshler and Jean Schumaker at the University of Kansas, Lawrence.

This issue features the Center on Accelerating Student Learning (CASL).

Creating a Strong Foundation for Mathematics Learning with Kindergarten Peer-Assisted Learning Strategies

Lynn S. Fuchs, Douglas Fuchs, Kmh Korns, Loura Yozdian, and Sarah Powell

The Center on Accelerating Student Learning (CASL) is a collaborative part of a new faculty at Vanderbilt University (Doug and Lynn Fuchs), Columbia University (Joanna Williams), and the University of Maryland (Steve Graham and Karen Harris). CASL's goal is to identify instructional practices that accelerate the learning of children with disabilities in kindergarten through Grade 3. This includes the development of effective, multi component instructional interventions in reading, writing, and math, with a focus on basic skills and higher-order learning and promote fluency, transfer, and maintenance. The intervention focuses on teaching of mathematical concepts in kindergarten as a means of intervening early to eliminate mathematical deficits and to build a strong foundation for math learning in the primary grades. The intervention is conducted in general education class rooms using peer-assisted learning strategies.

In the United States today, mathematics difficulties are widespread. Among students with disabilities, mathematical deficits affect more than 50% of the population. And these problems begin early and are difficult to remediate as school progresses. In fact, by the time children enter the school building on the very first day of kindergarten, mathematical thinking is well underway among children who will demonstrate strong achievement in the later grades.

By contrast, many children start school with little understanding of what numbers are. Thal is, within a single kinder - garten classroom, some children can solve mulit telp computation problems in their heads, while others do not know what the number 3 means and cannot identify which quantity, 4 or 7, represents next more. This diversity in mathemat ical knowledge within a single kindergarten classroom makes it difficult for even the best teacher to design an instructional program that simultaneously addresses the needs of all the children, including those with disabilities.

CASL's Kindergarten Mathematics Program

To help teachers deal effectively with this academic heterogeneity and to provide all students, especially those with disabilities, with understanding in mathematics, CASL designed and tested a program that kindergarten teachers can easily implement within their typical program. With CASL's kindergarten mathematics program, teachers rely on peer-assisted learning strategies, or PALS.

For kindergarten-PALS (i.e., K-PALS), each child in the class works with another student. To pair students in a class of say 20 children, the teacher ranks children in terms of their mathematical competence. The teacher pairs the highest-performing child with her lowest-performing student; the second highest-performing
ild with the next-to-the-lowest t-per-
ming child; and the third ranked 
ild with the student who is third-
on-the-bottom. Then, the teacher 
es a median split with the remaining 
lden (so that stu dents between 
ks 4 and 10 are in one half and stu-
dents between ranks 11 and 17 ne in 
e other half). Finally, the teacher 
atches the students in each half (i.e., 
udent 4 with Student 11, Student 5 
iU1 Student 12, and so on). The 
cher uses this pairing strate gy on 
st weeks, making minor changes 
ere and there so that students work 
here and there 
ances to each other. This 
ethod, which allows the highest-per-
ing children to provide help to their 
est-performing classmates, serves 
 e needs of the students with disabili-
es well. In addition, research (e.g., 
/e, 1989) shows that constructing 
athematical explana tions for peers 
so promotes the achievement of 
ghh- performing s tudents.

Every third week, however, teachers 
se an alternative strategy for creating 
airs. This alternative pairs Student 1 
th Student 2, Student 3 with Student 
, and Student 5 with Student 6. Then, 
e teacher does a median split with the 
main ing children and pairs Student 7 
th Student 14, Student 8 with Student 
, and so on. This alternative method 
rovides the highest-performing stu-
dents with opp on ut it ies to work 
gether for enrichment purposes. 
regardless of which pairing method is 
sed, tutoring roles are reciprocal so 
at both st udents in each pair get to be 
oth tutor and tutee wiU1 in every ses-
on.

K-PALS is a 16-week program. Two 
instructional sess io ns occur each week. 
eachers allocate the first week to train-
g their students on how PALS is 
or ganized and how to be a Coach (i.e., 
titor) and a Player (i.e., tutee). The 
K-PALS manual provides scripts for teach-
s to use in training t heir classes.

Subsequent weeks focus on different 
athematical concepts: number recogni-
tion (weeks 2 and 3), representing 
umbers with concrete objects and pic-
tures (week 4), place value (week 5), 
resenting numbers with num erals (week 6), comparing quantities (weeks 
7, 8, 9, 10), addition and subtraction 
cepts with pictures (weeks 11, 12, 
, and 13), addition and subtracti on with 
concrete objects (weeks 14, 15, and 16). 
The teacher begins each instructional 
session by briefly introducing the con-
cept and explaining how the day's PALS 
activity works. The K-PALSm a nul pro-
vides scripts for teachers to use in intro-
ducing each day's activity. This 
ual also provides masters of PALS 
board games, which teachers can 
 copy. Each day's PALS activity is 
conducted with a different gameboard, 
and most gameboards come in three 
vels of difficulty: 0-9, 10-19, or 20- 
99. All pairs within a class work on the same 
xiety; however, pairs work with number 
sets matched to the instructional level of 
the lower-performing student within the 
dyad. Other materials necessary for 
plementing K-PALS are laminated 
umber lines, clothespins, beans, bean 
icks (popsicle sticks with 10 beans 
ixed with glue), and spinners (that are 
marked with more and less).

Table I outlines the K-PALS activi-
ties. We illustrate K-PALS using two 
ctivities: Number Recognition (10-19) 
nd Addition and Subtraction Concepts 
 Pictures. Table Number Recognition 
 Gameboard for 0-19 shows num erals 
 ng in random order. Nex1 to each 
umeral is an emp ty box. The first 
ach, who is the stronger math stu-
dent, begins by asking, "What num-
ber?" The Player responds, "Six." 
he Coach says, "How many." 
The Player draws 6 lines in the box. Then, 
continuing on to the next numeral, the 
ach asks, "What number?" 
he Player says, "Twelve." 
he Coach asks, "How many." 
he Player represents a "bundle" of 10 by 
riting the numeral 10 and drawing a circle around 
it and then drawing two additional 
ines. The pair continues in this way 
 until they reach a flag on the game 
ard, at which time the Coach and 
ayer switch roles.

On the Addition and Subtraction 
cepts with Picture gameboard, each problem 
ows two sets of animals, either walking 
toward or away from each other. A third set shows the 
um across or difference between the 
s. The Coach asks, "How many do 
you start with?" The Player says and 
rites 3 under the picture of 3 turtles. 
then, the Coach says, "How many do 
you add or take away?" The Player says, 
"Add one." The Player then writes 1 
nder the picture of 1 turtle. Next, the 
ach asks, "Now how many?" The 
ayer says four turtles and writes 4 
nder the picture of 4 turtles. The 
ach then says, "Tell the story." The 
ayer develops a story, such as "Three 
turtles were sunning themselves on a 
og. Another turtle joined them. Then, 
ere were four turtles sunning u lves 
 on the log." The Coach then says, 
"Read it." The Player says, "3 plus 1 
equals 4." The Coach and Player 
continue on in this way until they reach the 
0 at the bottom of the gameboard, at 
whkh time they switch roles and con-
tinue with the next gameboard.

What to Expect?

Fuchs, Fuchs, and Karns (in press) test-
ed the effectiveness of CASI:s K-PALS 
program. Participants were 20 kinder-
garten teachers in three Title I and two 
-Ti e schools in Nashville. We 
recruited 20 teachers who agreed to be 
assigned randomly to K-PALS or the 
contrast group. The conuas t group had 
the same basal math series without K-
PALS. K-PALS teachers implemented K-
PALS with all students in their classes. 
To es timate the effectiveness of K-PALS, 
we sampled four types of students: stu-
dents with disabilities (8 children in 
PALS classrooms; 7 in contrast classes), 
those with initially low mathematics 
readiness test scores (8 in PALS 
and 7 in cont rast), those with initially 
average mathematics readiness test 
scores (49 in PALS and 52 in contrast), 
and those with initially strong math-
ematics readiness test scores (14 in PALS 
and 17 in contrast).

K-PALS teachers implemented K-
PALS twice weekly, each time for 20 
utes. They used PALS to replace 
other math activities so that the over-
time allocated to mathematics instruc-
tion was the same in the K-PALS and 
contrast classrooms. We observed 
K-PALS sessions (9 measure the accuracy 
with which K-PALS was implemented. 
In addition, chi.idren were pre- and 
posttested on the mathematics portion
of the mathematics readiness and the Primary Level of the Stanford Achievement Test. Also, following K-PALS implementation, teachers completed a feedback form on which they rated the effectiveness of K-PALS for their students and the feasibility of using K-PALS.

Here’s what we found. With the exception of one teacher, K-PALS was conducted accurately: Teachers implemented lessons well, and children worked on K-PALS gameboards in the manner in which the activities had been designed. In terms of student learning, K-PALS was very successful. As reflected on the mathematics standardized achievement tests, K-PALS promoted stronger learning than did the conventional, contrast program for the low-, average-, and high-performing students in these classrooms. And, for students with disabilities, effects were also strong. In fact, all hue one student with a disability in K-PALS improved more than the mean growth of the contrast group of students with disabilities. Moreover, the mean growth of the K-PALS students with disabilities exceeded that of their nondisabled K-PALS classmates. In light of the pervasive and persistent difficulties students with disabilities demonstrate in mathematics

<table>
<thead>
<tr>
<th>Topic</th>
<th>Activity</th>
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</thead>
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**Number Recognition**

C asks, “What number?” P says number name and shows the appropriate number of fulgurs. (For each with of 10, C “flashes” a “bean stick” of 10 by quickly showing all 10 fingers.)

**Representing Numbers with Concrete Objects and Pictures**

C asks, “What number?” P says number name. C says, “Show how many?” P represents number with beans or draws number of lines. (For each unit of 10, C uses a “bean stick” [i.e., a stick with 10 beans affixed with glue] or draws a “bundle” of 10 [by writing 10 and drawing a circle around it].)

**Representing Numbers with Numerals**

C asks, “What number?” P says number name. C says, “Write that number.” P writes the numeral.

**Comparing Quantities**

C asks, “How many?” P says and writes number name. This repeats for comparison number. C asks, “Which is more?” P responds. (Parallel activities with and without pictures to count and for “more” and “less.”)

C asks, “How many?” P says number name. This repeats for comparison number. C spins a spinner that shows the words more and less. If the spinner falls on more, C asks which is more; if the spinner falls on less, C asks which is less. P responds.

C asks, “What number?” C says number name. C says, “Find it on the number line.” P places a clothespin over the correct number on the number line. C asks, “What number is 1 more than?” P responds. C asks, “What number is 1 less than?” P responds.

**Addition and Subtraction Concepts with Pictures**

C asks, “How many do you start with?” P says number name and writes numeral. C asks, “How many do you add or take away?” P says number name and writes numeral. C says, “How many now?” P says number name and writes numeral. C says, “Tell the story.” P tells a story to go with the number sentence and the pictures. C says, “Read it.” P reads the number sentence. (This activity, which always shows pictures to go with each number sentence, first occurs only for addition problems; then, only for subtraction problems; and finally, for mixed addition and subtraction problems.)

**Addition and Subtraction Concepts with Concrete Objects**

C asks, “How many do you start with?” P says number name, writes numeral, and represents quantity with beans. C asks, “How many do you add or take away?” P says number name, writes numeral, and represents quantity using beans. C says, “How many now?” P says number name. C says, “Read it.” P reads the number sentence. (This activity, which does not provide pictures, first occurs only for addition; then, only for subtraction; and finally, for mixed addition and subtraction problems.)
e.g., Cawley, Parmar, Yan, & Miller, 1998), these findings are notable. They suggest that K-PALS is one effective strategy for getting these children off to a strong start. In this way, it is important to note that we also tested as many children as we could find again, in the subsequent fall. At that time, when hil- dren were beginning first grade, K-PALS students continued to outperform their counterparts who had been in kindergarten contrast classrooms.

Finally, teachers’ responses to our questionnaire suggested that K-PALS represents not only a successful approach, but also a feasible one. Teachers rated K-PALS as effective in promoting achievement for their students. And, just as importantly, in response to the question about how any K-PALS would be to implement on their own, teachers responded positively. In fact, 5 of the 10 teachers chose the highest end of the scale, stating that K-PALS was “very easy to use on their own.”

As special education reform prompts general education classrooms to incorporate increasing numbers of students with disabilities, teachers struggle to identify methods that can address the multifaceted needs of academically heterogeneous classrooms of children. K-PALS provides teachers with one strategy for addressing that academic diversity. It benefits students with disabilities even as it provides incalculable benefits to their low-, average-, and high-performing classmates as well. Moveover, teachers can easily use K-PALS in their classrooms.

References


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