OSEP Research Institutes: Bridging Research and Practice

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The article chat foUows is the second install- ment of a new column, *Bridging Research and Practice*, lhai will appear in each issue of TEC for the nex1 year or two. In this col- umn, ch.ree or the foderally funded special education research institutes report to you, the practitioner, on their progres in areas that will be particularly helpfol co you in working with your s tudents. The U.S. Office of Special Education Programs (OSEP) has funded these three research institutes to study specific curricular and insrructional interventions tbac wiJJ acceler- ate the learning of students with disabilit"ies in curricular **areas:**

CASL (Center on Accelerating Stu□ dent Leaming) 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 Unive rsity (Joanna WilJiam s) and the University of Maryland (Steve Graham and Karen Harris).

REACH (Research Institute to Accele rate Conten t Leami n g th rough High Support for **Students wi th Disabilities** in **Grades 4-8)** is examining interventions that reflect high expectations, content and support for st udent s. The Dire ctor of REACH is Catherine Cobb Morocco at Education Development Center in New ton, MA. Research partners include the University of Michigan (Aru1emarie Palincsarand Shirley Magnusson), the University or Delaware (Ralph Ferretti, Charles MacArthur and Cynthia Okolo), and the University of Puget Sound (John Woodward).

The Institute for Academic Access (IAA) is conduc ting rcsea.rch to t.levelop instruc- tional methods and materials to provide stud ents with authentic access to tbe high school general curriculum. The Institute Directors are Don Deshler and Jean Schumaker of the Uni versity of Kansas, Lawre nce.

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

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

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The Center on Acce lerating Student Leaming (CASL) is a collaborative part - nership a mo ng 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 include s the development of effective, multi compone nt ins t ruc- tional interventions in reading, writing, and math, whic h focus on basic skills and higher-order learning and promote fluen cy, transfer, a nd maintenance. The inte rventio n described in this column focuses on the teaching of mathematical concepts in kindergarten as a means of intervening early to eliminate mathe - ma tical deficits and esta blis hing a stro ng foundation for ma rhe ma tics learning in lhe primary grades. The intervention is conducted in general education class rooms using peer-assist- ed I.ea rning stra tegies.

In the United States today, mathe- marics difficulties are widespread. Among studen ts with disabiliti es, ma rb- ematics deficits affect more than 50% of lhe popula tion. And these problems begin early and are diUicult to remedj- are as school progresses. In fact, by the time children enter the school building on the very firs t day of kindergarten, mathematical thinking is well unde rway among children who will demonstrate strong ach ie veme nt in the later grades. By contrast, many children s tart school with little understandin g of what n um- bers are. Thal is, within a single kinder - ga11e n class room, some children can solve mul tis tep comput a tion problems in their heads, while others do not know what the number 3 means a1d cannot ide1 tify which q uan tity, 4 or 7, represe nts more. This diversi ty in math - ematical knowledge within a single kindergarten classroom makes it *dllii-* cult for even the best teacher to design an ins tructiona l program that simulta- neously add resses the needs of all the children, including U1ose with disab ili- ties.

CASL's KIncletgarten Mathematics Program

To help te achers deal effectively with this academic heterogeneity and to pro- vide all student s, especially those with disabilities, wiU1 a s trong fo unda tion for mathe ma tics learn in g in the later grades, CASL designed and tested a pro- gram that kindergarten teachers can easily implemen t within 1heir typical program. With CASL's kinderganen mathematics program, teac hers re ly on peer-assisted learning strategies. or PALS.

For kinde rgarten-PALS(i.e., K-PALS), each child in the class works with ano ther stu dent. To pair students in a. class of say 20 chJldren, the teacher rank orders U1e children in terms of their mathemarical competence. The teacher pairs the highest-performing child with her lowest-pe rforming stu - dent; the second highest-performing

ıild with the next-lo-the-lowes t-per- ›rming child; and the third ranked ıild with the s1udenl who is third- om-the-bottom. Then, the teacher ›es a median split with the remaining ıildren (so that stu dents between nks 4 and 10 are in one balf and stu□ ents between ranks 11 and 17 ne in e other half). Finally, the teacher atches the students in each half (i.e., tudent 4 wilh Student 11, Student 5 iU1 Student 12, and so on). The acher uses this pairing strate gy on ost weeks, making minor changes ere and there so that students work ilh a variety of other children. This ethod, which allows the highest-per-

›rming children to provide help to their ›west-performing classmates, serves ıe needs of the students with disabili- es well. In addition , research (e.g., Vebb, 1989) shows that constructing ıathematical explana tions for peers lso promotes the achievement of igh- performing s tudents.

Every third week, however, teachers se an alternative strategy for creating airs. This alternative pairs Student 1 ·ith Student 2, Student 3 with Student , a.nd Student 5 with Student 6. Then, ıe teacher does a median split with the emain ing children and pairs Student 7 ·ith Student 14, Student 8 with Student 5. and so on. This alternative method rovides the highest-perfonning stu- ents with op pon un it ies to work ›gethe r for enrichment purposes . egardless of which pairing method is sed, tutoring roles are reciprocal so ıat both st udents in each pair get to be oth tutor and tutee wiU1in every ses□ ion.

K-PALS is a 16-week program. lwo ıstructional sess io ns occur each week . eachers allocate the first week to train- ıg their students on how PALS is rganized and how to be a Coach (i.e., ıtor) and a Player (i.e., tutee). The K- ALS manual provides scripts [or teach - rs to use in training t heir classes.

Subsequent weeks focus on different ıathematical concepts: number recog- ition (weeks 2 and 3). representing umbers with concrete objects and pic- ıres (week 4), place value (week 5), epresenting numbers with num erals week 6), comparing quantities (weeks 7, 8, 9, 10), addition and subtraction concepts 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- cep1 and explaining how the day's PALS activity works. The K- PALSmanu al pro- vides scripts for teachers to use in intro- ducing each day 's activity. This manual also provides masters of PALS game□ boards, which teachers can photocopy . Each day' s PALS activity is conducted with a different gameboard, and most gameboards come in three levels of dif□ ficulty: 0-9, 10-19, or 20-99. All pairs within a class work on the same activi-

ty; howev,er pairs work with number sets matched to the instructional level of the lower-performing student within the dyad. Other materials necessary for implementing K-PALS are laminated number lines , clothespins, beans , bean sticks (popsicle sticks with 10 beans affixed with glue), and spinners (that are marked with more and less).

Table l outlines Ule K-PA LS activ i- ties. We illustrate K-PALS using two activities: Number Recognition (10-19) and Addition and Subtraction Concepts with Pictures . The Number Recognition Gameboard for 0-19 shows numerals arranged in random order. Nex1 to each numeral is an emp ty box. The first Coach, who is the stronger math stu- dent, begins by asking, " What num- ber?" The Player responds , "Six." The Coach says, "Show how many." The Player draws 6 lines in tbe box. Then , contin uing on to the next numeral , the Coach asks, "What number?" The Player says, "lwelve." The Coach says, "Show how many." The Player repre- sen ts a "bundle" of JO by writing the numeral 10 and drawing a circle around it and then drawing two additional lines. The pair conrinues in this way until they reach a flag on the game□ board, at which time the Coach and Pla yer sw itch roles.

On the Addition and Subtraction Concepts with Pict ur es gameboard, each problem s hows two sets o[ani- mals, either walking toward or away from each other. A third set shows the sum across or difference between the sets. The Coach asks, " How many do you start with?" The Player says and writes 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 l under th.e picture of l turtle. Next , the Coach as ks, " Now how many?" The Player says four turtles and writes 4 under the picture of 4 turUes. The Coach then says, "Tell the story." The Player develops a story, such as "Three turtles were sunning themselves on a log. Another turt le joine d them. Then, there were [our turtles sunning U1em- selves on the log." The Coach then says, "Read it." The Player says, "3 plus l equals 4." The Coach and Player con-

tinue on in this way until they reach the 0ag al the bottom of the gameboard, at whkh time they switch roles and con- tinue with lhe 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 teache rs in three Title I and two non-Ti tJ.e l 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 class- rooms), those with inilially low mathe- matics readiness test scores (8 in PALS and 7 in cont rast), those with initially average mathematics readiness lest scores (49 in PALS and 52 in contrast), and those with initially s trong mathe - matics readines s test scores (14 in PALS and 17 in contrast).

K-PALS teachers implemented K- PALS twice weekly, each time for 20 minutes. They used PALS lo replace other math activities so that the overall time allocated to mathematics instruc- tion was the same in the K-PALS and contrast classrooms. We observed K- PALS sessions tQ measure the accuracy with which K-PALS was implemented . In addition, chi.ldren were pre- and posttested on the mathematics portion

Table 1• K-PALS Activities

For each activity and gameboard, teachers determine which numbers pairs should work on four topics (0-9, 10-19, or 20-99). C is Coach (i.e., tutor); Pis Player (i.e.,tutee).

Topic	Activity
Number Recognition	Casks, "Wha t number?" P says number name and shows the appropriate number of fu1gers. (For each wtit of 10, C "flashes" a "bW1dle" of 10 by quickly showing all 10 fingers .)
Representing Numbers with C-0ncrete Objects and Picrures	Casks, "What number?" P says number name. C says, "Show how many?" P represents number with beans or draws appropriate number o[lines. (For each unit of 10, C uses a "bean stick" [Le•. a stick with 10 beans affixed with glue] or draws a " bund le" of 10 *[by* writing 10 and drawing a circle around iL).)
Representing NllDlbers with Numerals	C asks, "What number ?" P says number name. C says, "Write that number." P writes the numeral.
Comparing Quantities	Casks, "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 spi.nner falls on less, C asks which is less. P responds. Casks, "What nu mber ?" 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 as ks, "What number is 1 more than _ ?" P responds. C asks, "What number is 1 less than_?" P responds.
Addition and SublJ'action 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 n umeral. C says, "Tell the story." P tells a story to go with the number sentence and the pictures. C says, "Rea d 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 fina lly, for mixed addition and subtraction problems.)
.Addition and Subtraction Concepts \\ith Concrete Objects	Casks, "How many do you start wiU1?" 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, "Rea d it." P reads the num- ber 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.)

of the mathematics readiness and the Primary 1 le vel of the Stanford Achievement Test. AJso, following K-PALS implementation, teachers com□ pleted a feedback form on which U1ey 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 im ple - mented 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 reflect□ ed on the mathematics standardized achievement tests, K-PALS promoted stronger learning than did the conven- tiona l, contrast program for the low-, average-, and high-performing students in these classrooms. And, for students with disabilities, effects were also strong. In fa,ct all hue one student with a disability in **K-PALS** improved more than the mean growth of the contrast group of stude nts with d isa bilities . Moreover, the mean growth of the K-PALS students with disabilities exceeded that of lhe .ir nondisabled K-PALS classmates. In light of the pervasive and persistent difficulties students with dis□ abilities demonstrate in mathematics

e.g. , Cawley, Parmar, Yan, & Miller, 998) , these findings are notable. They uggest that K-PALS is one effective trategy for getting these children off to strong start. In this way, i t is impor- ant lo note that we also tested as many hildren as we could find again, in the ubsequent fall. At that time, when hil- dren were beginning first grade, K- 'ALS studenrs continued to utperform their counterparts who had een in kinder- garten contrast lassrooms.

Finally, teachers' responses to our uestionnaire suggested that K-PALS epresents not only a successful pproach, but also a feasible one. eachers rated K·PALS as effe cti ve in romoting achievement for their stu- lents. And, just as impo rtan tly, in esponse to the question about how asy l<-PALS would be to implement on heir own, teachers responded positive- y. In fact, 5 of the 10 teachers chose the ighest end of the scale, stating that K- 'ALS was "very easy to use on their wn."

As special educa tion reform prompts ge neral education classrooms to incor- porate increasing numbe rs of students with disabilities, teachers struggle to identi.fy methods that ca n address Lhe mu ltifaceted needs of academ ical ly het- erogeneous classrooms of c hildren. K- PALS provides teachers with one s trate- gy for addressing that academic diversi- ty. It benefits students wit h disabil ities even as it provides incide ntal benefits to their low-, average-, and high-perform- ing class ma tes. Moveover, teachers can easily use K-PAIS in their classrooms.

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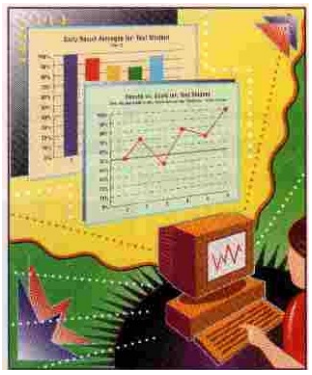

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