Mathematics Renewal for Struggling Learners within an Elementary Professional Development School: A Win-Win-Win Partnership

Susan P. Miller
University of Nevada Las Vegas

Dustin B. Mancl
Clark County School District

Daniell Ferreira
Deerfield School District

Meghan Kennedy
Clark County School District

ABSTRACT: The purpose of this article is to share information related to the emergence of mathematics renewal (i.e., enhancing teacher instruction) for struggling learners within an elementary PDS. Specifically, background related to the PDS and three phases of the renewal process are discussed (i.e., identification of needs, implementation of new instructional practices, outcomes and determination of next steps). The article concludes with a discussion of lessons learned and recommendations for others who choose to initiate mathematics renewal within their respective PDS settings.

NAPDS Essential(s) Addressed: #4/A shared commitment to innovative and reflective practice by all participants; #5/Engagement in and public sharing of the results of deliberate investigations of practice by respective participants

Mathematics continues to be one of the most important as well as one of the most challenging aspects of the school curriculum for many elementary students. Estimates reveal that between 5% and 13.8% of the school population have mathematics learning disabilities (Barbaresi, et al, 2005; Geary, 2004) and that many students without documented disabilities struggle with mathematics as well (Chard, et al., 2008; Jordan, Kaplan, Locuniak, & Ramineni, 2007; National Mathematics Advisory Panel, 2008).

For the past several decades, the National Council for Teachers of Mathematics (NCTM) has been at the forefront of mathematics reform (National Council of Teachers of Mathematics, 2000, 2006). This group has identified principles and standards for improving the quality of mathematics education for students in prekindergarten through twelfth grade. More recently, the Council of Chief State School Officers (CCSSO) and the National Governors Association Center for Best Practices (NGA

Center) released Common Core State Standards documents including one for mathematics. These standards were written to define the knowledge and skills K-12 students should obtain during their educational programs to ensure success in entry-level, credit-bearing academic college courses and in workforce career programs (CCSSO & NGA Center, 2010). Simultaneous to the work of the NCTM, CCSSO, and NGA Center, researchers have explored best practices for teaching mathematics to students who struggle with this complex part of the school curriculum (Baker, Gersten, & Lee, 2002; Fuchs et al., 2008; Miller & Hudson, 2007). Researchers and educators are now challenged to merge identified standards with appropriate instructional practices to improve mathematical outcomes for students who struggle with mathematics, including those with learning disabilities.

Professional Development Schools (PDS) offer a promising environment for investigations related to the merger of mathematics standards and appropriate instructional practices to take place. According to the National Association for Professional Development Schools (2008), an important part of the PDS agenda is the encouragement of joint school-university investigations of education-related issues and the promotion of learning among school-aged students who attend these schools. The association also identified "a shared commitment to innovative and reflective practice by all participants" as an essential component of a PDS. Clearly, the implementation of projects designed to promote mathematics achievement among struggling learners aligns with the conceptualization of the type of learning that should take place among teacher educators, teachers, and students within a PDS environment.

The purpose of this article is to share information related to the emergence of mathematics renewal (i.e., enhancing teacher instruction) for struggling learners within an elementary PDS. After a brief discussion of the specific PDS context in which the study on which we report here took place, information is provided related to the mathematics renewal process. This process included the identification of synergistic needs, the implementation of new instructional practices during year one of the project (2008–2009 academic year), and the implementation of new instructional practices during year two (2009–2010 academic year) of the intervention and study. The article concludes with a discussion of lessons learned and recommendations for others who choose to initiate mathematics renewal within their respective PDS settings.

Context for the Mathematics Renewal

The PDS involved in this mathematics renewal project was a public elementary school located within one of the largest school districts in the United States. Specifically, the school was located on the campus of a large metropolitan research university. The PDS served approximately 600 students from a wide range of backgrounds and educational experiences. Designated as a Title I school, 93.9% of the student body qualified for free or reduced lunch, and all students zoned to attend the neighborhood-elementary PDS resided in neighborhood apartment complexes. The PDS had a high student transiency rate (45.8%) that contributed to both teaching and learning challenges. Fifty-seven percent of the students attending the PDS were classified as Limited English Proficient (LEP), and 7% of the students had been identified as needing special education services. The prekindergarten through fifth grade PDS served an ethnically diverse student population, with Asian/Pacific Islander (7.4%), Hispanic (55.2%), Black/African American (20.8%), and White/Caucasian (16.1%) students. Although these school demographics are unique, it has been our experience that they seem to be more prevalent since the 2008 economic downturn.

According to the school accountability report card published by the state department of education, the PDS was designated as a "Needs Improvement" school based on the Annual Yearly Progress (AYP) report prepared to meet requirements of the No Child Left Behind Act (NCLB). Only 45% of the elementary PDS population met or exceeded the mathematics standards as reflected on the state mathematics assessment (i.e., *State Criterion-Referenced Test*). Of this 45%, 33% met and 12% exceeded the standards. Unfortunately, only 18.18% of students with mathematics learning disabilities met or exceeded the state standards. These latter students demonstrated needs related to computation with regrouping as well as a variety of other mathematics skills.

Process for Mathematics Renewal

The process for mathematics renewal within the described PDS context is beginning its third year at the time of this writing with the potential for further development. The process of change within established school settings, including PDS settings, requires diligent dedication and support from various stakeholders within the environment. Sound change processes also require time for thoughtful reflection. It has been our experience that current pressures emanating from national legislative mandates (e.g., NCLB achievement-related goals) have caused district personnel, school-based administrators, teachers, and students to perform in reactionary modes instead of proactive modes when it comes to instructional practices.

The push to "hurry up and do something" that has the potential to improve student academic performance sometimes results in fragmented attempts to implement new curricula and instruction without evaluating, refining, and scaling up the implementation before moving on to another new curricular endeavor in hopes of improving student achievement. Unfortunately, this results in limited sustainability of effective instructional practices. Because PDS environments are more in tune with the concept of blending research and practice and building capacity based on school-university partnerships, these schools represent greater potential for a more thoughtful and systematic approach to improvement. This has certainly been the case in the three-phase renewal process used within the PDS discussed in this article.

Phase 1: Identification of Synergistic Needs

Due to the low percentage of students with learning disabilities who met or exceeded the state standards in mathematics in our school, the PDS special education teacher was expected to prepare and provide supplemental instruction that included computation with regrouping to these struggling students. Coincidentally, a special education professor at the university where the professional development school was located had just completed writing mathematics lessons designed to help teachers provide regrouping instruction. The PDS teacher, also a doctoral student at the university, was meeting regularly with the professor who served as his doctoral advisor. In the course of one of these advising meetings, the professor mentioned the completion of the regrouping lessons and ongoing validation studies related to the lessons that were taking place. The PDS teacher/doctoral student then discussed the mathematics needs of his students related to this aspect of the curriculum. The mutual needs of the professor and teacher resulted in the realization that an opportunity for a new win-win relationship might have just presented itself.

Shortly thereafter, another doctoral student expressed interest in conducting her dissertation study in the area of elementary mathematics instruction to students with disabilities. The timing could not have been better. The win-win relationship (i.e., a teacher needing ideas for regrouping instruction, a professor needing classroom environments for validation studies related to the newly developed regrouping lessons) expanded to a win-win-win relationship with the addition of a third party (i.e., doctoral candidate interested in completing a dissertation study involving mathematics instruction). These synergistic needs resulted in a complementary research team pooling their knowledge and skills to meet the demands of struggling learners with mathematics disabilities, while simultaneously conducting research with the potential of validating and improving the design of supplemental mathematics instruction.

Phase 2: Implementation of New Instructional Practices Year One

Obtaining research permission. The implementation of new instructional practices began with securing permission to launch a mathematics research project within the PDS. Because of the multiple entities involved in the research, permission was needed from the PDS, the school district sponsoring the PDS, and the affiliated university. The process used to obtain these various levels of permission was timely and efficient (see Table 1 for details related to the permission process). The research was approved under the category of "exempt" status, meaning the instruction was going to be provided to specified students as part of the typical curriculum regardless of their participation in the formal research. Participation in the research aspect of the instruction required parent permission and student assent to allow the researchers to obtain their performance scores for the purpose of research analysis and dissemination without student identifiers.

Professional development for the special education teacher. Once permission was obtained to begin the research, the university professor and doctoral candidate involved in dissertation research held a professional development session for the special education teacher/doctoral student. Scripted instructional lessons along with accompanying learning sheets were provided to the teacher. The instructional procedures were discussed and modeled. Additionally, the ongoing monitoring system used for student performance tracking was discussed and assessments being used as pre- and posttests were reviewed. In addition to learning about the regrouping lessons and related assessment tools, the special education teacher shared information about a screening tool that he liked to use

Table 1. University - PDS Research Approval Process

Steps	*Tasks*
1	Researcher completes an online PDS Research Request Form. Items included on this form include (a) name of researcher, (b) telephone, (c) email address, (d) role (e.g., university student, faculty member, professional staff), (e) title of research, (f) purpose of request, (g) brief description of research (including timeframe, grade levels, special conditions, staff/student involvement), and (h) how proposed research is related to the mission, goals, needs, focus, and/or strategic plan of the PDS. This form alerts the PDS Coordinator that formal IRB requests are forthcoming and the PDS Research Committee identifies a meeting time.
2	Researcher submits both the school district and university IRB protocols electronically to the PDS Coordinator. The PDS Coordinator disseminates these materials to the PDS Research Committee for review. Approval or denial of the research is obtained from the PDS within 7-10 days. If approved, the researcher is given a letter approving use of the facility (required by university IRB) and a letter of sponsorship from the PDS Principal (required by school district IRB).
3	Researcher concurrently submits school district IRB protocol with sponsorship letter to the school district research office and university IRB protocol with facility use letter to the university office for the protection of human subjects.
4	Applications sponsored by the PDS Principal are "expedited", meaning they do not have to go to the full Research Review Committee for review. Following receipt of CCSD IRB materials, the school district research office issues tentative approval, pending UNLV IRB approval.
5	Evidence of university IRB approval is forwarded to the school district research office, and the formal approval letter is issued to the researcher. When final approval has been obtained, the research may begin.

to identify the various computation needs of his students. The newly formed research team embraced his idea related to using this tool and all three individuals left this training session with enthusiasm related to the upcoming mathematics project and a sense of joint commitment to its success.

Instructional implementation. As noted earlier, the PDS special education teacher was responsible for providing computation instruction, which involved regrouping to students who failed to meet district and school standards in this area. A total of eight students from the teacher's caseload of fifth grade students were eligible for this supplemental regrouping instruction. Of these students, six were eligible to participate in the research aspect of the instruction based on their failure to meet regrouping standards, having a mathematics learning disability, and signed parent permission and student assent forms indicating their consent for researchers to use performance data for the purposes of research. The additional two students received the mathematics instruction, but their scores were not included in the research (i.e., one had an intellectual disability instead of a learning disability and one did not return the parent permission form).

The participants ranged in age from 10 years 10 months to 12 years 0 months and were enrolled in the fifth grade. Of the six participants, five were male and one was female. With regard to ethnicity, the female was Black/African-American, one male was Asian Pacific Islander, one male was Black/African-American, one male was Hispanic, and two males were White/Caucasian. Their IQ scores ranged from 83 to 95 and their math achievement standard scores ranged from 66 to 88. The latter scores are provided for descriptive purposes only; they were not used to determine eligibility for research participation (see Table 2 for a summary of individual participant demographic data).

All instruction took place in the PDS within the special education teacher's classroom. The teacher implemented a total of 26 scripted lessons. Lessons one through five involved concrete level instruction (i.e., base ten blocks used to build conceptual understanding related to regrouping process). Lessons six through eight involved representational level instruction (i.e., drawings used to build conceptual understanding related to regrouping process). Lessons nine through 26 involved abstract level instruction (i.e., numbers only used to solve subtraction with regrouping problems).

Each lesson contained the explicit instruction sequence of (a) advance organizer, (b) describe and model, (c) guided practice, (d) independent practice, and (e) problem-solving. During the "advance organizer" component of the lesson, the teacher stated the lesson goal, reviewed previous performance, and provided a statement of encouragement. During the "describe and model" component of the lesson, the teacher provided "think alouds" while solving three problems on the whiteboard. During the "guided practice" component of the lesson, the teacher used questions and prompts to assist students in solving three problems. The level of

Table 2. Year 1 Student Demographic Data

Demographics	*Student 1*	*Student 2*	*Student 3*	*Student 4*	*Student 5*	*Student 6*
Gender	M	M	M	M	M	F
Ethnicity	Black	White	Hispanic	Asian	White	Black
Disability	LD	LD	LD	LD	LD	LD
Age	11.6	12.0	10.11	11.3	10.10	11.7
Grade	5	5	5	5	5	5
IQ	95 a	93 b	83 c	Not available	83 d	95 a
Math Achievement	76/5% e	69/2% e	66 /1% f	77/6% e	88/21% e	82/12% f

Note. M = male; F = female; LD = learning disability; IQ = intelligence quotient. a = Reynolds Intellectual Assessment Scale; b = Kaufman Brief Intelligence Test; c = Universal Nonverbal Intelligence Test; d = Stanford Binet IV; e = Winchester Individual Achievement Test II (Math Composite Standard Score and Percentile Score); f = Kaufman Test of Educational Achievement Math Concepts and Applications (Math Composite Standard Score and Percentile Score).

teacher support was decreased with each subsequent problem. The "independent practice" component of the lesson involved students solving six problems on their own without teacher assistance. During the "problem-solving" component of the lesson, the teacher read three word problems aloud and students solved the problems without teacher assistance.

Upon completion of the lesson, the teacher scored each student's work and provided feedback related to any missed problems. The teacher and students then plotted the scores on a progress-monitoring graph. Students who scored 80% or higher on the lesson problems were eligible to progress to the subsequent lesson the next day. Students who scored less than 80% repeated the lesson later in the day or the next morning prior to moving on to a new lesson.

Outcomes and determination of next steps. The university researcher and the doctoral candidate observed 20% of the total lessons to determine inter-rater reliability related to lesson implementation. The percentage of agreement between the two observers was 99%, indicating a very high level of instructional fidelity. Pretest, posttest, and maintenance test (i.e., administered seven days after instruction ended) scores were obtained using five curriculum-based measures (i.e., computation, word problems, conceptual understanding, fluency minute, and review minute that included both problems that required regrouping and problems that did not require regrouping). See Table 3 for individual student scores and see Ferreira (2009) for details related to the study procedures and student performance.

Although student outcomes were generally positive, the research team identified several instructional changes that had the potential to improve the regrouping lessons for future use. First, it was noted that students needed additional support related to using the base ten blocks and their place value mats during the regrouping aspect of the concrete level lessons. Thus, the teacher added a routine to the instructional lessons. For example, the teacher told the students,

> When trading a tens-block for ten ones-blocks, it is like shattering the tens-block into ten pieces. If the tens-block was to really shatter, it might knock other blocks off our place value mat. So, first put the ones blocks that you already have on your mat in a safe place above the line next to the word "ones." Now that you know they are

Table 3. Year 1 Student Pretest, Posttest, and Maintenance Data

Measures	*Student 1*	*Student 2*	*Student 3*	*Student 4*	*Student 5*	*Student 6*
Pretest	100%	0%	0%	80%	0%	0%
Posttest	85%	85%	40%	85%	95%	30%
Maintenance	85%	95%	90%	90%	90%	85%
Computation (20 problems)						
Pretest	90%	0%	0%	70%	70%	0%
Posttest	100%	70%	40%	80%	80%	70%
Maintenance	90%	70%	80%	100%	100%	90%
Word Problems (10 problems)						
Pretest	86%	9%	0%	38%	0%	29%
Posttest	100%	71%	67%	90%	100%	100%
Maintenance	100%	100%	90%	100%	100%	95%
Conceptual Test (21 problems)						
Pretest	3c 10e	3c 30e	0c 6e	19c 0e	8c 0e	3c 0e
Posttest	23c 0e	31c 3e	13c 11e	28c 0e	28c 0e	30c 1e
Maintenance	24c 4e	21c 1e	5c 0e	20c 2e	20c 2e	20c 4e
Fluency Minute						

Note. c = correct digits per minute, e = error digits per minute.

safe, you can trade/shatter your tens-block for ten single cubes using the area in the ones column of your place value mat.

Second, it was noted that when students moved to representational lessons, they were confused when marking out a tens-block drawing for regrouping purposes and when marking out block drawings because they were being subtracted. Thus, the decision was made to have students draw a squiggly line through the tens-block to represent regrouping and straight lines to show blocks were gone because they had been subtracted.

Finally, it was also noted that students had particular difficulty related to problems that required regrouping in both the tens and hundreds place due to zeros in the tens column. Thus, the research team decided that an additional lesson specifically related to this skill would be added to the lesson sequence. These are the types of refinements that typically emerge when conducting field test studies and clearly result in improved instruction for the students.

Another positive outcome that emerged from this work was interest from the PDS mathematics strategist employed at the school. She observed the special education teacher delivering the lessons and indicated an interest in using the same lessons with the students she served (i.e., students without disabilities who perform poorly in mathematics). Based on these outcomes and observations, the research team decided to conduct several follow-up steps:

- Refine the mathematics curricula to include the new routines related to concrete and representational instruction as well as enhance the content related to problems that include zeros
- Implement the regrouping lessons the following year with a new group of students with learning disabilities who are eligible to receive supplemental mathematics instruction from the special education teacher
- Implement the regrouping lessons the following year with students who are eligible to receive supplemental mathematics instruction from the mathematics strategist

Phase 3: Implementation of New Instructional Practices Year Two

Professional development for PDS mathematics strategist. The following year, the university professor and the special education teacher held a professional development session for the mathematics strategist. The refined scripted instructional lessons along with accompanying learning sheets were provided to both the special education teacher and the mathematics strategist. The instructional procedures were discussed and modeled. Additionally, the ongoing monitoring system used to track student performance was discussed and assessments being used as pre- and posttests were reviewed. The research team for year two left this training session with enthusiasm related to the upcoming mathematics project and anticipation of an approved extension related to the research aspect of the project.

Instructional implementation. Unfortunately, prior to obtaining an approved research extension, the PDS school administration determined that due to budget cuts, the mathematics strategist would be responsible for the organization and implementation of the high-stakes testing conducted at the school, which reduced the amount of time she could provide direct services to students. This was disappointing to the research team, but understandable given the current economic climate within this particular school district. Because this PDS was identified as a "Needs Improvement" and Title I school, the pressure associated with the high stakes testing was great. Although it was disconcerting to watch students miss out on additional support services due to staffing shortages, it was evident that the administration was making difficult decisions with limited resources, and meeting legal mandates was a priority. Thus, a decision was made to continue the research with the special education teacher only. The amount of instruction that his students would receive would be decreased from year one due to a slight delay in receiving approval to extend the research project, implementation of standardized testing, and end-of-the-school-year activities. The research team was anxious to see how the students would do with fewer regrouping lessons given the unavoidable constraints.

During year two of the project eight students from the teacher's caseload of 4th and 5th grade students were eligible for this supplemental regrouping instruction. Of these eight students, five were eligible to participate in the research aspect of the instruction based on their failure to meet regrouping standards, having a mathematics learning disability, and signed parent permission and student assent forms indicating their consent for researchers to use performance data for the purposes of research. The additional three students also received the mathematics instruction, but their scores were not included in the research (i.e., one student was eligible for special education services for intellectual disability not specific learning disabilities, one student did not have a learning disability in math, and one student failed to submit parent permission).

The participants ranged in age from 10 years 1 month to 11 years 6 months. Of the six participants, three were male and three were female. Three of the students were Hispanic and two were White/Caucasian (see Table 4 for participant demographic data). Their math achievement standard scores ranged from 59 to 89. The latter scores are provided for descriptive purposes only, and they were not used to determine eligibility for research participation. Again, instruction took place in the PDS within the special education teacher's classroom. The teacher implemented a total of eleven scripted lessons (i.e., 15 fewer lessons than in year one due to standardized-testing requirements and numerous end-of-the-school-year activities). Lessons one through five involved concrete level instruction (i.e., base ten blocks used to build conceptual understanding related to regrouping process). Lessons six through eight involved representational level instruction (i.e., drawings used to build conceptual understanding related to regrouping process). Lessons nine through eleven involved abstract level instruction (i.e., numbers only used to solve subtraction with regrouping problems). Each lesson again contained the explicit instruction sequence of (a) advance organizer, (b) describe and model, (c) guided practice, (d) independent practice, and (e) problem-solving.

Upon completion of the lesson, the teacher scored each student's work and provided feedback related to any missed problems. The teacher and students then plotted the scores on a progress-monitoring graph. Students who scored 80% or higher on the lesson problems were eligible to progress to the subsequent

Table 4. Year 2 Student Demographic Data

Demographics	*Student 1*	*Student 2*	*Student 3*	*Student 4*	*Student 5*
Gender	M	F	M	F	M
Ethnicity	Hispanic	Hispanic	Hispanic	White	White
Disability	LD	LD	LD	LD	LD
Age	10.6	10.1	11.6	10.3	10.3
Grade	4	4	5	4	5
Woodcock Johnson (SS/%)					
Calculation	93/32%	92/30%			
Applied Problems	59/.3%	57/<1%			
Fluency	89/23%	75/5%			
Wechsler Individual Achievement Test 2nd Ed. (SS/%)					
Operation			66/1%	89/23%	77/6%
Reasoning			74/4%	79/8%	81/10%
Composite			71/3%	82/12%	77/6%

Note. M = male; F = female; LD = learning disability; IQ = intelligence quotient; SS = Standard Score; % = Percentile Score.

lesson the next day. Students who scored less than 80% repeated the lesson later in the day or the next morning prior to moving on to a new lesson.

Outcomes and determination of next steps. The university researcher and her graduate assistant (a former pre-service teacher who collaborated with the special education teacher in a prior semester) observed 30% of the total lessons to determine inter-rater reliability related to lesson implementation. The percentage of agreement between the two observers was 95%, indicating a very high level of instructional fidelity. Pretest, posttest, and maintenance test scores were obtained on five curriculum-based measures (i.e., computation, word problems, conceptual understanding, fluency minute, and review minute). Pretest and posttest performance revealed skill improvement (see Table 5 for individual student scores). There were, however, more instances of declines in maintenance scores when compared to the maintenance performance in year one.

As with the first year of implementation, the research team met to discuss ideas for continued improvement of mathematics instruction within the PDS. It was agreed that the reduction in the number of regrouping lessons may have negatively influenced the students' abilities to maintain their newly learned skills and that, in subsequent years, the regrouping instruction should begin earlier to ensure the completion of more than eleven lessons. Also during this meeting, it was noted that students had particular difficulty related to solving word problems. Thus, the research team decided that the word problem lessons would be developed for use in the third year of the project. These lessons would involve teaching students to use a combination of evidence-based practices for solving word problems (i.e., cognitive strategies, schema diagrams, graduated problem solving sequence embedded within a concrete-representational-abstract teaching sequence). Because a majority of students in the school failed benchmarks related to solving word problems and because of the math strategist's interest in participating in mathematics research, it also was determined that both students with and without disabilities would receive the newly developed word problem lessons.

Table 5. Year 2 Student Pretest, Posttest, and Maintenance Data

Measures	*Student 1*	*Student 2*	*Student 3*	*Student 4*	*Student 5*
Pretest	0%	0%	0%	0%	0%
Posttest	100%	65%	70%	80%	75%
Maintenance	65%	60%	40%	90%	n/a*
Computation (20 problems)					
Pretest	0%	0%	0%	0%	0%
Posttest	70%	90%	80%	100%	100%
Maintenance	90%	60%	50%	60%	n/a*
Word Problems (10 problems)					
Pretest	43%	0%	33%	29%	0%
Posttest	90%	95%	90%	95%	67%
Maintenance	86%	62%	95%	95%	n/a*
Conceptual Test (21 problems)					
Pretest	11c 1e	2c 7e	7c 4e	1c 6e	2c 10e
Posttest	27c 6e	15c 8e	11c 0e	7c 1e	17 c 0e
Maintenance	28c 2e	14c 2e	26c 0e	13c 0e	n/a*
Fluency Minute					
Pretest	7c 8e	5c 6e	9c 2e	0c 8e	3c 6e
Posttest	18c 2e	13c 0e	17c 1e	11c 0e	16c 1e
Maintenance	21c 2e	13c 1e	16c 2e	6c 1e	n/a*
Review Minute					

Note. c = correct digits per minute, e = error digits per minute, n/a* = student 5 withdrew from school prior to completing the Maintenance measures.

Discussion of Results for Year One and Year Two

The computation pretest mean score for year one students (30%) was higher than the computation pretest mean score for year two students (0%). The computation posttest mean score for year one students (70%) was lower than the computation posttest mean score for year two students (78%). The computation maintenance mean score for year one students (89%) was higher than the overall computation maintenance mean score for year two students (63%). Table 6 compares the participant mean scores for year one and year two.

It is interesting to note that the same pattern emerged related to word problem performance. Year one students outperformed year two students as indicated by the word problem pretest mean scores (38% for year one students and 0% for year two students). Year one students performed lower than year two students as indicated by the word problem posttest mean scores (73% for year one students and 88% for year two students). Year one students outperformed year two students as indicated by the word problem maintenance mean scores (88% for year one students and 65% for year two students).

With regard to conceptual understanding, year one students outperformed year two students as indicated by the conceptual pretest mean scores (27% for year one students and 21% for year two students). Year one and year two students' conceptual posttest mean scores were quite similar (88% for year one students and 87% for year two students). Year one students outperformed year two students with regard to maintenance as indicated by the conceptual maintenance mean scores (98% for year one students and 85% for year two students).

With regard to fluency, year one students and year two students performed similarly. The mean number of correct pretest digits for year one students was six compared to five for year two students. On the fluency posttest year one students outperformed year two students (26 correct digits for year one students and fifteen correct digits for year two students). However, year one students did not outperform year two students on fluency maintenance scores (18 for year one students and 20 for year two students).

Thus, year two students started out lower than year one students, but ultimately performed as well as the year one students and in most cases performed at higher levels on the posttests for computation, word problems, and conceptual understanding. This was accom-

Table 6. Comparison of Participant Mean Scores for Year 1 and Year 2

Measures	*Year 1 Mean Scores*	*Year 2 Mean Scores*
Pretest	30%	0%
Posttest	70%	78%
Maintenance	89%	63%
Computation (20 problems)		
Pretest	38%	0%
Posttest	73%	88%
Maintenance	88%	65%
Word Problems (10 problems)		
Pretest	27%	21%
Posttest	88%	87%
Maintenance	98%	85%
Conceptual Test (21 problems)		
Pretest	6c 8e	5c 6e
Posttest	26c 3e	15c 3e
Maintenance	18c 2e	20c 1e
Fluency Minute		

Note. c = correct digits per minute, e = error digits per minute.

plished in spite of receiving fewer instructional lessons. This performance pattern varied a bit relative to maintenance scores. Year two students struggled more to maintain their performance than year one students. The reduction in lessons may have been a factor related to this outcome.

Great caution must be used when comparing these two groups of students due to the low number of students in each group: only six in year one and only five in year two. Additionally, no attempt was made to match students in year one with students in year two on potentially critical variables (grade in school, previous regrouping instruction, IQ scores as these were not available for year two students). Finally, the two studies took place during different school years. Even though the same teacher delivered the instruction both years, he had more experience the second year, and events within the school that had the potential to influence student performance were not controlled (e.g., overall school climate, effects of ongoing budget cuts).

Lessons Learned and Recommendations for Others

In spite of the complexities inherent to this PDS environment (i.e., high percentage of students living in poverty, high transiency rate, high percentage of students whose first language was not English, high percentage of low performers), the work of the collaborative research teams that included a dedicated PDS teacher, motivated graduate students, and a university professor interested in mathematics research served as an impetus for mathematics renewal and improved student performance. The process of identifying synergistic needs, implementing new instructional lessons, discussing outcomes and determining needed next steps proved to be beneficial to all stakeholders in the renewal endeavors. In addition to the previously noted reflections related to improving the mathematics instruction in this school, several additional suggestions emerged as being particularly noteworthy related to successful collaborative partnerships designed to improve student performance. Included among these were the following strategies:

- Attempt to preserve student learning at all costs. In the current era of increased emphasis on accountability via standardized testing and severe school budget cuts, careful planning is needed to ensure that important professional roles within the school are maintained, especially when the role involves providing direct services to students.
- Seek ways to scale up instructional interventions that result in positive outcomes for students with learning disabilities and to other students in the school that need support.
- Adopt flexibility with regard to lesson implementation, particularly at the end of the school year when field days, field trips, and changed schedules are likely to occur. Rather than abandoning important instruction for these end-of-the-school-year activities, look for ways to rearrange how instructional time is spent (i.e., prioritize primary instructional lessons over secondary instructional lessons based on students' greatest needs).
- Adopt an attitude of "How can I make things easier for my collaborative partners?" (e.g., provide instructional resources to the implementing teacher; retrieve students from their classes to attend instructional groups; stop by once a week to determine if things are going well; respond to emails quickly; establish clear lines communication).
- Focus on the fact that students, regardless of economic status, ethnic and cultural backgrounds, disability status, transiency in their home lives and subsequently their school lives, benefit greatly from high-quality, evidence-based instructional lessons. High expectations for students and use of appropriate curricula and instruction results in higher levels of success.

These suggestions should help ensure positive collaborative partnerships that have the potential to increase student learning, improve instructional delivery, support graduate student research, and keep university professors grounded in public schooling. School-university partnerships have so much to offer for everyone involved!

References

Baker, S., Gersten, R., & Lee, D. (2002). A synthesis of empirical research on teaching mathematics to low-achieving students. *The Elementary School Journal, 103*(1), 51–73.

Barbaresi, M.J., Katusic, S.K., Colligan, R.C., Weaver, A.L., & Jacobsen, S.J. (2005). Math learning disorder: Incidence in a population-based birth cohort, 1976–1982, Rochester, Minn. *Ambulatory Pediatrics, 5*, 281–289.

Chard, D.J., Baker, S.K., Clarke, B., Jungjohann, K., Davis, K., & Smolkowski, K. (2008). Preventing early mathemathics difficulties: The feasibility of a rigorous kindergarten mathematics curriculum. *Learning Disability Quarterly, 31*, 11–20.

Ferreira, D. (2009). *Effects of explicit subtraction instruction on fifth grade students with learning disabilities* (Doctoral dissertation). Retrieved from http://digitalcommons.library.unlv.edu/thesesdissertations.

Fuchs, L.S., Fuchs, D., Powell, S.R., Seethaler, P.M., Cirino, P.T., & Fletcher, J.M. (2008). Intensive intervention for students with mathematics disabilities: Seven principles of effective practice. *Learning Disability Quarterly, 31*, 79–92.

Geary, D.C., Hoard, M.K., Byrd-Craven, J., & DeSoto, M.C. (2004). Strategy choices in simple and complex addition: Contributions of working memory and counting knowledge for children with mathematical disability. *Journal of Experimental Child Psychology, 88*, 121–151.

Jordan, N.C., Kaplan, D., Locuniak, M.N., & Ramineni, C. (2007). Predicting first-grade math achievement from developmental number sense trajectories. *Learning Disabilities Research & Practice, 22*, 36–46.

Miller, S.P., & Hudson, P.J. (2007). Using evidence-based practices to build mathematics competence related to conceptual, procedural, and declarative knowledge. *Learning Disabilities Research & Practice, 22*, 47–57.

National Association for Professional Development Schools. (2008). *What it means to be a professional development school: A statement by the Executive Council and Board of Directors of the National Association for Professional Development Schools.* Retrieved November 12, 2009, from http://www.napds.org

National Council of Teachers of Mathematics. (2000). *Principles and standards for school mathematics.* Reston, VA: Author.

National Council of Teachers of Mathematics. (2006). *Curriculum focal points for prekindergarten through grade 8 mathematics.* Reston, VA: Author.

National Mathematics Advisory Panel. (2008). *Foundations for success: The final report of the National Mathematics Advisory Panel.* Washington, DC: U. S. Department of Education.

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Susan P. Miller is a professor of special education at the University of Nevada Las Vegas. Her research interests include mathematics and learning strategy interventions for struggling learners.

Dustin B. Mancl is a lead instructional coach for the Clark County School District. His research interests include content area strategy instruction, inclusive education, and diversity education.

Danielle Ferreira is a special education master teacher for Deerfield School District and a faculty associate at Arizona State University West. Her research interests include instructional interventions for students with disabilities.

Meghan Kennedy is a special education teacher for the Clark County School District. Her research interests include teaching reading, math, and science in resource and collaborative classroom settings.