# *Code RED (Remediation and Enrichment Days): The Complex Journey of a School and University Partnership's Process to Increase Mathematics Achievement*

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ABSTRACT: This study examined a focused remediation and enrichment effort among school and university faculty to affect the mathematics achievement of a group of third-grade students in a Title I elementary school. A total of 87 students participated in the Code RED (Remediation and Enrichment Days) Project. During the Code RED Project, student assessment data were used to identify high-need areas for mathematics instruction. The Code RED Project sessions occurred in small groups over a 10-week period. Pre- and posttest assessments, as well as state-standardized tests, were used for data gathering during the project. Pre- and posttest data indicate that students made significant gains in mathematics achievement during the Code RED Project overall, in different ability groups, and in different subgroup populations. In addition, during the Code RED Project, 100% of the third-grade class passed the end-of-grade state-standardized testing. A comparison of the pass rates for the state-standardized test for third-grade students before and during the Code RED Project indicates a significant increase in students labeled in the pass-proficient and pass-advanced categories. In addition to the students' increasing their achievement results, teachers adopted new instructional practices, and preservice teachers participated in the inquiry culture of the school.

School-based inquiry that results in improved mathematics achievement for all students is a complex process that requires much more than implementing new materials and teaching methods. This process involves the transformation of individual teachers, resources, and school goals into a collaboration that is willing to think about teaching and learning in new and different ways. This process is even more complex when the goal is undertaken as a professional development school collaboration between an elementary school and its university partner that trains preservice teacher interns.

This article describes the journey of one such partnership and the positive student achievement that resulted in mathematics because of this collaboration. First, we provide background information on the development of the relationship between the elementary school and a university faculty member who was working in the

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school with preservice teacher interns. We describe how the relationship began with preservice teacher internship supervision and how it evolved to focusing on student learning with classroom teachers in the school. The relationship resulted in the growth of a culture of inquiry for the teachers working at the school, the preservice teacher interns in field placements at the school, the university faculty member supervising interns in the school, and the school's administrators. During the academic school year reported in this article, these colleagues developed the Code RED Project (where RED is an acronym for Remediation and Enrichment Days) as a way to increase the mathematics achievement of third-grade students in the school. This article discusses the impact of the Code RED Project and the complex relationships and processes that led to its success.

## Professional Development School Relationships

Teacher education researchers have examined a variety of influences on the preservice teacher's development, including the student teaching experience, teacher education courses, methods in those courses, and teacher education programs and institutions (Civil, 1993; Griffin, 1999; Koehler, 1985; Tabachnick & Zeichner, 1984). In an effort to take advantage of the positive elements offered by a more site-based experience and to better connect university students to their future roles as teachers (Moyer & Husman, 2006), many teacher education programs have redesigned their academic configurations for earning teaching licensure (McKibbin, 1999; Spalding, Wilson, & Sandidge, 2000; Stein, Smith, & Silver, 1999). Some of these changes have led to professional development school partnerships between universities and local schools that support the preservice teacher's development in the context of meeting children's needs at the school site (National Council for Accreditation of Teacher Education, 2001). The school and university faculty described in this research were engaged in such a relationship.

Most teacher education programs have examined and articulated what beginning teachers should know and be able to do and what types of experiences might help them to develop teacher skills and dispositions (Reynolds, 1992). The professional development school internship experience in this collaboration was designed to prepare student teachers for today's evolving school culture. The preservice teacher interns in this collaboration were in the elementary school setting 4 days every week from 7:30 a.m. to 3:30 p.m. throughout the entire academic school year. This gave them many opportunities to be exposed to the culture, context, and community norms of the elementary school. Specifically, they were exposed to the rhythms and routines of the school day (culture); to the way in which the school subjects were taught, including the resources, the pacing guides, and the pressures of state assessments and mathematics accountability (context); and to understanding the needs of parents and children (community).

There is a shared belief that teaching requires an understanding of the rules and routines of the school culture, the ability to collaborate with other education professionals, and an awareness of the communities in which one teaches (Sikula, Buttery, & Guyton, 1996). A school that promotes an environment of continuous learning with a shared mission may have a different impact on the preservice teacher than one in which individuals work in isolation. Rather than view the practice of teaching as an isolated act, schools have begun to reframe the work that they do to embrace this spirit of teacher learning as a continuum by engaging teachers in professional learning communities (Eaker, DuFour, & Burnette, 2002; Hord, 1997).

## A School's Professional Learning Community

The term *professional learning community* is a term that was attributed to Hord in 1997

(Blankstein, 2004; Hord, 1997). This notion of a professional learning community developed from work on organizational theory and from Senge's writing in *The Fifth Discipline* (1990). One of Senge's five principles in these writings involved team learning, the concept of which has made its way into the educational context and given rise to the development of the school-based learning community. The development of the learning community constructs have come to include such common features as shared norms and values, a focus on student learning, collaboration, collective inquiry, and an action orientation (Blankstein, 2004; DuFour & Eaker 1998). With collaboration, inquiry, and an action orientation, various activities within the school can affect different members of the school community. For example, the learning curve for a preservice teacher in a yearlong in-school placement is similar to that of a 1st-year teacher. Therefore, connecting these two groups in ways that provide for their development can grow a network of support within the school setting where these two groups exist.

The character of the professional learning community is one of inquiry. Lambert (1998, 2003) describes the importance of the reciprocal processes of leadership in a professional learning community that include reflection, inquiry, dialogue, and action. For example, the kinds of questions that would promote inquiry and dialogue within a school (DuFour & Eaker, 1998) might include "What do we want students to know?" "How will we know if they know it?" "What will we do if they don't?" and "What will we do if they already knew it?" This disposition for asking questions about student learning leads to dialogue and discussions among preservice, novice, and experienced teachers about effective teaching practices. Research indicates that faculty in successful schools continuously question existing instructional practices and do not blame lack of student achievement on external causes (Glickman, 2002).

The professional learning community framework is structured into three critical areas: a collaboratively developed and collectively shared vision and mission, collaborative teams that work interdependently to achieve common goals, and a focus on results and commitment to continuous improvement (Eaker, DuFour, & Burnette, 2002). The collaborative relationship described in this project embraced these critical areas for a professional learning community. Posing DuFour and Eaker's (1998) key questions of a professional learning community provided the impetus for the school faculty in this study to document its efforts at increasing mathematics achievement for third graders.

In the sections that follow, we describe the project and its outcomes, which resulted in a significant increase in student achievement for all third-grade students in the school on state-level standardized tests. We share our story to highlight the time, effort, and complexities of engaging in this process. We also describe how this process developed the instructional and data analysis skills of the teachers in the project.

## The Code RED Project

The elementary school in this project entered into a professional development school relationship with the local university in 1999. The teachers at the school had worked together for 5 years with the same university professor, who had been assigned to that school by the university, and over that time a culture of inquiry had slowly evolved. Elementary teachers on the staff at the school were trained as clinical faculty, which meant that they were responsible for supervising and coteaching with graduate-level preservice teacher interns. This university training process for clinical faculty development created a core of teachers at the school who coached preservice teachers using reflective practices. At the same time, the school began to learn about the framework of a professional learning community. Reflective discussions about teaching occurred among preservice teachers, in-service teachers, and the university professor as part of regularly scheduled meetings between the school faculty and university professor, as part of regularly scheduled seminars between the preservice teachers and the university professor, and informally on a daily basis between the school faculty and the preservice teachers who were placed in the school. One of the elementary teachers described this reflective process as follows:

> If I was constantly coaching a student teacher to examine his/her practices and revise them based on student outcomes, I myself needed to be doing the same things. I needed to have better answers when a student teacher asked me why I did something in a certain way. I began to build more reflection into my own teaching.

The mathematics education professor who served as the supervisor for the preservice teacher interns was in the school every week interacting with preservice teacher interns and classroom teachers. Over the course of 5 years, the mathematics education professor and the teachers built strong professional relationships that were supported by weekly interactions at the school. The university professor's background included 10 years of public school teaching at the elementary and middle grades, which gave her an understanding of the routines of the elementary school culture from the perspective of a classroom teacher. She had 8 years of experience with beginning teachers, in teaching mathematics methods courses and in supervising teacher interns in field placements. This experience in classrooms and work with preservice teacher interns gave her a practical school-based perspective on current classroom practices and high-yield strategies for student success.

The preservice teacher interns were placed in full-year internships at the elementary school. Because of this long-term placement, the preservice teachers learned the culture and routines of the school through firsthand interactions with students, teachers, school personnel, and parents. In addition to experiencing these collaborations, the preservice teacher interns benefited professionally. In many cases, the preservice teacher interns were offered positions as classroom teachers in the school system because they had learned the culture and expectations of the school system after working for one full academic year in the elementary school. The hiring of preservice teacher interns at the school who came from the university's programs enhanced the relationships among these professionals that developed over 5 years. For example, the classroom teachers who had been mentors of the preservice teachers were now the latter's colleagues; the university professor, who had supervised the preservice teachers, was now a collaborator on their classroom projects.

As time passed, the preservice teacher interns, the classroom teachers, and the university professor began working together to conduct small classroom research projects. Having the preservice teacher interns in the school provided additional resource personnel for these projects and engaged the preservice teachers in classroom action research practices. The collaborative experiences and the trust that developed allowed classroom teachers, preservice teachers, and the professor to work together to collect data and examine instruction. This shared work included discussions with classroom teachers about teaching and learning, with a focus on how teachers might study and write about practices in their own classrooms. Some of these projects became presentations and published articles highlighting mathematics teaching and learning in the school (Kosbob & Moyer, 2004; Mailley & Moyer, 2004; Moyer & Mailley, 2004; Moyer, Niezgoda, & Stanley, 2005; Niezgoda & Moyer, 2005; Sweda, Knotts, & Moyer, 2004). These collaborative publications further enhanced the positive relationships between the school and the university.

## Expanding the Culture of Inquiry

As the university and school faculty wrote together for publication, they expanded the inquiry culture to other teachers and prompted the establishment of a more formal teacher research initiative within the school. The expansion of teacher research beyond the core of clinical faculty, who worked with interns, to other school faculty created an inclusive climate that set the expectation for all teachers to be engaged in inquiry on effective teaching practices. The teachers' classroom research resulted in the elementary school's holding an event that it called the Teacher Learning Fair, in which the teachers presented their individual classroom research projects. The fair was attended by teachers and administrators from the rest of the school system. To prepare for the presentations, teachers developed brief reports about their projects, which described their research questions, data collection methods, and resulting implications for classroom practices. As a result of this school-based activity, the school-system administrators enlarged the scope of the Teacher Learning Fair to include a cluster of 30 schools. The purpose of this new initiative was to broaden the collaborative culture of learning from classroom research across the K–12 school-system environment.

## Making Plans to Affect Student Achievement

Although the initial collaborative relationship was built on a school–university professional development school partnership to support preservice teachers, the partnership expanded well beyond this goal in subsequent years. These changes led to a shared focus on plans to affect students' mathematics achievement at the elementary school. This focus on mathematics involved the improvement of mathematics teaching and learning for preservice teacher interns, classroom teachers, and the university mathematics education professor, within the context of the school community.

During the year of this project, the improvement of student achievement scores on the state mathematics assessment surfaced as an important goal of the third-grade teacher team. Meeting adequate yearly progress goals in subgroup populations was critical in this Title I school because of accountability requirements of No Child Left Behind. This legislation mandates that all public schools be held accountable for the yearly progress of all students, including subgroup populations of students. Based on past state mathematics test scores, the third-grade team selected the improvement of mathematics performance as its collaborative goal. As part of the school's professional learning community goals during the year of the project, each grade-level team worked to collect student assessment data that could inform instruction. The use of released test items from the state's assessments allowed the teachers to develop common mathematics assessments for their grade level. Developing these common assessments enabled the school to identify students in need of mathematics remediation or enrichment.

During the fall of the project year, the school principal and the university professor had a crucial conversation. The school principal related to the university professor her concern about critical mathematics needs in the school and her vision for having a broad impact on student achievement. The two talked about how to put this vision into practice by using existing school structures and resources. These ideas focused on the use of high-yield strategies that would have a profound impact on mathematics achievement (Marzano, Pickering, & Pollock, 2001). The principal was aware that the research that the teachers and the professor had conducted had built confidence in individual teachers in using teacher research in their own classrooms. The principal believed that this relationship could be the basis for a move from individual teacher research to grade-level or schoolwide action research. She also understood that she was asking the university professor to work with classroom teachers beyond her role as a coach and supervisor for the preservice teacher interns; therefore, the principal committed school resources to this professional development work.

## Professional Development With a Purpose

As a result of the conversation between the university professor and the principal, the university professor began working with the third-grade teachers as a team. The professor prepared to take on a coaching role with the teachers that would include looking at student data and talking about instructional practices in mathematics that were based on those data. As a framework for designing the professional development, the university professor structured her planning around the research regarding what makes professional development effective for teachers of mathematics (Garet, Porter, Desimone, Birman, & Yoon, 2001; Loucks-Horsley, Hewson, Love, & Stiles, 1998; Smith, 2001). Results from a national sample of mathematics and science teachers indicate that six structural and core features of professional development have the greatest impact on teacher learning (Garet et al., 2001). The structural features include the form of the activity, duration, and collective participation. The core features include the content focus of the activity, active learning, and coherence.

Research indicates that the form of the professional development activity can make teachers more or less responsive to changing teaching practice (Darling-Hammond, 1995, 1996). The university professor chose reform types of professional development, such as a teacher study group with follow-up coaching, rather than a more traditional type of professional development, such as a teacher workshop. During the teacher study-group session, the university professor facilitated discussion among the teachers, the mathematics specialist, and herself. Although the professor did not make a presentation to the group, she did prepare manipulative materials and other handouts that could be used as examples to discuss the mathematics topics that arose as part of the group discussion. When questions arose about mathematics instruction, the professor shared ideas in the role of a coach and colleague rather than an "ivory tower expert."

Professional development that is sustained over time, or that has duration, has the highest likelihood of making lasting changes in classroom practice. Because of the long-term relationship of collegial work in the school, the transition into the Code RED Project was a natural extension of the work that was already being done. During the Code RED Project, the teachers and university professor continued their interactions both formally (in a study group and in grade-level meetings) and informally (in hallway conversations). Throughout the school year, these discussions provided teachers with opportunities to test instructional strategies and discuss the results with their colleagues and the university professor.

A third structural feature of the professional development during the Code RED Project was collective participation. When professional development is designed for teachers from one school who are teaching at the same grade level, they have many more opportunities than otherwise to discuss the concepts they are learning and the instructional strategies they are finding effective in their classrooms. In this case, the teachers shared curriculum materials, assessments, and standards, and they were able to share ideas about the needs of the third-grade students whom they were teaching.

To the university professor, the focus on mathematics content was one of the most important features of the professional development. When professional development has a specific content focus, such as the Code Red Project's focus on third-grade mathematics, it can have a significant effect on changing teachers' practices (Corcoran, 1995). During the study-group discussions, the university professor shared mathematics problems, and the group discussed the mathematics content knowledge that students would need to solve those problems. After the mathematics content in a problem was identified, the group discussed strategies for teaching that content, common error patterns that students experience in learning that particular content (Ashlock, 2006), and how to extend the content for advanced learners. These discussions, focusing primarily on the mathematics, revealed that teachers did not always understand how to develop a particular mathematical topic, because of gaps in their own learning. Through these mathematics discussions, the classroom teachers' mathematical content knowledge was strengthened.

A feature of effective professional development that is particularly important to classroom teachers is coherence. Coherence involves how the teachers perceive the professional development in connection with other school goals, as aligned with their state and school-system standards and assessments, and as a catalyst for ongoing discussion and communication among the group and beyond the group to other members of the school faculty. The goals of the Code RED Project were clearly embedded in the school's goals and the teachers' goals as a third-grade team. Their efforts to improve student learning were aligned with the content of the state standards and included an in-depth examination of the state-standardized assessment items for their third graders. Because of this coherence, the Code RED Project prompted many discussions about mathematics topics among teachers, administrators, preservice teacher interns, the university professor, and the mathematics specialist.

The core feature of active learning was evident throughout the Code RED Project. The university professor and the school's mathematics specialist were actively engaged in discussing types of data available at the school and data that they needed to collect and analyze. The university professor learned how the data in the school were aggregated by subpopulations and how these were important to the school's yearly goals. The mathematics specialist learned strategies that the university professor used to organize the data and determine focus areas where students were repeatedly having difficulty on the school's assessments. During the study-group sessions with the teachers, participants examined the third-grade data and collaboratively identified mathematics content that was particularly difficult for students. An important part of this process was that the teachers were actively engaged in learning to read the student data, in identifying the mathematics content in the data, and in determining priorities for addressing areas of weakness for the third-grade class. Having teachers analyze the data was a much more powerful process than if the professor had announced the weakness areas to the teachers. Learning how to conduct an analysis of student mathematics data enabled the teachers to use the process on their own in subsequent years to identify students' needs.

## Instructional Practices That Focus on Representations

During the group sessions, the professor distributed copies of mathematics problems from the state assessment tests so that teachers could answer the questions and discuss strategies and content. As teachers reviewed the test items, they realized that they had not taught a particular concept in the format that was presented to students on the state assessment, even though they had taught the mathematics content of the test item. Teachers recognized that students would need exposure to a variety of visual and pictorial representations of mathematics content to understand and correctly respond to a mathematical question. Through this recognition, teachers used grade-level meetings and informal discussions to talk about how best to teach a particular mathematics topic.

The university professor worked with the teachers to recognize the importance of connections among various forms of representations (such as manipulatives, pictures, and symbols) and how those representations might appear as test items. Mathematical representation is one of five process standards in the *Principles and Standards for School Mathematics* (National Council of Teachers of Mathematics, 2000). In the teaching and learning of mathematics, teachers and students use a variety of representations to organize, communicate, and record mathematical ideas. The teachers here therefore began using more nonlinguistic representations (Marzano et al., 2001) in their teaching, including graphic representations (graphic organizers), physical models (manipulatives), mental pictures, drawing pictures, and kinesthetic activity, to expose students to various representations for a mathematical concept. Teachers also provided more opportunities for students to translate among various representational forms, including physical models, visual or pictorial models, and symbolic notation. An example of this translation from one representation to another may occur among the following: a picture of a fraction region, words or numerals for that fraction amount, and a $10 \times 10$ decimal-grid representation equivalent to that amount. To engage students in this new way of thinking about the mathematics, teachers used more questioning during instruction to promote student thinking.

Teachers also began using a problem of the day in which the teacher talked through her thinking and solution routes when solving a problem, and she encouraged students to do the same. The third-grade teachers and mathematics specialist collaborated to select and create these problems of the day so that they would focus on weakness areas identified from the third-grade assessment data. Verbalizing their solution routes for students and preservice teacher interns allowed the classroom teachers to examine their own thinking, which influenced how they viewed their instructional practices. This verbalization, in an effort to make their thinking more transparent, was a shift in instructional practices for the teachers on the third-grade team. The principal and the university professor realized that these shifts in thinking would be required across the grade levels for changes to be made throughout the school. By the end of the academic year and into the summer months, the university professor worked with the entire elementary staff to focus on grade-specific mathematics topics, nonlinguistic and visual literacy, and the use of representations for teaching mathematics.

### Third-Grade Team Takes Ownership of Student Achievement

The school's professional learning community was a noticeable shift from teachers' focus on teaching to their focus on student learning. It was evident that the third-grade team had taken ownership when it decided to name the project Code RED. Giving the initiative a name signified the importance of the project to the team, and it was one of the third-grade teachers who created the name. The teachers were especially concerned about students' mathematics achievement in Grade 3 because this was the first grade level where children in the state took the state-level standardized test. The teachers knew that this content was an important benchmark in mathematical learning for subsequent grades.

## Method

In the sections that follow, we describe the research conducted by the team for the Code RED Project—including the participants, procedures, data sources, analysis, and results—which focused on the following overarching research question: What is the impact of the Code RED Project's focused remediation and enrichment on the mathematics achievement of students in Grade 3?

### Participants

This project was conducted at an elementary school on the East Coast near the Washington, DC, Metropolitan area. The school is a designated EXCEL school, which means that it receives Title I mathematics and reading support. After-school programs include After-School Remediation and School Age-Child Care (SACC). There were 580 students attending the school during the project. The student population was comprised of students from over 29 countries with major concentrations of Hispanic and Vietnamese populations. Schoolwide populations were reported with the following demographics: Asian 25%, Black 2%, Hispanic 44%, White 24%, and other 5%. There were 34% English-as-a-second-language students, 43% fee-waiver students (free/reduced lunch), 4% gifted services, and 23% special education services. Of these students, 20% were classified with little or no English proficiency.

*Third-grade students.* A total of 84 third-grade and 3 second-grade accelerated students participated in the Code RED Project. The students in the five 3rd-grade classes ranged in age from 7 years to 10 years. Twelve special education students participated. The ratio of females to males in the Code RED Project was 42 to 45. The students varied in their degrees of mathematics proficiency, from high levels of achievement to low levels of achievement. During the Code RED Project activities, students were placed in 10 heterogeneous groups of approximately 8 or 9 students for their participation in the remediation and enrichment days.

*Code RED Project faculty.* A total of 15 educators were involved in the design and implementation of the Code RED Project. Of the 15 educators involved in the project, 11 served as instructors for the Code RED Project. These individuals included the third-grade teachers, school administrators, and instructional support staff. Each teacher was asked or had volunteered to participate in the Code RED Project. Some instructors taught lessons every session, whereas other instructors took turns teaching the 10 identified weakness areas for remediation and enrichment. These instructors varied in their years of experience in education, from 2 years to 21 years. Three individuals served as substitutes in cases where a teacher was absent.

## Procedures

At the beginning of the project, students in third grade completed a mathematics pretest. The pretest was a 50-item measure based on released items from the state's learning standards test. The assessment was administered in January as a pretest and again in May as a posttest. The university mathematics education professor and the school mathematics specialist collaborated to disaggregate the data gathered from the pretest.

We analyzed the pretests to identify patterns in the test items that were missed by over 70% of the students in each of the five 3rd-grade classes. We first identified these test items by individual class and then looked across the classes to identify items most frequently missed in all of the classes. An analysis of the pretest showed that there were common areas that over 70% of the third-grade students answered incorrectly.

After determining these key areas of weakness, the university mathematics education professor and the school mathematics specialist shared the data with the third-grade team of teachers in a half-day study-group session. During the session, the group collaboratively decided to focus on 10 key areas for the Code RED Project. These 10 key areas were integrated into daily mathematics instruction in all third-grade classrooms and were used for focus lessons on the Code RED Project days. The 10 key focus areas included probability and interpreting outcomes, fraction denominators/numerators, rounding, problem-solving strategies, using/interpreting visual images, translating from pictures to word text and word text to pictures, recognizing test distracter items, vocabulary used for subtraction, keys on graphs and different types of graphs, and decimals/fractions and their relationship to one whole.

There were 10 Code RED Project days that occurred over a 10-week period. On each Code RED Project day, third-grade classroom teachers did not teach a regular mathematics lesson. Instead, students participated in a Code RED Project–day mathematics lesson that focused on 1 of the 10 key areas of identified weakness for the third-grade students. The students participated in the Code RED days in 10 small groups, with approximately 8 or 9 students in each group. The lessons were taught in classrooms and other locations throughout the school. The distribution of students to these groups was based on their performance on the pretest assessment, as well as other classroom performance indicators from the fall semester. The distribution of students in the 10 groups included two groups of advanced students and eight groups of students with an equal distribution of low- and average-ability students. Students in the eight groups participated in instructional sessions that focused on remediation and enrichment of the key focus areas. Students in the two advanced groups participated in instruction with a greater focus on enrichment. All of the sessions focused on developing students' mathematical proficiency and fluency by working with skills, content, and strategies. The focus of the remediation was on conceptual understanding and common student error patterns. The focus of the enrichment was on extending the concepts beyond grade level and to deeper levels of understanding.

One instructor was assigned to each of the 10 key focus areas. In addition to the five 3rd-grade classroom teachers, instructional aides, administrators, and other support staff served as five additional instructors so that students could participate in Code RED days in small groups. Each instructor taught one key focus area every week for 10 weeks. For the instructors, this reduced the amount of their preparation time for the 10 lessons. Instead of preparing 10 different lessons, each instructor could prepare an in-depth lesson on one focus area (e.g., different types of graphs). In preparing this lesson on different types of graphs, for example, the instructor found numerous types of graphs with different presentation orientations, examined error patterns that students make when reading and interpreting graphs, and reviewed advanced types of graphs with multiple points of information and complex keys. This enabled the instructor to become an expert on understanding graphs and the developmental progression of students when they learn to read and interpret graphs. The instructor prepared basic lessons on graphs to support students who were just learning to read graphs, as well as complex lessons for the more advanced students. This deep level of engagement with the content strengthened teachers' own mathematics knowledge and gave them practice in creating lessons that differentiated for various levels of student learning.

The nature of the instruction during the lessons included the use of physical models (manipulatives), visual/pictorial models, and symbolic notation, in an effort to make connections among these various forms of representation. The interactions among students and instructors focused on questioning and discussing mathematics topics and on students and instructors sharing their thinking through writing and drawing.

During the Code RED Project, students had a different teacher every week for 10 weeks on each project day. Students focused on content during the Code RED days different from that of some of their classmates, and the instruction was more interactive for the students. Because the students were participating in lessons taught by nine instructors plus their third-grade classroom teachers, they were exposed to a variety of representations and presentations of the mathematics. Because the students were learning content different from that some of their classmates, students discussed the mathematics with one another when they returned to their classrooms. And because they were in smaller groups, they had more interaction with the instructor and were able to have more discussions about mathematics with their small groups.

As part of their participation in the project, the third-grade teachers received additional released time to collaborate and to plan the Code RED days. These opportunities to plan and collaborate prompted discussion about instructional strategies. These discussions supported changes in instructional practices during the daily mathematics lessons and gave instructors ideas for the 10 Code RED–day experiences. Preservice teacher interns participated in the professional development activities and discussions, learned new instructional strategies to use for support in the classrooms, and provided instructional support to release teachers from their classrooms for some of the grade-level team planning times, and they participated in other team planning sessions.

The first Code RED Project day started in early March and occurred every Tuesday until the end of May for a period of 10 weeks. The mathematics specialist, school principal, and mathematics education professor documented activities during the project. They believed that the results of the Code RED Project may have the potential to provide the information needed to implement the process of remediation and enrichment in other grades at the school.

## Data Sources

The first source of data for this project was the pretest and posttest assessments of students' mathematics content knowledge in the five 3rdgrade classrooms. Both the pretests and posttests were forms of the same mathematics assessment. This assessment was a 50-item multiple-choice test composed of the mathematics release items from the third-grade state mathematics test.

A second source of data for the project was an informal teacher ranking by each teacher to identify student achievement levels in each class. Students were ranked by teachers as high, average, or low achievement, depending on their in-class performance in mathematics during the first half of the academic year.

The third source of data was compiled from the annual pass-rate scores on the state-level mathematics standards test for the third-grade students at the elementary school. Pass rates were examined from the third graders tested the years before, during, and after the Code RED Project. These scores allowed teachers to make comparisons between the third-grade Code RED Project students and students who completed third grade the year before and had not participated in the project. It also allowed the teachers to see how student performance on the test was affected the year after the Code RED Project, when teachers were using instructional strategies during regular instruction that were based on the use of multiple forms of representation.

## Data Analysis and Results

*Analysis 1.* The first analysis examined the results from the pretest and posttest measures to answer the following question: What was the overall impact of the Code RED Project treatment on the mathematics achievement of students in Grade 3?

To answer this question, we used a paired-samples $t$ test to determine the effect of the treatment on students' posttest scores. The individual student scores served as the dependent variable. Because of student mobility at the school, the number of students that are reported here with complete data points equals 70. The analysis showed a statistically significant gain between the pretest ($M = 66.9$, $SD = 15.2$) and posttest ($M = 80.9$, $SD = 14.8$), $t(69) = -11.882$, $p = .000$. The result indicates that students' scores on the posttest measure of mathematics achievement increased significantly following the Code RED Project treatment.

*Analysis 2.* The second analysis examined the gain scores between the pretest and posttest measures using a comparison of the gain scores among the three teacher-identified groups of students (high, average, and low) to answer the following question: Following the Code RED Project treatment, were there differences in the mathematics achievement gain scores among the three teacher-identified groups of students (high, average, and low)?

To answer this question, we used an analysis of variance to compare the gain scores of the three groups to determine the effect of the treatment on students' mathematics achievement. The mean gain scores served as the dependent variable. The analysis showed no statistically significant differences among the gain scores of the three groups, $F(2, 67) = 1.97$, $p > .05$. The results shown in Table 1 indicate that the gain score of each group was not statistically different from the others. Although there is numerical evidence to suggest that the students identified as low achievement made the greatest gains of the three groups, there is no statistical evidence supporting this trend. In small sample sizes such as this one, it may be difficult to reveal statistical differences using these analyses.

*Analysis 3.* The next analysis examined the results from the pretest and posttest measures to answer the following three questions: What was the impact of the Code RED Project treatment on the mathematics achievement of students in the teacher-identified low group? The teacher-identified average group? And the teacher-identified high group?

To answer these questions, we conducted three separate paired-samples $t$ tests to determine the effect of the treatment on students' posttest scores for each of the three groups, with the individual student scores serving as

Table 1. **Mean Gain Scores for Teacher-Identified Student Groups**

| *Student group* | *Score* |
|---|---|
| Low achievement | 16.45 |
| Average achievement | 14.71 |
| High achievement | 10.60 |

Table 2. Pre- and Posttest Score Means for Low, Average, and High Achievement Students

| *Group* | n | *Pretest* M | *Posttest* M | M *Gain* | p *Value* |
|---|---|---|---|---|---|
| Low | 22 | 52.64 | 69.09 | 16.45 | .000* |
| Average | 28 | 66.86 | 81.57 | 14.71 | .000* |
| High | 20 | 82.50 | 93.10 | 10.60 | .000* |

*$p < .001$.

the dependent variable. Table 2 presents the results of this analysis. These analyses showed a statistically significant gain between the pretest and posttest measures for all three of the individual groups. These results indicate that each of the teacher-identified ability groups earned scores on the posttest of mathematics achievement that increased significantly following the Code RED Project treatment.

*Analysis* 4. Another analysis examined the results from the pretest and posttest measures to answer the following five questions: What was the impact of the Code RED Project treatment on the mathematics achievement of students in Teacher A's class? In Teacher B's class? In Teacher C's class? In Teacher D's class? In Teacher E's class?

To answer these questions, we conducted five separate paired-samples $t$ tests to determine the effect of the treatment on students' posttest scores for each of the third-grade classrooms, where the individual student scores served as the dependent variable. Table 3 shows the results of this analysis. This analysis shows a statistically significant gain between the pretest and the posttest in four of the five 3rd-grade classrooms.

The results indicate that four of the five classrooms earned scores on the posttest of mathematics achievement that increased significantly following the Code RED Project treatment. Although students in Teacher D's classroom showed numerical gains on the posttest, these gains did not reach statistical significance. The students in Teacher B's and C's classes showed the most significant average gains following the Code RED Project treatment.

*Analysis* 5. In the final analysis, we examined the following question: How did the standardized state-level test scores of students in third grade who participated in the Code RED Project compare with the test scores of students who completed the third-grade standardized test the year before and the year after the Code RED Project?

To answer this question, we examined the overall scores of students in Grade 3 at the elementary school who participated in the state-level assessment in spring 2003 with students who participated in spring 2004 (the year of the Code RED Project) and spring 2005 (the year after the Code RED Project). In essence, this gave us a control group for comparison of the state-level testing data. It also allowed us to examine how the new teaching strategies being used by teachers during regular instruction, with a focus on representations and visual/pictorial models, carried over into the next year of instruction after the Code RED Project had ended. We disaggregated these data to further examine the scores of students in several subgroups. Table 4 presents pass rates for all students and subgroup populations.

Table 3. Pre- and Posttest Score Means for Each Third-Grade Class by Teacher

| *Teacher* | n | *Pretest* M | *Posttest* M | M *Gain* | p *Value* |
|---|---|---|---|---|---|
| A | 16 | 67.00 | 81.38 | 14.38 | .000* |
| B | 14 | 58.43 | 74.86 | 16.43 | .000* |
| C | 13 | 69.85 | 86.46 | 16.61 | .000* |
| D | 12 | 68.00 | 76.67 | 8.67 | .074 |
| E | 15 | 71.07 | 84.80 | 13.73 | .000* |

*$p < .001$.

Table 4. Third-Grade Pass Rates on the State Mathematics Assessment in 2003, 2004, and 2005

| Group | *Control* *2003* | *Code RED* *2004* | *After Code RED* *2005* |
|---|---|---|---|
| All third-grade students | 79% | 100% | 91% |
| White | 83 | 100 | 100 |
| Hispanic | 74 | 100 | 84 |
| Limited English proficient | 68 | 100 | 83 |
| Economically disadvantaged | 75 | 100 | 86 |
| Disabled | 67 | 100 | 92 |

These pass rates show that 100% of the students—that is, every student in the third-grade class—passed the state-level mathematics assessment during the Code RED Project. As the table shows, in the year before the Code RED Project, 21% of the third grade did not pass the state mathematics assessment. Table 4 also shows that only 9% of all third graders did not pass the state assessment the year after the Code RED Project. In addition, there were overall increases in the pass rates for all subgroups between the 2003 and 2005 academic years. The largest populations of students who did not pass the mathematics assessment in 2003 were in the limited-English-proficient and disabled subgroups. As the table indicates, there were strong numerical increases in these pass rates following the Code RED Project.

It is also significant to note the number of students who tested in the pass-proficient and pass-advanced achievement categories when comparing the 2003, 2004, and 2005 results. Figure 1 reports numbers of students in the fail, pass-proficient, and pass-advanced reporting categories for 3 years. Not only does it show that the number of students who failed the test in 2003 dropped to zero in 2004, but it also illustrates that students testing in the proficient category increased by 48% and those in the advanced proficiency category increased by 48%. These percentages represent significant increases in student achievement for the third-grade students during the year of the Code RED Project. The distribution in 2005 is also an improvement in all categories when compared with the 2003 baseline data.

A final note that is important to consider is the 100% pass rate on the state assessment, as well as the performance of students on the pre- and posttests in the five classes. Although the pre- and posttest assessments designed by the Code RED Project team revealed that four of the five classes demonstrated significant gains on the posttest, one of the classes (that of Teacher D) did not. However, when the students in Teacher D's class completed the state standardized testing later that spring, the students in Teacher D's class, like the students in the other four 3rd-grade classes, all passed the state test.

## Discussion: Increasing Student Achievement

These findings show that the Code RED Project had a positive impact on students' mathematics achievement scores in Grade 3 during the year of the project. The pre- and posttest results showed significant improvements for third-grade students when the team focused on students' needs based on the data they had gathered. The 100% pass rate on the state-level mathematics assessment for all third-grade students during the year of the Code RED Project was a second source of data to confirm these conclusions. We believe that an important part of this project was the teachers' learning to interpret student data and their using that data to focus on remediation and enrichment. Students participated in mathematics sessions that targeted their needs for a period of 10 weeks. Rather than review or remediate using general concepts, the Code RED Project days were focused on identified weaknesses for this group of third-grade students.

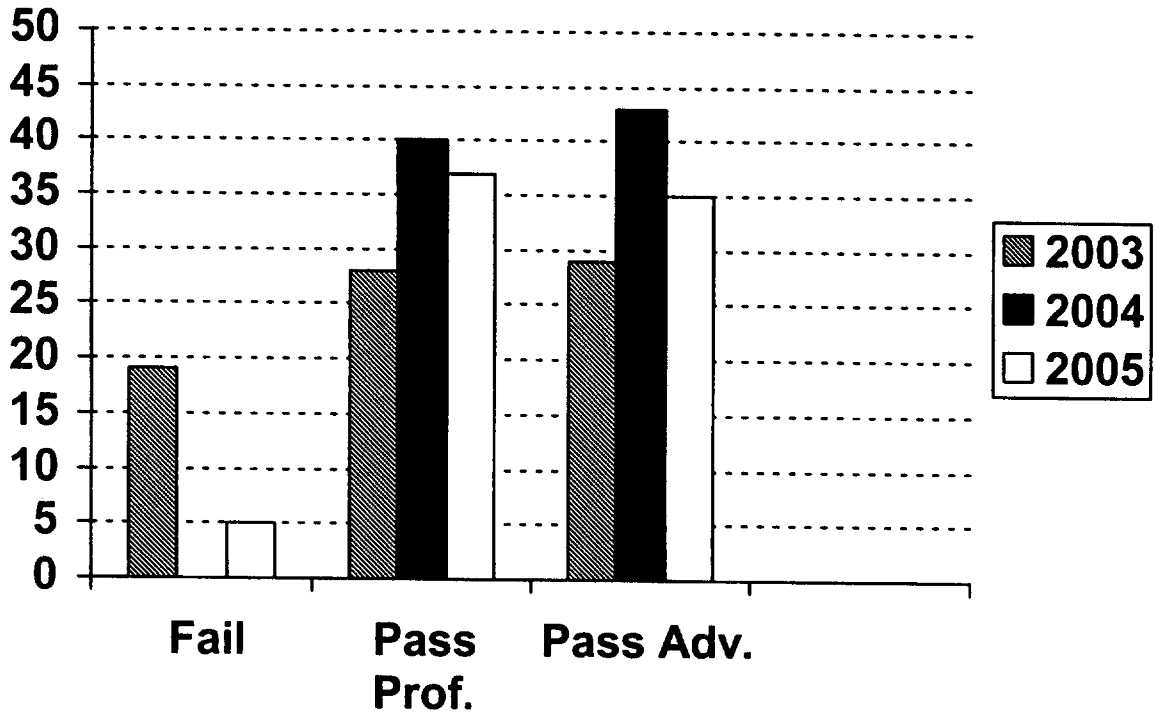


Figure 1. Number of third graders in the fail, pass-proficient, and pass-advanced categories on the 2003, 2004, and 2005 state mathematics assessments.

Another important component of the increase in student achievement was that the classroom teachers were focusing on a deeper understanding of the mathematics and on various representations for the mathematics during regular instruction as well as during the Code RED Project days. Rather than focus on the teaching of a lesson, teachers shifted their focus to student needs, student thinking, and how students were learning. This shift meant that the culture for teaching among the members of the team moved from planning for teaching to planning for learning. The teachers were learning planning, instead of lesson planning. A culture of learning planning means that teachers are more apt to ask questions about learning outcomes and examine their own role in those outcomes. We believe that the teachers seriously examined how they might have a positive impact on student learning in this project.

The resulting increase in student achievement launched other school teams to engage in more reflection, inquiry, dialogue, and action—all hallmarks of a successful school culture (Jolly, 2005). As teachers in other grade levels observed the efforts and outcomes of their colleagues' work, this embedded professional practices associated with inquiry throughout the school. As a result of the Code RED Project, all grade levels began schoolwide planning that focuses on improving mathematics achievement for all students in the school.

## Enhancing Teachers' Instructional Practices and Leadership Attributes

The evidence of students in the third grade continuing to be successful on the state-standardized assessments following the Code RED Project demonstrates how teachers embedded what they learned during the project into their daily instructional practices. We believe that these persisting improvements can be attributed to a change in teachers' mathematical content knowledge, use of more representational forms (including visual/pictorial), and strategies for differentiating instruction for students of differing ability levels. Teachers worked together with the university mathematics education professor and the school mathematics specialist to target specific mathematics content strands and concepts, and develop strategies that would increase students' understanding of those concepts. In particular, teachers engaged in examining mathematics items and understanding the mathematical thinking that would be required of students for responding to those items.

When the teachers worked backward from the test items, it allowed them to focus on the mathematics content in the items, the various forms of representation (including numbers, symbols, pictures, graphs) that were used to convey mathematical ideas in items, and the complexity of the multistep thinking that was required for a response. For example, when teachers examined one of the fraction items, they found that the question stem was presented in the form of a fraction numeral with fraction words; the picture that accompanied the problem was presented as a set model for fractions; and the response items were presented in decimal form. When teachers examined this question format, they began to think about how they were teaching the concepts and whether their instructional strategies were addressing the knowledge that students needed to respond accurately to these types of test items. This shift in focus enabled the teachers to, rather than teach to a test, focus on the types of teaching strategies required for teaching mathematical concepts in ways that build students' mathematical thinking.

Another important distinction in their instruction was that, from a developmental perspective, teachers had a deeper understanding of the mathematics. They recognized students' error patterns as well as how to extend and enrich a concept for advanced students. This type of analysis of mathematics problems carried over into teachers' regular instruction, and viewing concepts from remediation through enrichment became a part of regular practices following the Code RED Project. By incorporating these professional strategies into their daily mathematics instruction, teaching and learning in third grade regularly included differentiated learning with planned remediation and enrichment that supported students. In the year following Code RED, these instructional practices continued, and students' scores on the state-standardized assessment positively reflected these changes in teachers' instructional patterns.

## Preservice Teacher Development

When a school develops common practices, they become institutionalized by the common language that all parties begin to use. That then becomes the way in which the school conducts its business. In this elementary school, the practice of using data to inform instruction and plan for learning in collaborative teams was modeled by the classroom teachers (Reeves, 2004). Examining student data together provided a context for the preservice teachers to be engaged in professional planning and reflection as members of the school community. Preservice teachers embedded in grade-level teams were engaged in the daily dialogue of the project. These conversations allowed them to participate in the culture of inquiry modeled by the teachers, acquire the language of the professional community for which they will be members, and practice professional learning planning in the real-life context of the school. The classroom teachers made their thinking and planning transparent to the preservice teachers throughout the Code RED Project. This openness allowed the preservice teachers to observe and discuss the process with their supervising classroom teachers and the university professor. It also developed the classroom teachers as better mentors for the preservice teachers.

The preservice teachers at this school were able to see firsthand how their supervising classroom teachers participated in a process of their own professional learning and development. They saw how the teachers took ownership of a school concern and developed a solution that they implemented and how this implementation yielded positive learning results for the students. This systematic examination and inquiry process on the part of the classroom teachers showed good instructional practices in mathematics. It also modeled for the preservice teachers the processes used by professionals to engage in collective inquiry and achieve the common goal of affecting student achievement for the entire grade level.

## Concluding Remarks

This study highlights the broader impacts of how a partnership among school and university faculty and students can result in meaningful mathematical learning for everyone involved in the process. Although the results for the third-grade students on the state mathematics assessment were an impressive outcome of this project, even more significant were the lessons that the teachers learned about mathematics and the analysis of student data, the instructional shifts that the teachers made in their focus on learning planning (rather than lesson planning), and the benefits for the preservice teachers whom they were supervising. These shifts in thinking are the kind of results that can change a school's culture and have a resounding impact on professional practices for years to come. These changed practices will not simply affect the outcome of one year's standardized mathematics test results but will influence the way that teachers approach student learning throughout their careers. A current reality of public schooling is student accountability. We encourage our colleagues in education to think about accountability beyond our standardized testing results and to use our creative partnership as an impetus to focus more on the actions that schools can take to create a culture of inquiry that results in sustained learning for teachers and students. ATE

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