Strategic Math: A Student-Centered Approach to Remediation in Mathematics

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Abstract

A middle school level, one semester long mathematics remediation course was created (a) for students who scored below the 50th percentile on a diagnostic test, and (b) with a curriculum focused on rational number concepts. Students were placed in Strategic Math remediation courses based on their diagnostic test scores. Diagnostic tests revealed students' greatest remediation need was in the area of rational number concepts and operations. The Strategic Math curriculum was created with the expressed purpose of providing remediation in rational number concepts and operations. Strategic Math students noted improved scores on the same diagnostic test they had taken for placement in the course. Students' standardized test scores in mathematics before and after attendance in Strategic Math were compared. Students who participated in Strategic Math realized test score improvements on the California Standardized Test in the mathematics content area. The greatest standardized test score gains were noted on the rational number concepts mathematics cluster.

This case study aims to contribute to the current research in mathematics reform. The school district in which the school under study resides, Palm Grove Middle School, was embroiled in

broad and sweeping reform and restructuring in an effort to respond to the demands of the No Child Left Behind Act, NCLB, and to keep pace with the increasingly diverse needs of students. Palm Grove Middle School made substantial progress toward reaching the growth targets of NCLB. Within the content area of mathematics, however, Palm Grove's standardized test scores leveled off and fell short of targeted growth requirements. In response to this urgent circumstance, a mathematics remediation program was established at Palm Grove. Students were given a diagnostic math test and placed in semester-long Strategic Math classes focusing on rational number concepts and operations, the diagnosed greatest area of need as revealed on students' diagnostic tests. The Strategic Math intervention program evaluated in this study was a targeted remediation course in which students' placement and curricular design were determined by a diagnostic test.

In preparation for conducting this study, three large case studies of school reform demonstrating the need for focused, student-centered mathematics reform were reviewed. The large case studies of school reform emphasize current large-scale efforts in Houston, San Diego, and Chicago thereby pointing to a nation-wide need for continued and varied school reform. Hess (2006) researched and wrote about San Diego; Bryk, Sebring, Kerbow, Rollow, and Easton (1998) researched and wrote about Chicago; and McAdams (2000) researched and wrote about Houston. Additionally, this research refers to the findings of a case study conducted within a pre-algebra setting (Brenner, Mayer, Moseley, Brar, Duran, Reed & Webb, 1997) involving the social construction of knowledge about functional relationships and multiple mathematic representations. The research conducted by Brenner et al. (1997) use of multiple representations to understand functions in mathematics grounds the specifically mathematic focus of this research study. Brenner et al. studied prealgebra students' constructed understanding of multiple representations of functions within 6 mathematics classrooms at 3 middle schools within urban southern California. All four case studies analyzed and presented research results using mixed quantitative and qualitative methodology. The stories of school reform are told in the narrative as they unfold within widely diverse contexts. Data within all four cases is also presented using

statistical methods to reveal constructs and circumstances that complement the discourse analysis.

This Strategic Math study presents an evaluation of a one-school reform effort that is specifically targeted at remediation within the mathematics content area in general and on rational number concepts and operations in particular. Strategic Math students were selected for participation in Strategic Math remediation and for participation in this study based on a diagnostic mathematics test. The diagnostic test results were also used to determine that students' greatest area of need was in rational number concepts and operations; the Strategic Math curriculum therefore targeted this specific need. Current research within the mathematics content area demonstrates that when educators focus their remediation efforts on creative ways of helping students to understand rational numbers, these efforts have realized positive student learning outcomes (Tzur, 1999; Cramer, Post & derMas, 2002; Izsak, Tillema, & Tunc-Pakkan, 2008). The efficacy of Palm Grove Middle School's reform effort focusing on students' determined needs in the mathematics content area of rational number concepts and operations is evaluated within this case study.

Rationale

Rationale for the creation of Strategic Math remediation courses. As a result of the No Child Left Behind Act, school districts across the United States, have undertaken large and small scale efforts to reform educational practices and procedures in ways that will hopefully and necessarily lead to positive student outcomes as noted in improved standardized test scores. The school included in this case study was a part of a larger school district which underwent major reform and restructuring efforts. A review of case studies of large-scale reform was conducted prior to this one-school case study in order to place this research within a reform context that paralleled the current circumstances in the school district under study. A major constituency of every large-scale reform effort undertaken was a plan for remediation in the content area of mathematics. Each large case study reviewed exposed reform efforts in the content area of mathematics as failing to achieve targeted student outcomes. This was also the case within the school district under study. Although much effort had gone into reforming the schools in the local school

district, students continued to fall short of NCLB growth requirements specifically in the content area of mathematics. The large reform studies cited here therefore situate this case study in a circumstance that is currently experienced by other school districts where effective mathematics reform specifically continues to elude reformers.

I begin by reviewing current research of reform in San Diego, Chicago and Houston as each school district underwent reform-based restructuring in an effort to improve students' standardized test scores through deep reorganizing efforts and pedagogical shifts. In the San Diego case study, Hess (2006) noted that "the San Diego reform reached into every school in the district – no mean achievement" and "made a concerted effort to change what happens with classroom instruction" (p. 65). Teachers were empowered to change their pedagogy and administrators were empowered to relocate unsuccessful teachers. The San Diego reform efforts were considered by Hess (2006) to be a success in terms of student achievement. Standardized test scores in reading and mathematics increased steadily from 1998 until 2000 in San Diego. The pedagogical practice of first identifying student need, then targeting curriculum and teaching at students' needs through strategically coordinated and applied community practice formed the basis of San Diego's reform efforts. This Strategic Math reform effort studied here mirrored, on a much smaller scale, the San Diego case. Sheltered Instruction teaching strategies form the basis of instructional practice in Strategic Math classes, while the California Math Standards drove the curriculum.

Of all the subjects taught and tested under the NCLB Act, mathematics has been exposed as the most problematic as demonstrated by Hess (2006) in a case study analysis of San Diego's reform efforts. Schools in San Diego demonstrated marked and continuous standardized test scores in all subjects except mathematics. Mathematics test scores improved during the initial 2 years that reform efforts were implemented and then remained flat after that. Hess noted that linguistically diverse students attending San Diego public schools consistently scored lower on standardized mathematics tests than students for whom English was their first language. For reform efforts in

San Diego, Hess noted, English-Language proficiency remains a major obstacle for many students.

Chicago and Houston used similar strategies to bring reform to a large public school district. Bryk et al. (1998) detailed Chicago's reform efforts and unlike in San Diego where the school district bureaucracy was not the subject of the study, bureaucracy took center stage in Chicago. Local school communities in Chicago and Houston had been completely disenfranchised by the education bureaucracy at large. Reformers in both Chicago and Houston (Bryk et al., 1998; McAdams, 2004) found that organizational change and reform were impossible given the bureaucratic system's administrative constraints. Internal control was given back to school principals who engaged parents and stakeholders from the surrounding community. Community groups were encouraged to involve themselves in decisions regarding staffing and curriculum. Once local schools had the power to bring about pedagogical and curricular change, teaching and learning began to improve and flourish within empowered communities of teachers and learners. I was given the power to change both the pedagogy and curriculum of remedial math classes at my middle school. As with the Chicago and Houston case studies, I sought to learn whether teacher empowerment makes a difference in student learning. The Houston case example I present was conducted by McAdams (2004), and eventually led to The No Child Left Behind Act. As with Chicago, the Houston education bureaucracy steadfastly obstructed productive teaching and learning within the city's massive school district. After an extensive and bitter leadership shuffle at the central district office, Houston schools were given both the authority to reform pedagogy and curriculum at the local level and the accountability for student results after reforms were put in place.

Paramount in Houston's reform plan was the transparency of school reform activities and outcomes. The Strategic Math reform effort has been equally transparent from the outset. Detailed plans were first brought to administrators and the education community. Ongoing observations were discussed by teachers and administrators and shared with the district leadership. This Strategic Math case study results were presented to the school, parents, and the

school board. The transparency goal within the Houston reform efforts mirrored my transparency goal within the Strategic Math reform effort.

Rationale for a mathematics remediation curriculum. Current research shows that students' understanding of mathematical concepts improved when curriculum and instruction targeted specific content using multiple representations in alternative contexts (Brenner et al., Kamii & Warrington, 1999). The case study cited by Brenner et al. (1997) presents a research setting that is more closely associated in subject content and research setting with this Strategic Math study than are the large scale reform studies described above. Within the Brenner et al. study, "Learning by Understanding: The Role of Multiple Representations in Learning Algebra," researchers sought to understand how prealgebra students came to understand functions within a teaching unit that emphasized multiple problem representations, a thematic context for learning, and problem solving within cooperative groups. Brenner et al. found that the students who participated in the study demonstrated greater deep mastery of content on both posttests of content, and in their demonstrated understanding of graphic representations of functional analysis than did the control group. Kamii & Warrington found that students gained deep understanding of rational number concepts through the visual and social construction of meaning throughout the teaching and learning process as opposed to the rote teaching of algorithms. The above studies demonstrated that targeted remediation in mathematics that focuses on specific content has noted improvements in students' mastery of designated remediation content. This Strategic Math project presents a case study of prealgebra students in 10 semester-long classes at one middle school in urban, central California. The curricular focus of the Strategic Math program and study was rational expressions; students who were enrolled in these Strategic Math remediation courses demonstrated on a diagnostic test that they were experiencing the most amount of difficulty in understanding concepts involving rational expressions.

Rationale for remediation in rational number concepts. Current mathematics research in the content area of rational number concepts and operations shows that focused intervention efforts using specifically designed curriculum can result in improvement in students' mastery of rational

number concepts and operations (Tzur, 1999; Cramer, Post & derMas, 2002; Izsak, Tillema, & Tunc-Pakkan, 2008). The need for remediation in rational number concepts and operations immerged as I analyzed the diagnostic test results during May and June of 2006. I now examine 3 research studies that examined how students construct understanding (or not) of rational numbers concepts. Within each of these case studies, researchers examined the effects of a unique curriculum on students' construction of fractional thinking. Tzur (1999) examined students' thinking as they discussed problems they were solving with manipulatives (sticks). Tzur's analysis of students' dialogue throughout the research process enabled him, the teacher, to reflect upon students' thinking processes and adjust the teaching and learning activities to best react to emerging teaching and learning needs. The creation of the Strategic Math curricula based on students' diagnosed needs models how a reflexive teaching and learning process can be formalized within a focused unit of study.

One study on students' construction of rational number concepts (Cramer, Post & derMas, 2002) compared the effects of two mathematics curricula each focusing on the teaching and learning of rational number concepts and operations. These researchers compared a commercial curriculum (CC) for initial fraction learning with The Rational Number Project (RNP) fraction curriculum. After conducting this 30-day research study, the researchers found that the students who used the RNP curriculum noted a significant improvement in their test scores over students in the control group who used the CC curriculum. The students I endeavored to study worked with a commercial curriculum published by Prentice Hall (2000) in their regular grade-level math classrooms. Additionally, Strategic Math students used Prentice Hall (2000) "Intervention Units" pertaining to rational number concepts and operations in their Strategic Math classes. Students participating in Strategic Math did so in addition to their participation in regular math classes. The Cramer, Post and derMas (2002) study therefore provides an example of research comparing the effects of divergent fraction curriculum on students' understanding of rational number concepts as demonstrated on focused, multiple-choice tests. Within my study of Strategic Math

students at Palm Grove, I compared the effects of divergent fraction curriculum on students' learning as demonstrated on multiple choice mathematics tests.

Finally, I point to a study conducted by Izsak, Tillema, and Tunc-Pakkan (2008) in which teaching and learning were observed while students used number lines as they constructed their understanding of fractions. This case study exemplifies how graphic representation of fraction problems reveals students' thinking to teachers, while providing students with a means for visualizing rational number concepts and operations. Through this process of using number lines to help students understand fractions, Izsak, Tillema, and Tunc-Pakkan found that 6th grade math students were able to clearly communicate their understanding of fractions to their teacher. A manipulative kit (including number lines) was prepared for each Strategic Math teacher. The number line study discussed above provides a rationale for including manipulatives within the Strategic Math curriculum.

The Case for Strategic Math

History. Palm Grove Middle School originally opened its doors to 6th grade students as a satellite campus of another overcrowded middle school in 1994. Over the next seven years, the school took on more and more students in first 7th and then 8th grades until finally in 1999 the school became an independent middle school with a completely separate and unique campus. Palm Grove is situated in the center of a town of approximately 40,000. Agriculture, a federal penitentiary, and aerospace are the primary employers in the area. This is a neighborhood school; the school district does not provide busing for attending students. The school's socioeconomic circumstances as well as political issues relating to the NCLB, (edsource, 2004) have led to the need for a unique approach to school reform and academic remediation.

For the first two years that Palm Grove operated as an independent school, students' standardized test scores declined. In the third year of operation, the school saw a 75 point increase in students' test scores as measured and reported in the Academic Performance Index (API). The staff at Palm Grove worked very hard to consolidate their efforts during this time of increasing scores. New mathematics programs were researched and implemented, while the

English departments also invested heavily in curricula that would help to develop students' writing skills. Test scores reached their pinnacle in the 650 API range, however. This placed the students' test score average in the proficient range on a scale of 1000; scores between 600 and 799 on a scale of 1000 are considered to be proficient. According to EdSource (2004), NCLB however, will not allow for a single student, regardless of language or special education status, to fail to meet the test score growth requirements. Because of this middle school's large and growing population of students with special language and socioeconomic circumstances, the school failed to meet NCLB growth requirements from 2003 to 2006.

Current Circumstances. At the time of this study in 2007, Palm Grove was in year three of Program Improvement Status. The NCLB Act progressively implements sanctions and penalties in schools that do not meet growth requirements with every individual student over a five year period (EdSource, 2004). The students at the school who were not meeting their test score growth targets were primarily socioeconomically disadvantaged and Latino. The tests that are used to measure students' proficiency are written in grade-level English. The majority of students at Palm Grove cannot read grade-level English as evidenced by their standardized test scores in reading. Palm Grove's stagnating test scores in English/Language Arts show that socioeconomically disadvantaged students and students who speak English as a second language have particular difficulty with the academic language that the standardized tests are written in. The linguistic logic that is used in the word problems on standardized tests can be acutely troubling for second language learners as noted in a study by Cummins et al. (1988). Another study conducted by Sebrechts et al. (1996), for example found that "when reading a problem a student must use linguistic knowledge to translate what is stated into the givens and goals of the problem" (p. 87). Students in my classes at Palm Grove were noticing improvements in their classroom performance and grades as I struggled to build academic language proficiency within the subjects of math and science. Students' progress had gone largely unnoticed by the public, however, as NCLB reports continued to overshadow news articles and public opinion.

Part of the sanctions and penalties implemented during year two of Program Improvement Status at the school was a public offer to parents by the school district to allow their children to attend another middle school under the "school of choice" option (EdSource, 2004). Given a "school of choice" option and as evidenced by the "school of choice" request forms, many Latino parents chose to send their children to Palm Grove Middle School where they would receive the highest quality Sheltered Instruction in all subject areas that the district as a whole had to offer, while a small number of white families chose to move their children to schools with fewer minority students. The school therefore saw the proportion of Latino students within their total population increase dramatically from 2003 to 2006. Students who speak English as a second language score lower on the standardized tests than do students who speak English as their first language (edsource, 2004). Mathematics scores, in particular, were especially difficult to maintain given the diverse language circumstances of the students at this middle school. Combined with the difficulty of the academic language used on the standardized tests, the immensity of the California standards further complicated issues for English Language Learners.

The mathematics teachers at my school, within my district, as well as all those teachers I have discussed the subject with at professional development sessions agree that the standards for mathematics in California have two overarching and obvious flaws. First, there are far too many standards at each grade level (Shoenfeld, 2007). Mathematics is a comprehensive subject; learners must master concepts progressively as early, foundational ideas support more advanced understanding. In California, students are asked to master foundational concepts in mathematics very quickly as their teachers rush through exhaustive lists of standards in an effort to prepare students for standardized tests.

The second major flaw in the NCLB standards-based logic resides in a lack of attention to the developmental needs of students (Reed, 1999). In *Word Problems Research and Curriculum Reform,* Reed (1999) discussed mathematics reform research in which reform curriculum and pedagogy have attempted to address the developmental needs of students. As with the Strategic Math program, each reform mathematics program discussed by Reed was grounded in the

assumption that reform is necessary in order to align students' developmental needs with mathematics content standards. The California math standards, for example, require 4th grade students to learn linear equations in two variables. The large majority of 6th grade students attending Palm Grove suffer from variable aversion as noted in their obvious sense of panic when they are confronted with problems containing just one variable. As a middle school math teacher, I have experienced this problem with variable aversion in my students for years. I have had the pleasure of teaching mathematics to 6th, 7th, and 8th grade students. This experience in the classroom has provided additional evidence for this math teacher that children need long-term, in-depth teaching and learning in algebra as they develop and expand their algebraic thinking. In this math teacher's opinion, the daily confrontation of students with mathematics concepts that they are not developmentally ready for has led to widespread apathy and hopelessness on the part of the students and teachers.

It was within this climate of growing frustration and apathy that a new and more student-centered approach to mathematics remediation evolved. My personal frustration as mathematics department chair reached its peak during the 2005/2006 school year when my school district underwent a Categorical Program Monitoring inspection with particular attention being devoted to my middle school. The Categorical Program Monitoring (CPM) team sent word to the local district office that my middle school would be the site of their most detailed inspection during the fall of 2005. Many staff members from the school attended a workshop held by the state in an effort to prepare for the upcoming inspection. The CPM team spent almost a full week in February of 2006 at the school looking through categorical program records. The English Language Development program passed the inspection with flying colors. The inspectors noted, however, that far too many English Language Learners were receiving poor grades in math and science. Clearly these students were not connecting in some way with the standards that teachers were required to teach at each grade level. The math teachers at Palm Grove were asked to take a very careful look at mathematics instruction, particularly in relation to English Language Learners. The Sheltered Instruction Observation Protocol (SIOP) was adopted by the district

office to be implemented in math and science classrooms, and six of the math teachers from Palm Grove attended state-sponsored AB466 training to help us to better access our adopted math texts.

AB466 math training occurred in March of 2006. Six of the eight math teachers from Palm Grove attended a week-long training. During the training, the school's problems with standardized test scores and the CPM inspection surfaced and became the topic of discussion many times throughout the week. Mathematics remediation programs and scheduling options were presented by the AB466 presenter. The math teachers from the school came to realize that our current remediation program was not working because students were not appropriately placed and the curriculum was not targeted at students' needs. Together we developed a scheme for testing all our students for placement in remedial math classes. We decided to use the diagnostic test and curriculum that accompanies our adopted text.

Designing a Mathematics Remediation Course Based on Students' Needs

The Strategic Math Curriculum. Palm Grove already had six sets of the Prentice Hall Intervention Units on our campus when it was decided that we would restructure our remedial math program (Prentice Hall, 2004). The Prentice Hall Intervention Units consist of ten separate curricular units covering distinct, foundational standards for middle school. NCLB sanctions left us with scarce financial resources, so it was important that our remediation program take advantage of the resources we had on hand. We also realized that our remediation curriculum must be drawn from the list of state adopted programs, or the district office and our site administrator would not accept our plan. The Prentice Hall Intervention Units provided us with both the diagnostic test we needed for appropriate student placement as well as a state adopted curriculum to directly support students' needs.

After several meetings and negotiations with the site administrator, counselor, and the district assistant superintendent, it was decided that Palm Grove would implement the Strategic Math remediation program during the 2006-2007 school year. Diagnostic tests were given to all current 6^{th} and 7^{th} grade students and tests were sent out to 5^{th} grade teachers at feeder

elementary schools. As the tests were returned, I scored them and decided on a cut-off score of 50% for placement in Strategic Math the following school year. The diagnostic tests also provided me with information as to which Prentice Hall Intervention Units should be used in Strategic Math classes. The students scored the lowest on the sections of the diagnostic test concerning fraction and decimal concepts. I selected three Intervention Unit books covering Fraction Concepts, Operations with Fractions, and Ratio and Proportion to form the basis of the Strategic Math curriculum. I supplemented the Intervention Units with materials I created to help students with vocabulary and academic language development. The Strategic Math curriculum was placed in three binders for the three different teachers who would be teaching the classes. The school scheduled a total of ten semester-long Strategic Math classes for the 2006-2007 school year. These classes were supplemental to the regular, grade-level math classes.

Theoretical Framework

Introduction. Traditional mathematics instruction in the middle grades has focused on the teaching and learning of standard algorithms using state-approved adopted texts. The traditional middle school mathematics program moves students through standards-based course content without consideration for individual student's needs; the standards for each grade and subject level drive instructional pace and focus. The Strategic Math remediation program placed students in a mathematics classroom and context in which curriculum content was determined by students' diagnosed needs, and where teachers were encouraged to use multiple and alternative representations of rational number concepts. The teaching and learning context within Strategic Math classrooms was markedly distinct as the students, curriculum and pedagogy were specifically arranged with the expressed aims of targeting remediation without imposing upon students' regular mathematics instruction. This research study of the Strategic Math remediation program was informed by an ecological theoretical frame as I sought to understand how an entire teaching and learning context affected student learning.

Providing Mathematics Students with a Different Learning Context. As I endeavored to study and analyze the circumstances as they unfolded within the context of the Strategic Math setting, I positioned myself within the situation of study. An ecological and insider's conceptual framework guided my observations and investigations as I made every attempt to understand each participant's perspective (LeCompte & Schensul, 1999; Ho, O'Farrell, Hong & You, 2006). I was interested in the experiences of Strategic Math students and teachers as they carried on with their daily business of teaching and learning. Strategic Math classes were viewed by me as situated learning communities in which each member has a vital and interesting role to play. I wanted to understand how and why Strategic Math communities develop and evolve through issues of *power*, *identity,* and *literacy* from the insiders' perspectives. These terms were delineated for definition here as the Strategic Math students and teachers who participated in this study were observed actively negotiating relationships involving power, identity and literacy. For the purposes of this research study, power, identity and literacy are defined as follows:

Power: The ability to negotiate our activities and thereby shape the contexts in which one can shape and construct a particular context and identity (Wenger, 1998).

Identity: A person's negotiated experience within a particular community of practice (Wenger, 1998).

Literacy: "a social process, in which particular socially constructed technologies are used within particular institutional frameworks for specific social purposes" (Street, 1984, p 97).

Learning as Situated. As I undertook this study, I acted under the assumption that mathematics is a social process (Baker, Street & Tomin, 2005). Students and teachers form conceptualizations, utilize discourse, and interject their individual values and beliefs into the classroom culture as each individual engages in "numeracy practices" (p. 20). I have attempted to endorse ethnomathematical pedagogy within my curricular design in an effort to validate the personal cultural backgrounds of all members of the Strategic Math community. It was hoped that

teachers would realize that the ethnicity of students is a resource as classroom interaction is shown to value students' cultural backgrounds and foregrounds (Pressmeg, 1998).

Mathematics Literacy. Mathematics understanding is a literacy issue for all students including English Language Learners (Street, Baker, & Tomlin, 2005). As students struggle to grasp mathematics problems, the problem goal may be explicitly expressed, while other language related concerns that deal with systemic, relational, and process issues are implicit in the language used to frame and structure the problem (Sebrechts et al., 1996). English Language Learners have been shown by Dobb (2005) to benefit from inquiry-based, literacy-rich teaching and learning. The inquiry model proffered by Dobb explains that English Learners need an opportunity to share common experiences in their primary languages, participate in hands-on learning activities, realize links between new and prior knowledge, and collaborate in and around concept development (2005). Dobb's research demonstrated how students' situated literacy develops and grows through and in the inquiry-based teaching and learning process.
An ecological construct was used to capture the perspective of all Strategic Math students including English Learners as they engaged in inquiry within Strategic Math classrooms. Past standardized test scores of the English Learners at Palm Grove Middle School identified very clearly that these students were not learning the mathematics that had been taught in regular math classes. English Language Learners persistently scored lower on standardized tests in mathematics than students for whom English was their primary language. The Strategic Math curriculum was specifically designed to approach teaching and learning from a more culturally cognizant and situated point of view.

Second Language Learners in Mathematics from a Social Constructionist Paradigm. I embarked upon this research endeavor with research instruments and methodology that were decidedly pragmatic and stemmed from a social constructivist paradigm. According to Bredo's definition of pragmatism (2006), "Every situation is unique and requires interpretation, judgment, and

possible adaptation to fit its peculiarities to some more general pattern" (p. 25). The situation at the Palm Grove was definitively unique.

From the social constructionist paradigm, I present four case studies in which communities of practice were transformed by education researchers who ethnographically analyzed teaching and learning in action as knowledge construction evolved through social interaction. The first three cases were presented by Roth and Calabresse Barton (2004); the fourth case, by Calabrese Barton, Ermer, Burkett and Osborne (2003).

The learning communities of "Oceanside," "Southside," and "Pakistani Teachers" were analyzed by Roth and Barton (2004). These researchers detail how research participants socially constructed scientific literacy and knowledge as they investigated the health of a local watershed, planned and built a community garden, and taught health to poor children in a dangerously closed society. As is the case with Strategic Math, the curriculum was established in all three cases presented by Roth and Barton (2004); the participants were using various research tools to investigate aspects of water quality, community gardening, and health and sanitation. Participants in my Strategic Math research project were using a pre-designed remediation curriculum to socially investigate and explore fraction concepts. The scientific literacy of the participants in Roth and Barton's (2004) case studies evolved within a reflexive learning environment as they socially collected data, then publicly presented reports of their findings to their communities. Roth and Barton (2004) depicted their research analysis in narrative form with only participant data presented graphically and quantitatively. Conversations among research participants and between participants and members of the community were cited as evidence of evolving and growing scientific literacy. My own data analysis will take only quantitative form. As with the Oceanside case, participant data will be presented quantitatively.

Barton, Ermer, Burkett, and Osborne (2003) documented the social construction of knowledge ethnographically of participants in the "Southside" and "Hope Springs" case studies. The researchers in these case studies noted how participants met the science standards through interactive engagement in relevant inquiry. The Southside project was another analysis of the

case presented above. In the Hope Springs project, researchers analyzed children involved in science activities at a homeless shelter. The science standards were used in both case studies as benchmarks for teaching and learning. I used the California mathematics standards as benchmarks within my Strategic Math study. Students' activities and outcomes were compared against the science standards by Barton et al. (2003) in both the Southside and Hope Springs research studies.

Methods

Purpose of the Study. It is my hope that my study will provide a research-based justification for the continuation of the Strategic Math remediation program at the two other middle schools within the district where the former students of Palm Grove Middle School will attend. I also hope to find that these mathematics intervention efforts and tactics have been fruitful in that they resulted in positive student outcomes as evidenced by improved standardized test scores on the part of participating students.

Research Questions. This case study analysis of the Strategic Math program at a rural middle school is aimed at determining the efficacy of remediation from the students' perspective. The following research questions have been devised as the first semester of Strategic Math unfolded and data collection ensued:

1. **In what ways did a math remediation course, Strategic Math, improve students' performance on targeted mathematics skills?**
2. **Are gender differences apparent in behavior and in academic performance both within Strategic Math classes and between Strategic Math classes and regular math classes?**

These research questions changed as first semester data were analyzed. Data collected during the second semester were analyzed using a similar more refined set of questions:

1. **Did a math remediation course, Strategic Math, improve students' performance on the Mathematics portion in general and the rational number cluster in particular of the California Standardized Test?**
2. **Are gender differences apparent in academic performance within Strategic Math classes?**
3. **Was there a difference in performance on the California Standardized test between Strategic Math students in grades 6, 7 and 8?**

Methods. I used quantitative methods and frameworks for analysis (Rocco, Bliss, Gallagher, Perez-Prado, Alacaci, Dwyer, Fine, & Pappamihiel, 2003; Smith, 2006). In an effort to determine the efficacy of the curriculum instituted within Strategic Math classes, quantitative statistical measures were used to compare pre- and post-test scores of the students in the study.

Data Collected. Observational and quantitative data were collected in fieldnotes, pre- and post- diagnostic tests, and in the California Standardized Mathematics Tests from 2006 and 2007. These data were analyzed by grade and gender.

Standardized Test Scores. Strategic Math students' California Standardized Test, CST, scores from 2006 before the students participated in the course in 2006, and in 2007 after the students participated in the course. Only students' CST scores on the mathematics portion of the test were compared.

Rational Number Concepts. The rational number cluster within the mathematics section of the CST test was compared between the 2 CST testing cycles.

Gender and Age. Pre- and post-test scores were compared and cross tabulated with data sliced according to gender, age, ethnicity, and score percentile change after the first semester for probative reasons.

Observations and Fieldnotes. Fieldnotes, observations and discussions were transcribed and coded according to pertinence to issues relating to content or culture.

Pre- Test Scores. During May of 2006 a diagnostic pre-test was given to all students who would attend Palm Grove during the 2006-2007 school year. This test had 25 total possible points.

Sheltered Instruction Observation Protocol. Three classroom observations were conducted each semester for a total of 6 observations, of each Strategic Math class and each regular math class during the first semester of the 2006-2007 school year. The Sheltered Instruction Observation Protocol was used to take notes during observations.

Post- Test Scores. All Strategic Math students were given the same diagnostic, post-test that they were given during May of 2006 at the end of their semester of instruction. This test had 25 total possible points.

Probative Analysis. The quantitative comparisons of Strategic Math students' pre- and post-test scores brought about a shift in focus within my observational analysis during the second semester. There were 14 more boys in the preliminary sampling group than girls; the boys did not outperformed the girls to a significant extent. The statistics below will demonstrate this initial difference between the academic performance of girls and boys in Strategic Math. Three observations were conducted during the second semester, attempting to highlight the effects of the different contexts on girls and boys. Originally it was my intent to slice my data by ethnicity in addition to gender and age. After coding each of the 58 students selected within the probative sample for ethnicity, I realized that there were not enough European American students within the sample, perhaps within the school population as a whole, to render any meaningful results for statistical comparison.

Test score data for the Strategic Math students' California Standardized Tests, CSTs, and for their pre- and post-tests were categorized and analyzed using mean scores, *t*-statistics, levels of significance (*p*) values and standard deviations (*SD)* . The pre- and post- diagnostic test section pertaining to rational number concepts and operations was used for my initial probative analysis. The test contained 25 multiple choice math problems; each problem was given one point. The

test was worth a total of 25 points. Strategic Math students took the test for diagnostic purposes during placement in the class, and after completing the class. Students mean scores on the pre- and post-tests were compared using a t-statistic during my initial analysis in an effort to learn after just one semester if the course was having an impact on students' learning. All Strategic Math students (218) were included in t-test analyses of students' CST test score averages both before and after participation in the course. These analyses were conducted on Strategic Math students' mathematics CST scores in general and on the rational number cluster of the CST specifically.

Sampling Procedures and Focus

- *Content Focus.* Rational number concepts formed the basis for the Strategic Math curriculum. After analyzing pre- and post-test scores and total mathematics CST scores, I therefore chose to focus my analytical lens on the CST 'fraction' cluster in an effort to reveal what effect the course might have had on students' standardized test scores in this particular content area.

- *Statistics.* Test score data was described statistically using descriptive statistics, analysis of covariance (ANOVA), and t-test analyses to find: means, *t*-statistics, standard deviations *(SD*), and levels of significance (*p*) values.

- *Diagnostic Test and CST Test Comparisons.* Pre- and post-test scores for the 58 students who were originally sampled after the first semester in addition to the final data collected on all 218 Strategic Math students who participated in the study during both semesters were broken down by grade, gender, and test score.

Participants. The study took place at one middle school serving students from primarily working class and poor immigrant families. Two hundred eighteen students participated in 10, semester-long Strategic Math classes during the year of the study. Of these 218 participants, 89% of the students were Latino, 7% were European American, 3% were African American, and 1% was

Asian American. Three fourths of the students in the study were classified as English Learners who continued to receive academic support with language. Ninety percent of the students studied qualify for free or reduced lunch. I began by randomly sampling 58 6^{th}, 7^{th}, and 8^{th} grade students from the 128 enrolled in 5 Strategic Math classes during the first semester of the 2006-2007 school year for the purposes of statistically identifying areas for further, more in-depth analysis.

Three teachers taught Strategic Math during the year of this study. The Strategic Math teachers were all White; 2 were male, and one was female. All 3 teachers were in their mid-fifties. Each teacher held a Multiple Subjects Teaching Credential with a supplemental authorization to teach mathematics. The female Strategic Math teacher had been teaching for 24 years; one of the male teachers had been teaching for 11 years, while the other male teacher had been teaching for 7 years. The teachers all used the Strategic Math curriculum which had been provided in its entirety except for the manipulatives. It was observed that the manipulatives were primarily used by the female teacher and largely ignored by the male teachers. The teachers were questioned during collaboration about the use of manipulatives. The male Strategic Math teachers both noted that they were not using the manipulatives and had no intention of doing so in the future. Five semester-long Strategic Math classes were conducted for 2 semesters; ten Strategic Math classes in all have been included in this study. Strategic Math classes served an average of 22 students each. Participating students were required to take 1 semester of Strategic Math rather than an elective course such as art or music. Additionally, all participating students attended grade-level math courses during 2 semesters. The Strategic Math remediation program did not replace students' regular math class; this course was an addition to not a replacement for standards-based, grade-level mathematics instruction.

Results and Discussion

Introduction. I will first present the results of a preliminary sampling and analyses of 58 Strategic Math students after participation in the course during the fall semester of 2006. For these preliminary investigations, pre- and post-test scores were compared using descriptive

statistics, t-tests and covariance (ANOVA) analyses. Preliminary data on the 58 Strategic Math students was dissected by gender and grade level in an effort to understand if these factors affected students' performance on the pre- and post-test.

Strategic Math students' 2006 and 2007 CST mathematics scores were compared in my final analyses. Strategic Math students' CST mathematics scores were dissected by gender and grade level. Additionally, students' 2006 and 2007 CST scores on the rational numbers cluster within the total mathematics test were analyzed. Descriptive statistics, t-tests and covariance (ANOVA) analyses were used to determine whether participation in Strategic Math had a statistically significant effect on students' total CST math scores and on the rational numbers cluster of the test. As with my preliminary analyses, CST data was dissected by gender and grade level in an effort to understand whether these factors had statistically significant effects on my overall findings.

A Preliminary Sampling of Data

1) In what ways did a math remediation course, Strategic Math, improve students' performance on targeted mathematics skills?

Of the 58 students included in this preliminary data analysis of the first semester Strategic Math class, 42 students improved their test score between the pre- and post-test score; 11 students received a post-test score that stayed the same as the pre-test score; and 5 students received a post-test score that was lower than their pre-test score.

In order to more precisely answer research question 1 above, the pre- and post-test score means for the 58 Strategic Math students included in this preliminary analysis were compared using a t-test. A descriptive statistical analysis of the pre-test mean scores for the 58 Strategic Math students indicated the following: $M = 8.98$ and $SD = 3.7$; a descriptive statistical analysis of the post-test mean scores for the 58 Strategic Math students indicated the following: $M = 12.7$ and $SD = 3.5$. Clearly, the test score averages of the 58 Strategic Math students initially sampled increased markedly. I next conducted a paired-sample t-test analysis of the 58 Strategic Math

students pre- and post-test scores: $t(57) = 6.1$, $p < .05$, and *SD = 4.5.* These initial results provide evidence that Strategic Math students were making significant improvements on the targeted math skills that were tested on the diagnostic pre- and post-test.

2) Are gender differences apparent in academic performance within Strategic Math classes? Of the 58 students sampled after the first semester in this probative analysis, 22 were female, while 36 were male. This imbalance reflects the same imbalance that existed within the total population of students enrolled in Strategic Math during the first semester. Given the fact that 22 of 58 students included in this probative analysis were female and 36 of 58 were male, the high proportion of female improvement is dramatic and interesting from an ecological perspective, however the small sample size of females has likely skewed these analyses.

For the purposes of determining the significance of the originally sampled 58 Strategic Math students' test score improvements by gender, descriptive statistics and covariance (ANOVA) analysis were used. The mean and standard deviation for pre-test scores yielded the following results for females: $M = 9$, and $SD = 3.6$; and mean and standard deviation for pre-test scores for males: $M = 9$, and $SD = 3.6$; the mean and standard deviation for post-test scores for females were $M = 12$, and $SD = 4.1$; the mean and standard deviation for post-test scores for males were $M = 13$, and $SD = 3.2$. An analysis of covariance (ANOVA) was conducted on the post-test scores using pre-test scores as covariates testing for the effects of participation in Strategic Math on each gender. These covariant analyses indicate that females noted significant variance between their pre- and post-test scores, while males did not note significant variance between their pre- and post-test scores. Covariance analysis for females yielded the following results: $F(11, 10) = 4.36$, $p < .05$; covariance analysis for males yielded the following results: $F(12, 23) = 1.162$, $p = .363$ ($p > .05$). These descriptive statistics and covariant analysis for pre- and post-test scores and gender indicate that gender represents a significant factor in students' improved post-test scores only for the 22 females in the sample. Female Strategic Math students' post-test scores varied significantly from their pre-test scores according to the covariance analyses above,

while the 36 male Strategic Math students sampled did not note significant variance between their pre- and post-test scores. However, the mean pre- and post-test scores for males varied from 9 on the pre-test to 13 on the post-test, while females varied from 9 on the pre-test to 12 on the post-test. Clearly sample size and an uneven distribution presented a significant and deleterious threat to the validity of the above analyses. These preliminary analyses point to a significant gender effect on Strategic Math students performance on post-test scores, but further investigation using all students' standardized test scores both before and after participating in Strategic Math were necessary to substantiate this gender effect with a larger sample size.

3) Was there a difference in performance on the pre- and post-test between Strategic Math students in grades 6, 7 and 8? For the purposes of understanding how the 58 sampled Strategic Math students performed on the pre- and post-test by grade level, descriptive statistics and paired-sample t-tests for grade and pre- and post-test scores were conducted. Descriptive statistics were first conducted resulting in the following grade-level means and standard deviations on students' pre- and post-test scores:

Grade	Pre-Test Mean	Pre-Test Standard Deviation	Post-Test Mean	Post-Test Standard Deviation
6	*M = 5.4*	*SD = 3.7*	*M = 12.6*	*SD = 4.3*
7	*M = 10.8*	*SD = 1.9*	*M = 12.6*	*SD = 2.9*
8	*M = 11.2*	*SD = 3.4*	*M = 13.1*	*SD = 3.6*

The descriptive statistics above indicate that 6^{th} grade students realized the greatest growth in mean test scores between the pre- and post-tests. Additionally, paired-sample t-test analyses were conducted on each grade level resulting in the following: $6^{th} t(19) = 7.2$, $p < .05$; $7^{th} t(25) = -2.5$, $p < .05$; and $8^{th} t(11) = -2.3$, $p < .05$. These paired-sample t-test results on the original sample of 58 students indicate that Strategic Math students made significant improvements on the

diagnostic pre- and post-test across all three grade levels tested with 6th grade students experiencing the greatest improvement in their mean test score after participation in the course.

Discussion of Preliminary Findings. The quantitative analysis depicted above clearly indicates that a math remediation course with a curriculum that has been specifically targeted at students' needs has the potential for resulting in improvement in students' post-test scores. I find it to be of particular interest that females improved more than males even though fewer females were enrolled in the courses and in the study. With these data results in mind, I refined my observation protocol in an effort to understand why females were gaining more from their participation in Strategic Math remediation courses.

The preliminary data collected after the first semester of the 2006-2007 school year and analyzed above helped to refine my focus as I conducted observations of Strategic Math classrooms during the second semester while taking fieldnotes. These original findings were shared with the math department at Palm Grove Middle School during weekly teacher collaborations. The final statistical representations of all 218 Strategic Math students' CST test scores over a two-year comparison are presented next. These preliminary analyses presented thus far were not intended to be definitive or absolute; the data were collected and analyzed for purely probative purposes.

Statistical Depictions of CST Findings. I will first present statistical representations of all 218 Strategic Math students' CST test score data as it is compared over a two-year period of time. Each of my 3 research questions will be deconstructed using the data I have collected and the analysis I have constructed. I will first revisit my original research questions below:

1. **Did a math remediation course, Strategic Math, improve students' performance on the Mathematics portion in general and the rational number cluster in particular of the California Standardized Test?**
2. **Are gender differences apparent in academic performance within Strategic Math classes?**

In order to better describe the data that has been collected I added 1 additional research question:

3. **Was there a difference in performance on the California Standardized test between Strategic Math students in grades 6, 7 and 8?**

An initial examination of Strategic Math students CST test scores demonstrates through very simple comparisons that of the total 218 Strategic Math students tested on the CST during both the 2006 and 2007 testing cycles, 140 students noted an improved test score while 78 students noted a decreased test score or their scores remained the same. The CST tests were administered during the first week in the month of May in 2006 and 2007. CST test score comparisons within the entire Strategic Math student group reveal 64.2% of students raised their standardized test scores after taking the course, while 35.8% of students either realized a test score decline or their scores remained the same after participating in the course. While it is impossible to demonstrate a direct cause-effect relationship between participation in Strategic Math and improved standardized test scores given the myriad other variables in play within the public school system and the private lives of students, these initial findings are positive.

I next attempted to exhume a more detailed analytical portrayal of the effects of participation in Strategic Math on students' CST test scores on the rational numbers cluster and total mathematics. Descriptive statistics, t-tests, and covariant (ANOVA) analyses were conducted on the total Strategic Math student population, on male and female students, and on students in grades 6, 7, and 8. Strategic Math students noted an 18 point gain in CST test score averages within the one-year testing cycle. Palm Grove Middle School as a whole noted an improvement in CST test score averages across all subjects tested of 16 points. Fully half of the student body at Palm Grove participated in Strategic Math. Male Strategic Math students realized a CST mathematics test score average of 293.7 in 2006 and 296.3 in 2007 with a net gain in test scores of 2.5. Female Strategic Math students received a mean CST mathematics score of 281.9 in 2006 and 297.1 in 2007 with a net gain of 15.2. Before participating in Strategic Math, male students noted a CST test score average in 2006 that was 11.8 points higher that female students; whereas after participating in Strategic Math, female students' CST test score average exceeded males'

scores by .9 points. Analyses by grade-level (listed below) indicated that 6th grade students realized the greatest gains on their CST test scores after participating in the course, but this greater gain is not statistically significant. The greater test score gains that were realized by Strategic Math students could possibly have pushed the entire school's CST test score averages in a positive direction. While a direct cause-effect relationship continues to elude my analysis, the evidence continues to point in this direction.

1) Did a math remediation course, Strategic Math, improve students' performance on the Mathematics portion in general and the rational number cluster in particular of the California Standardized Test? Descriptive statistics and a paired sample t-test analysis of Strategic Math students CST mathematics test scores for 2006 and 2007 were conducted. Mean standardized test scores and standard deviations of Strategic Math students before participating in the course in 2006, and after participating in the course in 2007 resulted in for following: 2006 $M = 288.1$, $SD = 39.9$, 2007 $M = 296.7$, $SD = 34.4$. These descriptive statistics indicate that Strategic Math students did note improved CST mathematics test scores in 2007 after participating in the course. A paired sample t-test analysis of Strategic Math students CST mathematics test scores in 2006 and 2007 was used to determine that students' mean test score improvement on the CST mathematics test was significant $t(208) = -2.7$, $p < .05$. Between the two-year standardized testing cycle, Strategic Math students' test scores noted a narrowing of the standard deviation and bell curve as the standard deviation for the 2006 test scores was 39.9, while the standard deviation for the 2007 test scores was 34.4. This narrowing of the standard deviation and bell curve within this analysis of standardized mathematics test scores indicates that after participating in Strategic Math, students' test scores are more generally clustered around the group mean 2007 score of 296.7. The above data indicates that the mean mathematics CST test scores for Strategic Math students increased by 8.6 over the 2006-2007 testing cycles. The t-test score of -2.7 represents a significant improvement in performance on the mathematics portion of the California Standardized Test by students who participated in Strategic Math during the 2006-2007 school year.

The data depicted above begins to answer research question #1: **"In what ways did a math remediation course, Strategic Math, improve students' performance on the Mathematics portion in general and the rational number cluster in particular of the California Standardized Test?"** With this initial depiction of data regarding the CST test scores of Strategic Math students both before and after participating in the course, it is only possible to say that the majority of the students under study did in fact note an improvement in CST test scores. These data, however, do not answer the portion of the research question pertaining to the rational number cluster on the CST. The Strategic Math curriculum which I organized and contrived very specifically focused on the California Mathematics Standards for rational number concepts and operations for grades 6, 7 and 8. It must also be noted that the regular math teachers at Palm Grove were also teaching the state standards to their students including the Strategic Math group. This is why a cause-effect relationship cannot be determined, although there is a strong correlational association between participation in Strategic Math and improved standardized test scores.

The Strategic Math curriculum was designed and organized in accordance with the students' demonstrated need for mathematics remediation in and with rational numbers (fractions). The CST cluster pertaining to rational number concepts within the mathematics test section was isolated for a more targeted comparison between Strategic Math students' performance on rational number problems before and after participating in the course. Descriptive statistics, t-test, and covariance (ANOVA) analyses were conducted to determine the effects of students' participation in Strategic Math on their test scores on the rational numbers cluster on the CST. Descriptive statistics demonstrated only a slight mean score improvement and narrowing of students' data about the mean between the 2007 and 2006 CST tests; 2006 $M = 5.0$, SD = 2.7; 2007 $M = 6.0$, $SD = 2.4$. A paired sample t-test of students CST test scores on the rational numbers cluster noted that students' test scores demonstrated a significant effect $t(220) = -5.2$, $p < .05$. Additionally, a covariance (ANOVA) analysis was conducted of students 2007 test scores using the 2006 test scores on the rational numbers cluster as a covariate yielding results that fall

short of a significant effect and finding $F(12, 208) = 1.5$, $p > .05$. These descriptive statistics, t-test analysis, and ANOVA reveal an improvement by Strategic Math students on the rational numbers cluster after participating in the course; the effect of the course on the students' test scores on the rational numbers cluster of the CST test is significant according to the above t-test values, while the covariance analysis does not indicate a significant effect. I will now investigate the effect of gender on Strategic Math students' CST test scores. An examination of the above data analyses in relation to research question 1, **"In what ways did a math remediation course, Strategic Math, improve students' performance on the Mathematics portion in general and the rational number cluster in particular of the California Standardized Test?"** gives a basis for finding that Strategic Math did realize a significant effect on students' performance on the mathematics portion of the CST, while a significant effect was not realized by participating students on the rational number cluster of the standardized test.

Are gender differences apparent in academic performance within Strategic Math classes? I now direct attention to research question 2 pertaining to gender differences among Strategic Math students. The following data analysis begins to uncover gender differences within the Strategic Math group. One hundred fourteen males and 107 females are included in the Strategic Math data set of 221 students in total. This total number of 221 is different from the 218 used in the majority of my statistical analyses because 3 Strategic Math students did not take the CST test during May of 2007. The preliminary sample of Strategic Math boys and girls was not fairly balanced with 22 girls and 36 boys included; this unbalanced sample posed a serious threat to statistical validity, while resulting in ambiguous statistical findings. Only 7 more males than females are included in the final analysis. This marginal difference in numbers is not large enough to have had any definitive effect on the findings that follow.

Descriptive statistics, t-tests and covariance analysis of males and females CST mathematics test scores before and after participating in Strategic Math show that demonstrably greater numbers of females than males noted improved CST mathematics test scores over the 2006 and 2007

standardized testing cycle. Descriptive statistics of males' and females' CST mathematics test scores reveal that males raised their mean test scores after participating in the course only slightly, while females noted a very large mean test score gain. In 2006, Strategic Math students noted the following descriptive statistics by gender: 06 males $M = 293.7$, $SD = 41.1$, and 06 females $M = 281.9$,

$SD = 37.9$; 07 males $M = 296.3$, $SD = 37.6$, and 07 females $M = 297.1$, $SD = 30.2$. These descriptive statistics were used to conduct t-test analyses of Strategic Math students' 2007 CST mathematics test scores by gender: 2007 males $t(113) = .01$, $p > .05$, and 2007 females $t(106) = .01$, $p > .05$. These descriptive statistics and t-test analyses of Strategic Math students' CST mathematics test scores indicate that female students realized greater gains on their standardized mathematics test score means than did male students after participating in the course. The t-test analysis of variance from the sample mean indicate, however, that gender did not have a significant effect on students' CST mathematics test score improvements after participating in Strategic Math.

Descriptive statistics and a covariate (ANOVA) analysis of males' and females' CST test scores on the rational numbers cluster indicate that females raised their mean score over the 2006-2007 testing cycle on the rational numbers cluster of the CST slightly more than did males: 2006 females $M = 4.7$, $SD = 2.5$, 2006 males M = 5.4, $SD = 2.8$; 2007 females $M = 5.9$, $SD = 2.3$, 2007 males $M = 6.4$, $SD = 2.5$. A covariate (ANOVA) analysis was also conducted on students 2007 CST scores on the mathematics cluster using 2006 scores as a covariate $F(1, 219) = 1.6$, $p > .05$. The findings I draw from the above analyses in relation to research question 2, **"Are gender differences apparent in academic performance within Strategic Math classes?"** are that while female students noted greater improvements on their 2007 CST test score means after participating in the course than did male students, these differences were not significant as revealed by the t-tests and covariate analyses above. I therefore find that gender did not have a significant effect on Strategic Math students' 2007 CST test scores. Additionally, this finding is interesting and correlational, but does not indicate a positive gender effect on Strategic Math

students CST scores on the rational numbers cluster in 2007. These gains in the CST test scores of female students could indicate a school-wide trend amongst all the students attending Palm Grove Middle School in which girls are outperforming boys on standardized tests.

The first semester ended in December of 2006 leaving a time gap of five months between the completions of the Strategic Math courses and standardized testing in May of 2007. This time gap between remediation and testing while students were busy applying the skills they had acquired in Strategic Math in their regular math classes raises many interesting curricular and pedagogical questions: Do students need time to ponder, time to reflect, time to discuss and time to apply? This data is likely capturing gender differences in academic performance that would exist apart from participation in Strategic Math. A cause-effect relationship has not been proven, but the evidence is mounting in favor of Strategic Math participation having a positive, if not statistically significant effect on the CST test score performance of both females and males.

3)Was there a difference in performance on the California Standardized test between Strategic Math students in grades 6, 7 and 8? My next level of analysis consisted of a breakdown of Strategic Math students' CST test score averages by grade and CST test scores before participating in the course in 2006, and after participating in the course in 2007. This data analysis addresses my third research question "**Was there a difference in performance on the California Standardized test between Strategic Math students in grades 6, 7 and 8?"**

Descriptive statistics and t-test analyses were conducted to determine if grade had a significant effect on Strategic Math students standardized test scores. This data analysis was obtained by entering the actual CST test scores for each Strategic Math student for both testing periods. This particular view of the data uncovers several interesting configurations within the overall data set that allow additional interpretations to be drawn. Descriptive statistics revealed the following data by grade-level and testing year:

Grade	2006 Mean	2006 Standard Deviation	2007 Mean	2007 Standard Deviation

6	*M = 279.9*	*SD = 45.6*	*M = 296.1*	*SD = 38.4*
7	*M = 299.5*	*SD = 37.6*	*M = 296.0*	*SD = 36.4*
8	*M = 282.5*	*SD = 32.9*	*M = 298.2*	*SD = 26.0*

The 6th grade Strategic Math students noted a gain in their test score average of 16.3 points, the 7th grade students noted an average test score decline of (3.75) points, while the 8th grade students noted an average test score gain of 15.7 points. The 6th grade CST test score averages rose by 17 rounded points, the 7th grade CST test score averages declined by 4 points (rounded), and the 8th grade CST test score averages rose by 16 rounded points. The above descriptive statistics were used to conduct t-test analyses by grade level with the following results: 2007 $6^{th}t(71) = .02, p > .05$, $7^{th}t(83) = -.02, p > .05$, $8^{th}t(61) = .05, p > .05$. The finding I draw from these analyses is that 6th and 8th grade Strategic Math students improved their CST test score means over the 2006/2007 testing cycle as noted in the table above, while 7th grade students did not. Additionally, the t-test analyses above show that grade level did not have a significant effect on Strategic Math students' performance on the 2006 or 2007 CST mathematics test scores.

Discussion of Findings. The data collected during the first and second semesters of Strategic Math indicate that an effective means of remediation in mathematics has been utilized. Diagnostic testing to determine students' needs, followed by intensive instruction using a curriculum that deliberately focuses on the mathematics content in which students have demonstrated the greatest weakness, according to this one case study analysis, will improve students' performance within the content area of focus. If it is our aim to address primarily content within the remediation process, then the Strategic Math program represents a significant success. These analyses attempted to demonstrate the efficacy of the Strategic Math remediation program by statistically investigating students' diagnostic and standardized test scores before

participating in the course in 2006, and after participating in the course in 2007. Strategic Math students' test scores were dissected by testing year, by gender and by grade level in an effort to determine whether the Strategic Math course had a statistically significant effect on students' test scores in 2007 after participation in the course.

Participation in Strategic Math did have a statistically significant effect on participating students CST mathematics test scores. A covariant (ANOVA) analysis of Strategic Math students test scores on the rational numbers cluster on the CST did not reveal a significant effect on students' test scores on the rational numbers section of the standardized test. It is highly likely, if not certain, that rational numbers are used in the mathematics test questions and problems throughout the mathematics section of the CST. Strategic Math students did realize significant improvements on their total 2007 CST mathematics tests after having participated in a remediation course focusing on rational number concepts. I therefore find that the Strategic Math remediation program did realize a statistically significant effect on participating students standardized test scores in total mathematics.

The statistical analyses that were conducted to determine if gender and grade level had an effect on Strategic Math students performance on the 2007 CST produced interesting, but not statistically significant findings. In relation to gender, female students noted a lower CST test score mean than did males in 2006 before participating in the course, and a higher test score mean than males after participating in the course in 2007. After participating in the course, female Strategic Math students realized a larger increase on their CST test score mean in 2007 than did males resulting in a higher test score mean for female students than for male students in 2007, while the test score mean for males was higher than females in 2006. However, this greater improvement by females who participated in the course does not constitute a statistically significant gender effect.

Finally, statistical analyses was conducted in this case study to determine whether grade level had an effect on students' 2007 CST mathematics test scores. Statistical findings indicated that grade level did not have a significant effect on Strategic Math students' performance on the 2007

CST mathematics test. It is interesting to note that Strategic Math students in grades 6 and 8 increased their CST test score means in 2007 over 2006, while students in grade 7 noted a decreased test score mean in 2007 over 2006. All statistical analyses that were conducted in search of a grade level effect, however, demonstrated no significant effect of grade on Strategic Math students' 2007 CST test scores.

Repeated case study analyses of the Strategic Math program are highly recommended. Students in their middle school years tend to change dramatically from both a physical and an intellectual standpoint. Maturation could very well account for the students' improvement on the post-test thereby presenting an important threat to the validity of this case study. It must also be pointed out that all the students who participated in the Strategic Math case study also attended regular, grade-level math classes. The learning that occurred within regular math classes could also account for students' increased scores on the post-test. A third and significant threat to the validity of this case study arises out of the unusual circumstances currently surrounding the school under study. After the 2007/2008 school year, the school under study was closed. The climate within the school in particular and within the community in general echoes with a sense of frustration and defeat. The students attending Strategic Math could very well have done better than they actually did given a different political climate at the school and in the community. From an ecological point of view, this case study analysis only scratches the surface of understanding from the students' and teachers' insider perspective of teaching and learning within both Strategic Math classes and regular math classes. I can note that something different was noticed in the behavior and academic performance of girls and boys in both Strategic Math and in regular math classes. Given the limited amount of time, one school year, that was spent studying the math classrooms at Palm Grove Middle School, another ecological case study is warranted. I would specifically like to analyze the gender differences further during the second year that Strategic Math classes are taught at Palm Grove.

Concluding Comments. One case study of 10 semester-long Strategic Math classes clearly will not provide enough data to state definitively that targeted remediation within supplemental math classes will always realize statistically significant improvements in students' performance on standardized math tests. The students did note significant improvement in their understanding of the mathematics that was taught in Strategic Math classes, but it could not be shown that this improved understanding had carried over and been internalized until grade and standardized test score comparisons had been made. The Strategic Math curriculum seemed to influence the learning climate in that it was clearly targeted at students' specific needs. The teaching pedagogy that was delineated by the lesson plans within the curriculum clearly made the content accessible to the majority of the students. The girls in particular appeared to benefit the most from the pedagogy that was prescribed by the Strategic Math curriculum. The curriculum does offer the opportunity for teachers to undertake teaching practices that approach learning from the social constructionist paradigm, but it is up to individual teachers to take up this paradigm within their own teaching practice. Of the 3 Strategic Math teachers included in the study, 2 teachers were observed practicing social constructionist pedagogy, while 1 teacher was not engaged in this type of teaching practice. A replication of this study with another group of students taking Strategic Math with the same teachers would significantly enhance my understanding of the phenomenon observed.

Most significantly in my view as a teacher and researcher, the overwhelmingly positive performance of girls in Strategic Math represents at the very least a call for further study. The results from the pre- and post-tests as well as my observations and discussions revealed learning environments in which girls felt more competent and secure in their performance. I observed both regular math classes and Strategic Math classes and deliberately compared the behavior of boys and girls within both settings. Boys did not change their behavior or demeanor between different classes except to make minor modifications in response to the attitude of the teacher. Girls, on the other hand, were markedly different between classes in their attitudes, demeanor, and enthusiasm. I watched many girls eagerly raising their hands, discussing problems, and

calling out mathematic information in Strategic Math classes. These same girls were quiet, withdrawn, and reluctant in their regular math classes. I do not profess to know why girls behaved in this way; but I do find this anomaly to be particularly interesting.

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