Texas Instruments

Comments to the

National Math Panel

August 20, 2007

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August 20, 2007

Ms Jennifer Graban
Deputy for Research and External Affairs
National Math Panel
400 Maryland Avenue SW
Washington, DC 20202

Dear Ms. Graban:

Texas Instruments (TI) is again pleased and honored to have the opportunity to submit comments and to address the National Math Panel (NMP) on our MathForward™ mathematics program. We continue to support the critical work of the Panel and look forward to continuing to serve as a resource for the NMP.

We look at the enclosed comments as an addition to the October 12, 2006 material that we sent to you, but one that includes the most up-to-date research material available. Also enclosed is a CD with a video highlighting educators, students, and parents discussing the impact of MathForward™ and TI technology on mathematics instruction.

I personally look forward to addressing the Panel and answering any questions that they may have. Please contact me at 214-912-5799 or rschaar@ti.com should you need further information.

Thank you,

Richard J. Schaar

Second-Year Results of MathForward™

A systemic intervention for pre-Algebra and Algebra using TI technology

Presented to the National Math Panel, September 6, 2007

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Introduction

On October 12, 2006, Texas Instruments (TI) provided comments to the National Math Panel (NMP) on a variety of issues related to its charter for the improvement of mathematics education. Since then, the NMP made the decision to consider technology and its role in math instruction. TI has submitted to the Panel research and materials on this subject.

TI subsequently was asked to provide additional comments and testimony on a systemic, technology- enabled program called MathForward™. This program was described in the previous submission as the effort that TI began in the 2005-2006 school year in a single middle school in Richardson, TX Independent School District (RISD.) This year, RISD expanded their implementation, and pilot studies were started in schools in Euclid, OH, West Palm Beach, FL, and Dallas, TX. We summarize Math Forward's second year results (for the 2006-7 school year) in this report.

Independent evaluation research was conducted by Mara Winick (The University of Redlands) and Jeffery Lewis (Pitzer College of the Claremont Colleges) using survey, teacher math knowledge, and achievement data gathered at the beginning, middle and end of the year, and state test data from the previous year and end of this year[1]. A separate team led by Walter Stroup (University of Texas – Austin) performed independent analysis of the RISD achievement data. Comparisons of state test achievement data from 2006 and 2007 showed that in three of four school districts, more MathForward students moved to the Proficient level than those in comparison groups. In RISD where regression discontinuity analysis could be applied due to the larger number of students, it confirmed the effect on students who began MathForward below proficiency in the previous year. In one district, classrooms where fidelity of implementation was low have shown reduced gains or even negative results relative to the comparison group.

Although we present new second-year results in this report, we want to emphasize that the key points TI made in its earlier comments remain valid. These are the principles we have used for over 20 years in the development of our products and programs:

- To achieve and sustain student performance improvement, we have learned that key elements of the mathematics education system need be addressed in a coherent, integrated way, and there is no "silver bullet" focused on a single system element.

- To be effective at improving student learning and achievement, technology needs to be integrated into a coherent and complete instructional program. When this is done, technology becomes an

[1] Analysis of the West Palm Beach achievement data was conducted by the school district.

enabler to integrated instruction, curriculum and assessment, thus resulting in increased student achievement.

TI asks that after reviewing the following research results, the NMP acknowledge that appropriate use of graphing technology can have a positive impact on student achievement. TI submitted research on the effectiveness of graphing calculators in our previous comments. We also ask the NMP to recognize our hypothesis and the early research and support deeper research efforts to continue improvement and broader scaling of Math Forward.

The next section of this document summarizes the Math Forward program. Then, we provide an overview of the 2006-7 research results for the four participating MathForward school districts. We close with remarks on lessons and next steps for moving this program to from pilot to scale. In our original testimony, we included additional information on the MathForward program's theoretical basis and background on the pilot study. Full research reports on the district results have been appended. They include both quantitative and qualitative analysis.

Overview of the MathForward Systemic Intervention

The MathForward™ program was created with the intent of eliminating the achievement gap between African American and white students, and Hispanic and white students, in middle school mathematics. While it is critical to eliminate the gap, we designed MathForward with the intent to increase the learning opportunities for all students, and improve student achievement results for all students, regardless of ethnicity or social economic status. The program is designed to provide technology-enabled immediate feedback to teachers and students regarding mathematical knowledge with the help of additional assessments, and to help students communicate their mathematical thinking through one-to-one handheld technology (TI-73 or TI-84), and classroom collaboration technology (TI-Navigator).

The program is research-based[2] and is comprised of eight key components: use of technology to motivate and enhance learning opportunities for students; extended learning time; increased teacher content knowledge; ongoing professional development; common, aligned assessments; set high expectations for all students; accelerated and rigorous curriculum; and increased administrator support for teachers participating in the project.

Components of the Program

Technology to enable data-driven decisions and to engage students through interaction and visualization

Middle school students are expected to apply mathematical concepts as a natural part of instruction and assessment in mathematics. Graphing technology enhances students' ability to process and visualize the content they are learning. Used effectively, technology can increase student motivation and engagement, which leads to increased student achievement. The graphing calculator has become an integral component of mathematics teaching and learning, and is seen as a valuable tool by teachers, students and parents.

In Math Forward, teachers use technology daily to enhance district lessons, provide students with feedback about learning, and reinforce mathematics content through a wide variety of pedagogical mechanisms. The TI-73 graphing calculator, a handheld device for math learning, is designed for use in middle school. The TI-84 is a graphing calculator designed for high school curricula. Both devices allow for input of data and equations, which are instantly represented visually as graphs. This technology is not used

[2] See Carnine, D. (2002) *The Ten Components of High Achieving, High Poverty Schools.* Unpublished manuscript. Eugene, OR: University of Oregon. Summary available from http://www.tea.state.tx.us/math/TenComEffSch.htm

to ‘check’ work, but is provided to students as an instrument to augment dynamic mathematical modeling. Research, presented in our previous comments to the Panel, shows that when students use graphing calculators to visualize math concepts and principles, deeper understanding results with no effect on computational skill. Graphing calculators allow students to focus on high-level problem solving strategies while automating computation.

Each classroom is equipped with the TI-Navigator wireless classroom network. The network links students’ calculators with the teacher’s computer, which is loaded with special software to allow communication with the calculator for instantaneous distribution of activities and formative assessment. The teacher can send questions to the student devices, and students then send their answers back to the teacher for display and grading. The system allows the teacher to project classroom displays of their screens and student responses. Teachers use the TI-Navigator to deliver and grade daily warm-up problems for each student. These three to four item assessments allow teachers to reinforce topics that have been previously taught, and provide immediate feedback to students about solutions.

The TI-Navigator system also can enhance student learning by adding a classroom collaboration component. Students participate in the lesson via activities and polling. The teacher can project the class’s calculator displays and their responses to questions. All students provide solutions and the class can judge their accuracy and discuss reasoning behind the various answers they provide. Since answers are collected anonymously, students feel safe submitting, and resubmitting solutions to problems given by the teacher.

This research-based technology[3] is uniquely designed to transform the interaction patterns of the classroom. Exploratory research on effectiveness shows that when the system is used as designed, increments in achievement result. Research studies are appended.

Extended Learning Time

Schools implement the MathForward™ program in two block-scheduled mathematics class periods per day. The daily mathematics class is partitioned into three distinct sections: daily skills warm-up, district curriculum (lesson), and problem solving (task or lesson). The additional time spent in the mathematics classroom allows teachers to use problem solving and collaborative learning strategies necessary to improve deep understanding and develop skills.

[3] See SRI International (2004), *Research Relating to TI-Navigator*. Available from education.ti.com/research.

Increased Teacher Content Knowledge

Training with a Mathematician. This component has been designed to build teachers' personal mathematical understanding. Participating teachers meet regularly with a mathematician to build content knowledge for curriculum lessons they will be teaching in the coming weeks. In-depth learning opportunities are provided to teachers to strengthen content knowledge and relate content back to the topics that must be taught within the state and district curriculum. Based on National Center for Education Statistics data, many teachers working in middle school mathematics classrooms are elementary certified. As a result, these teachers need additional time to better understand advanced mathematics. Teacher's content knowledge is assessed using the University of Michigan's Content Knowledge for Teaching Mathematics measurements prior to the beginning of the program and at the conclusion of the program.

Ongoing Professional Development

Professional Development Prior to Project Initiation. At the beginning of the project, teachers are trained on the use of the extended classroom time, appropriate integration of technology, data driven decision making and setting high expectations, all in the practical context of daily math teaching.

Ongoing Professional Development. Teachers are given a common, duty-free, planning time at least a few times a week. The time is used to plan lessons for the week, discuss teaching strategies, analyze student work, and discuss underlying math concepts. Coaches/Implementation Specialists participate regularly in these sessions to provide guidance and feedback.

Common, Aligned Assessments

Within the MathForward™ program, teachers are trained and required to administer assessments with students in the block classes at the beginning and end of each unit of study. Various forms of formative and summative assessments are used to inform teachers about students' content and procedural knowledge and the communication used to discuss content and processes within open response, or problem solving items.

The frequency of assessments allows teachers to meet individual student need, and easily identify struggling students. Teachers are able to restructure lessons and activities prior to a student failing the course at the end of six-weeks, or waiting for the results of a district benchmark exam.

Accelerated and Rigorous Curriculum

Research has shown that the curriculum for underachieving math students often is narrowed to the low-level procedural, with little attention paid to the more demanding learning tasks involved in deep conceptual understanding and high-level problem solving. By contrast, the MathForward™ model is based on the principle that all students benefit from a rigorous curriculum: the right way to ensure math success for all is to build deep understanding and then expertise in problem solving.

Toward this end, MathForward™ coaches work with teachers to achieve appropriate rigor in the curriculum using available curriculum resources. In addition, special supplemental learning activities and assessments have been developed that target key math concepts, principles and problem-solving strategies. These learning activities are aligned to state standards and can be included in the local curriculum as appropriate.

High Expectations for All Students

By middle school, many students lack self-confidence in mathematics. They perceive themselves as deficient in content and tend to be hesitant to respond to questions in the classroom. In this program, teachers create safe environments and encourage student responses. Students are valued for their ability to solve problems and are given tools to enhance content knowledge, justification, reasoning and proof. With the frequency of feedback and support students receive, they gain knowledge and the ability to do well in mathematics and feel confident their assessment results will be positive.

Increased Administrator Support

Administrator support is critical to the success of this program. Administrators are asked to participate in staff development, meet with project staff to discuss components of the model, and actively support implementation. Administrators set expectations for teachers and students during the initial phase of the project and continue to monitor progress throughout the year.

MathForward™ Research Results

Reminder of RISD 2005-2006 Results

TI's testimony last Fall to the Panel included an appendix with results of the MathForward pilot year at one RISD middle school. Key findings from that report were:

- When the systemic intervention was applied to middle school math students who had previously failed the state math test (TAKS), the result was a 33% pass rate, vs. 19% for a comparison group from a similar campus.
- Average scores increased at a time when comparison groups and the district as a whole experienced a decline in scores.
- The positive effect is shown in four statistical analyses, including regression discontinuity analysis, a "gold standard" methodology.
- Teachers reported many positive qualitative effects on their classes. A number of suggestions were made for improving the interventions

For reference, Stroup and Alexander's full 2006 report is again supplied to the Panel.

Expanding the Program

In the school year 2006-2007, the Richardson, TX Independent School District (RISD) assumed management of their MathForward program. They expanded the program to classes in 5 middle schools. They also extended the intervention from grades 7-8 to include pilot classes in grade 9 Algebra at two high schools. In addition, TI began to gain experience with scaling MathForward to other school districts, with the addition of pilot programs in the West Palm Beach, FL school district as well as Euclid, OH and Dallas , TX Independent School District (DISD). Full reports are included in the supporting documentation provided to the Panel and contain a complete statistical treatment of the data.

Because of the difficulty of equating state tests, we are presenting data on those students who reached proficiency in the 2007 Spring administration of their state test. Proficiency rate is a meaningful statistic to school administrators. In addition, we will present a more rigorous regression discontinuity analysis of RISD middle school data. This analysis leads us to some important conclusions about the effects of MathForward.

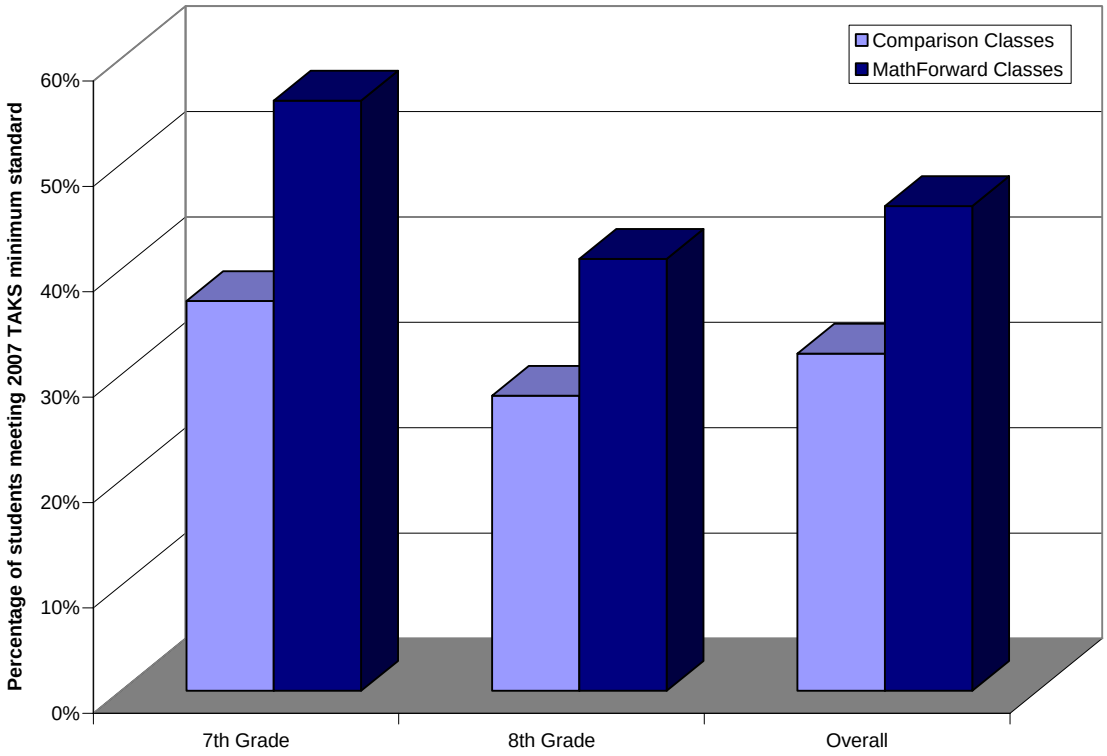
RISD 2006-7 Results

The grade 7-8 MathForward program at RISD was expanded from one school last year to five schools this year. In addition, class composition was intentionally more heterogeneous this year: students were selected because they performed between 50% and 75% on the incoming district benchmarks, and then other slots were filled in with students above that range, including some pre-AP students. This is different from last year when the pilot program was confined to students who had failed the state test in the previous year. Consistent with MathForward's model of building capacity and sustainability, the District took over management of MathForward this year. The implementations clearly benefited from the year of experience with the program.

However, note that, due to teacher turnovers, all but three of the teachers in the program were new to it this year.

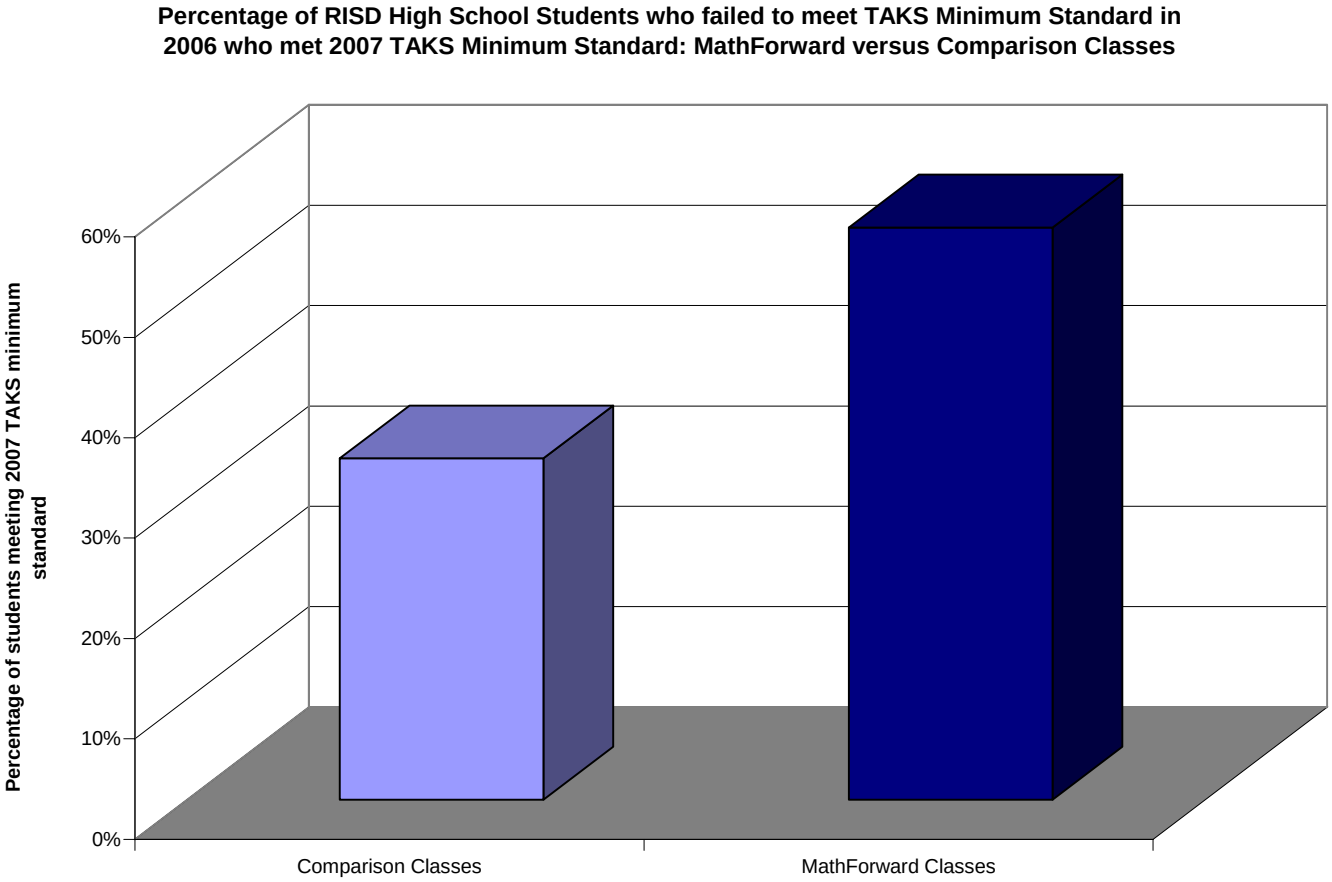
Results for RISD's middle school programs are summarized in the chart below.

Percentage of RISD Students who failed to meet 2006 TAKS Minimum Standard who met 2007 TAKS Minimum Standard: MathForward versus Comparison Classes



The overall 46% state test pass rate (for students who did not pass the state test last year) represents an improvement when compared to last year's 33% pass rate, as well as a gain when compared to the comparison group. Additional analysis which examined the score gains (with normal curve equivalent conversions) by school confirms significant positive differences in all schools but one, and also points to a slight year-to-year decline in district-wide scores, both in 2006 and in 2007. Thus the positive trend in the middle school MathForward program is even more notable because it is counter to the district-wide trend in both years.

The 9th grade Algebra high school program, while only a small-scale pilot project, also showed promising gains. These are summarized in the chart below:



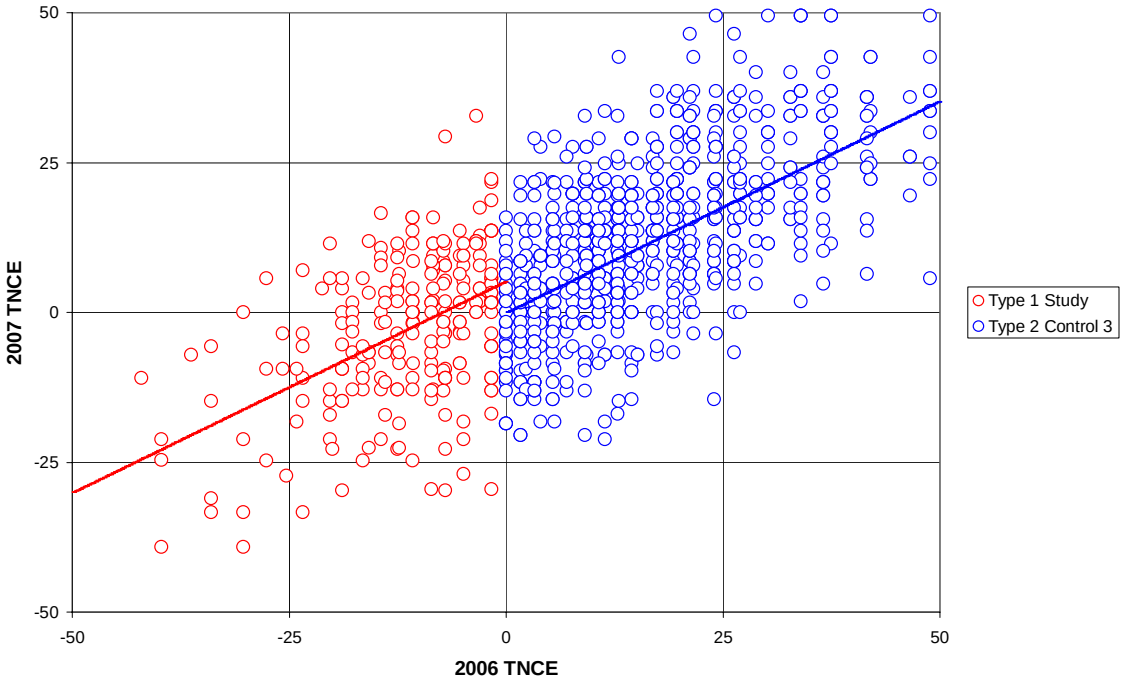
Considering the two high schools involved in the pilot, the chart shows that 57% of MathForward students who failed the state test in 2006, attained proficiency in 2007. By contrast, the comparison group had a 34% pass rate. This suggests that MathForward can be successfully extended from Pre-Algebra to Algebra.

Another remarkable feature of MathForward emerges from a more rigorous regression discontinuity analysis, shown in the graph below. Regression discontinuity (RDD) studies rely on the hypothesis that in the absence of the treatment program, the pre-post relationship of the groups would be equivalent[4]. The regression discontinuity is basically a pretest-posttest program-comparison group design. This type of design is appropriate when educators want to target a program to students who need intervention the most. Assignment of participants to a particular treatment or programs is based on a cutoff point. Because we know that the treatment and control group means differ since the group assignment is based on a pretest score, we can estimate the treatment effect by the size of the projected discontinuity (jump or change) at the cutoff.

[4] Trochim, W. (1994). The Regression-Discontinuity Design: An Introduction. Research Methods Paper Series, Number 1, Thresholds National Research and Training Center on Rehabilitation and Mental Illness, Chicago, IL

This analysis compares 2007 scores[5] of a district-level comparison group (students taking classes at non-study schools who passed the TAKS in the previous year, called Type 2, Control 3 in the Stroup, et al paper) and MathForward™ students who were below the 2006 TAKS cut score(referred to as Type 1, Study, in the analysis). This RDD analysis confirms the conclusion of MathForward's effectiveness shown in the descriptive analysis presented above. The RDD comparison is statistically significant ($p<.000$).

Graph 7. Regression Discontinuity for 2007 Study and Control 3 groups



We should also note that Stroup et al present additional ordinary least squares (OLS) analyses of the 2007 data which examined the effects of MathForward on students above the TAKS cut score in the previous year. While this is less rigorous than RDD, the analysis shows that the MathForward intervention is effective in raising scores of students who failed the state test the previous year, and those who passed. They conclude:

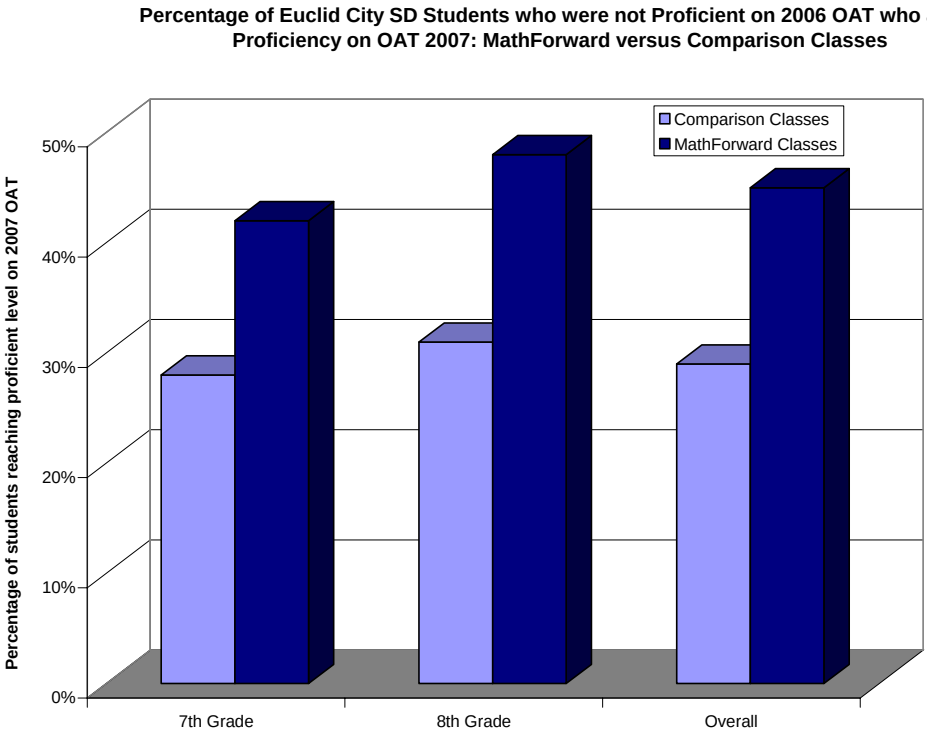
> …under OLS analyses the study intervention is effective in raising both Type 1 (students who failed the previous year TAKS) and Type 2 (students who passed the previous year TAKS) students' mean NCE scores. This lends significant support for the versatility and inclusiveness of the intervention when it comes to classroom use.

[5] Scores were transformed to normal curve equivalents to allow year-to-year comparisons. Refer to the Stroup, Pham and Alexander report for a complete discussion.

If this finding holds in subsequent years, it will show that the intent of MathForward to have positive results for all students is confirmed.

Euclid 2006-7 Results

The Euclid pilot intervention included selected classes in grades 7 and 8 at two middle schools. The program followed the standard guidelines for MathForward, except that teachers did not receive direct instruction in math content knowledge, because no nearby mathematician could free time for such an assignment. Proficiency rate comparisons for both schools are summarized in the chart below. Note that in this district, the same teachers taught MathForward and comparison group classes.

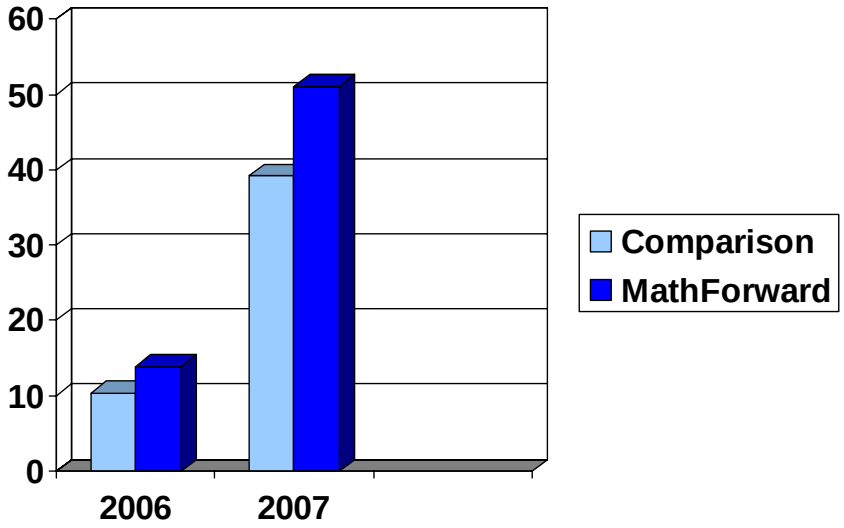


The chart shows that the program had a substantial impact on pass rate, in comparison to non-MathForward students in the same schools. Overall, 2007 pass rate of students who were not proficient in 2006 and who were in MathForward was 45%, while the similar comparison group's 2007 pass rate was 29%. Additional analysis comparing score gains confirms this effect, and shows its statistical significance.

West Palm Beach 2006-7 Results

In West Palm Beach, MathForward was piloted in the Palm Springs Middle School Grade 8 (pre-Algebra). All classes in the school used a double period (block) for math, so the

only difference between MathForward and the control was in the components other than increased class time. Note also that in Florida the spring administration of the state test (FCAT) occurs in February, so these results show only the impact of a little more than one semester of MathForward. Results are summarized in the graphic below:



West Palm Beach 8th Grade FCAT Proficiency Gains

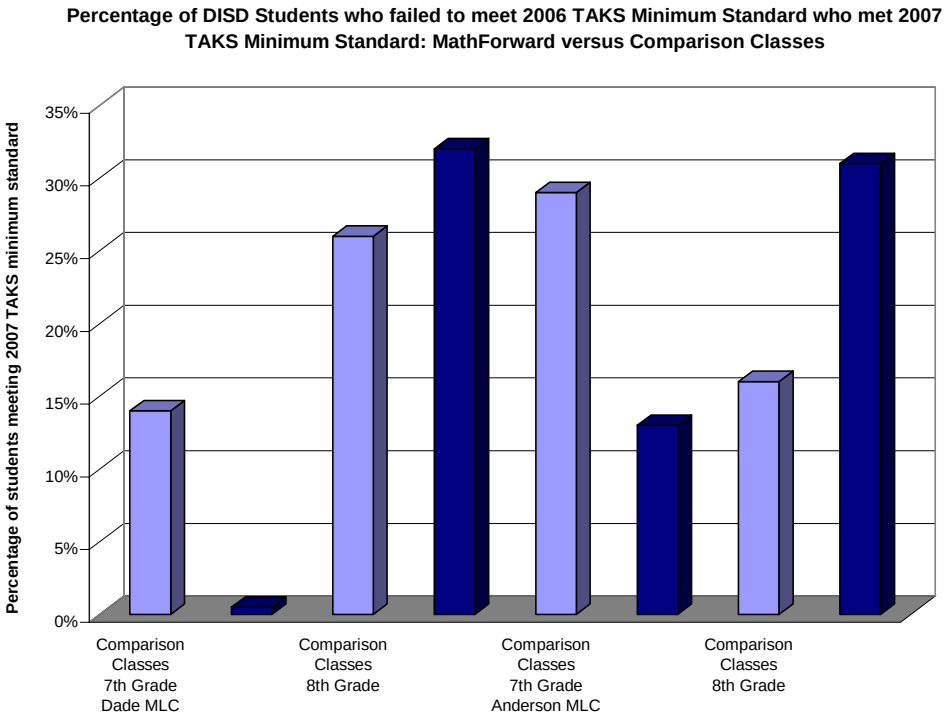
For the control group, 469 demographically similar students enrolled in Pre-Algebra classes in other schools were selected district-wide; some of these students were proficient in 2006 as were some in the MathForward group which differs from the other pilot sites. Consequently, the chart shows non-zero 2006 scores. 29% of this comparison group reached proficiency in 2007, while 37% of the MathForward students did so.

Dallas 2006-7 Results

The Dallas ISD pilot program was at two middle schools, Dade and Anderson, for grades 7 and 8. For a number of structural reasons, DISD was not prepared to offer their full support to the pilot; and both implementations were incomplete leading to positive and negative results which differed by school and by grade. For example, due to late hiring, teachers at both schools were not available for early training. In Anderson, the school's technology was not compatible with the Navigator system and was replaced mid year. In both schools, the 8th grade teachers had more mathematical knowledge and could better implement the program.

Consequently, at both schools, MathForward programs in 8th grade showed greater gains in pass rate than a comparison group drawn from within the schools. This was not the case in 7th grade. In both schools, the 7th grade pass rates for the MathForward program was less than the comparison classes. However, in both grades, the number of students in

each group was very small, so for example, the results are based on changes in the status of one or two students, and not larger-scale results. Consequently, with DISD support, the pilot will be restarted in the coming school year; and the results will be re-evaluated next year.



Lessons Learned and Next Steps

It is TI's intention to follow four paths based upon the research for the school year just concluded:

Scalability: The intention is to expand the program both within districts and geographically under the controlled conditions that have made the program successful. To that end, in RISD, the MathForward will be used in all 10 Middle Schools as well as in all 4 high schools for Algebra 1. This is the District's decision. In Euclid and West Palm Beach, there will also be an expansion into additional schools. In DISD, TI has the commitment from the administration to do a complete implementation. In addition, MathForward will be expanded geographically with additional pilot programs in California, New York, Ohio, and Texas.

Sustainability: The goal of the program is to build internal sustainability within the teaching staff. In the pilot phase, TI has provided large portion of support in year one, and expected districts to have a plan for supporting the model in year two and beyond. For example, in RISD, the program was managed by a TI consultant in year one; starting in year two, the program was managed by a master teacher from RISD with strong leadership and administrative support. This capacity building approach is needed in other districts.

Completeness: There is now a much better understanding of how the 8 components of the intervention join synergistically to make a coherent and complete whole. While there are improvements where only part of the program is implemented; the gains are much greater when the complete MathForward system is implemented. In West Palm Beach, where double blocks were used for all students who had not been successful on the FCAT, MathForward students still did significantly better. In Euclid, where teachers taught both MathForward and control group class and so were trained in technology and given professional development, the MathForward students showed improvement.

Learning: Finally, underpinning the entire effort is research. Research has been a critical, necessary component of everything that TI has done in its over 20 year history of serving the education market. The lessons from research have and will continue to guide the direction of MathForward.

For the coming school year, TI has engaged SRI International to perform independent evaluations of all sites. The Principal Investigator for this study is William Penuel. The study will use refined survey measures validated by a reliable classroom observation protocol, and will examine a wider range of effects important to schools. Their analysis will include a rigorous analysis of student achievement data. While this will be publishable research, TI will not wait for publication before acting to improve MathForward with the results of the studies.

Conclusion: What is the conclusion from MathForward™ for technology, both Graphing calculators and the TI-Navigator™ classroom network?
Our conclusion is consistent with the practices we have learned and implemented over two decades in mathematics education: Technology has to be integrated into a coherent, complete instructional program and then used appropriately. It has to modify instructional practices, and then it can be considered a key supporting element of assessment, curriculum, and instruction. If used in a supporting role, technology will lead to significant improvements in student achievement and their understanding of mathematics. TI's work with MathForward and the research done on the program has reinforced this view.

Request: What position would Texas Instruments like the National Math Panel to take with regard to technology? TI has developed our systemic intervention hypothesis over many years, and our experience from pilot projects and preliminary research results are evidence of its validity. We are encouraged to conduct expanded and deeper research on the basis of early findings. TI would like the NMP to recognize our hypothesis and early research and support deeper and ongoing research to improve and scale the Math Forward program. In addition, TI would like the NMP to acknowledge that graphing technology if applied in an appropriate manner by a trained, professional teacher can have a positive impact on student achievement when integrated into a coherent and complete instructional program.
These programs include the 8 program components:

1. Technology for data-driven decisions and to engage students through interaction and visualization
2. Extended Learning Time
3. Increased Teacher Content Knowledge
4. Ongoing Professional Development
5. Common, Aligned Assessments
6. Accelerated and Rigorous Curriculum
7. High Expectations for All Students.
8. Increased Administrator Support

along with the principle that there is no single component or "silver bullet" that will improve student's mathematical knowledge.

Texas Instruments is dedicated to increasing students' understanding and ability to use mathematics. We would like the NMP to recognize and acknowledge that on going research and development of programs like MathForward and appropriately integrated technologies like graphing calculators and TI-Navigator can help fulfill this goal.

Richardson *MathForward* Project
Second Year Final Report: Math TAKS Results

Walter Stroup, Ed.D., Vinh Pham
and Celeste Alexander Ph.D
The University of Texas at Austin

Introduction

The Richardson Independent School District in Richardson Texas has implemented a novel program to improve mathematical skills for some 7th, 8th, and 9th graders called *MathForward*. With the help of new technology and innovative assessments students are able to communicate their mathematical thinking and then receive immediate feedback regarding their mathematical knowledge.

Earlier pilot results indicate several components of the intervention are crucial to the success of the intervention. The key components of *MathForward* include: extended learning time, use of technology to motivate and enhance learning opportunities, provision of common, aligned assessments, increased teacher content knowledge, and development of high expectations for all students.

The teachers involved in the *MathForward* program received specialized professional development training. Students participate in a 100-minute mathematics class that focuses on enhancing mathematical understanding through the use of TI Navigator™ system and advanced graphing calculators, in-classroom networks and daily problem solving. The students also participated in daily lessons where they must communicate solutions, apply content, and connect mathematical models to abstract concepts. The technology allows teachers to monitor, on a screen, each student's progress as concepts are taught and problems are worked. This allows for immediate feedback and opportunities for intervention.

This report is focused on both the analyses from 2005-06 and the continuation into this year (2006-07) for the intervention study. To ensure a clear and concise understanding, a consistent vocabulary bridging the two years was needed. The following definitions are used for the remainder of this report:

Type 1 – Students who failed the previous year's TAKS
Type 2 – Students who passed the previous year's TAKS
Study – Students who are in the study intervention (2005-06 only students that failed the previous TAKS, *2006-07 inclusive* – combined students, some who passed and some who failed the previous TAKS)
Comparison – Students who are at the comparison campus*
Control 1 – Non-study students who are taking other math classes with study teacher
Control 2 – Students who are taking classes with non-study teachers at study schools
Control 3 – Students who are taking classes at non-study schools

*Forest Meadows was the comparison campus and was chosen for similar demographics to the study school. This was for year one only.

Methodology

Student Demographic Information

Data provided by the district includes indicators for student ethnicity and whether student is classified as economically disadvantaged this is referred to as "SES" in this report. There were no other indicators such as classification as Limited English Proficient (LEP) or participation in Gifted and Talented classes. Students included in the analyses were required to have both a 2006 and 2007 math TAKS score (so change could be assessed). This means that highly mobile students tend to be excluded from the analysis. Students were 7^{th}, 8^{th}, and 9^{th} graders in the 2006-07 school year in regular math classes. The variable "SES" is the indicator for whether a student is participating in the federal Free and Reduced Priced Lunch (FRPL) program.

Regression Discontinuity

Before continuing, a description of regression discontinuity and its usefulness in *need-based* programs is necessary. Regression discontinuity studies rely on the hypothesis that observations will have a different pattern at a pre-defined point on a continuum (Cook and Shadish, 1994, Shadish, Cook, Campbell, 2001). Or in other words, in the absence of the treatment program, the pre-post relationship of the groups would be equivalent (Trochim, 2006). The regression discontinuity is basically a pretest-posttest program-comparison group design. This type of design is appropriate when educators want to target a program to students who need intervention the most (Trochim, 2006). Assignment of participants to a particular treatment or programs is based on a cutoff point. Because we know that the treatment and control group means differ since the group assignment is based on a pretest score, we can estimate the treatment effect by the size of the projected discontinuity (jump or change) at the cutoff. For the regression discontinuity design, if there are possible interactions or nonlinearities, it is very important to include these in the model. It is better to over-fit a model because over-fitting still yields unbiased coefficients, although it decreases power. Over specification assures that all necessary terms have been included even at the expense of unnecessary ones.

For the 2005-06 *MathForward* intervention, a "pull out" approach was implemented for the 2006 academic year. Students below the passing score for the Texas Assessment in Knowledge and Skills for mathematics in 2005 were assigned to separate classes and subject to a complex, but well-defined, set of interventions that constitute the the *MathForward* program. When scores are plotted using Normal Curve Equivalent (NCE), significant positive discontinuities were observed in comparing the 2005 TAKS results with the 2006 TAKS mathematics scores. These results can be seen to provide strong evidence for the causal validity of this treatment. Results from ordinary least squares analyses of the data set also showed significance as well as effects of comparable size to those resulting from the RDD analyses. OLS analyses also provide additional complementary information about the relative significance of factors like ethnicity and/or socio-economic status.

Based on the judged success of the first year's intervention, the scope of the implementation was broadened in the 2006-07 school year.

Inclusive 2006-2007 Regression Discontinuity Design

As part of the scaling-up of the *MathForward* intervention, students below the cut score were included in the same classes as students above the cut-off score. Methodologically this moves the use of regression discontinuity techniques beyond the "pull out" interventions with which it is typically associated. In medical contexts, interventions are administered to a treatment group that is, by definition, independent of the population above the cut-off score (the non-treatment group). Also, grade 9 students were added in the intervention for this second year. When transferred to educational contexts, the methodological artifact of an experimental treatment taking place in a self-contained intervention (e.g., a certain drug or therapy being administered in physical isolation to individuals in a treatment group) is often maintained by placing students below a cut-score in a self-contained, or "pull out", educational program. This was the model used for the first year of the *MathForward* study (2005-06) and the results of using RDD in this standard way are reported below.

Mathematically, however, the only significant requirement beyond the use of a well-defined cut score for deciding who is in the treatment is that the student population of the treatment group is independent, or orthogonal, to the population of students above the cut score. For year two of the study, being in classes with students above the passing score is considered part of the overall treatment for the students below the passing score. This "inclusive" model for the year-two (2006-07) classroom implementation of the intervention is matched in this report to the use of an "inclusive" regression discontinuity design. This inclusive RDD does maintain the required mathematical independence (orthogonality) of the comparison group.

Normal Curve Equivalent

All scores were derived by converting each student's TAKS scale score into a NCE (Normal Curve Equivalent) score using that year's TAKS score frequency distribution as reported by the Texas Education Agency (2007) for the student's grade level. This approach allowed for arithmetic manipulation of the scores in a way that is consistent and more transparent. The intervals between the scores are now equivalent in a way that would not be the case using the scale scores. To ensure standardization of the scores relative to the cutoff score for each year and grade, the NCE scores were further transformed by subtracting the cutoff NCE score for the grade level from the students' NCE scores. All transformed NCE scores are labeled as TNCE. A TNCE score of 0 would correspond to the cut score for passing the TAKS. Another refinement is that the analyses largely omitted, except where noted, data from students who were in pre-AP classes. These students represented a distinct and skewed subset of the population not comparable to the sample of the population for which the intervention was implemented.

These changes account for the relatively minor differences in the reported results from last year's analysis.

Results

Descriptive Statistics

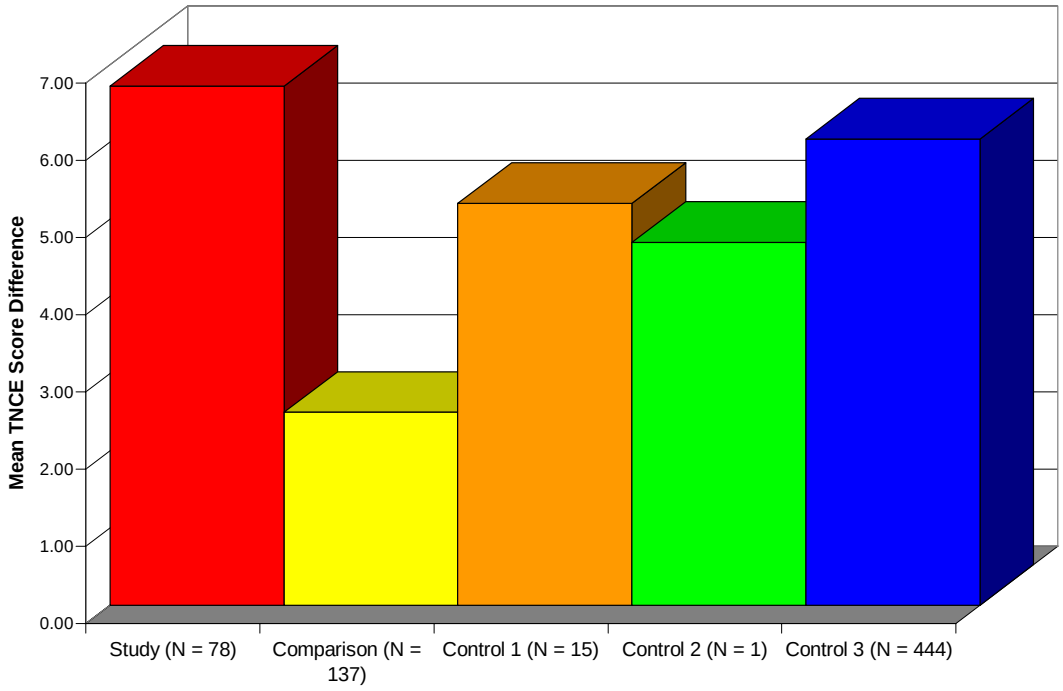
Table 1 shows the descriptive statistics for 2006's data based on the convention set forth above.

Table 1. 2006 Statistic Descriptives

		Minority	Low SES	Passed 2006	2005 TAKS TNCE	2006 TAKS TNCE	Change in TNCE
Type 1	Study (N = 78)	95%	65%	33%	-13.04	-6.32	6.72
	Comparison (N = 137)	96%	81%	19%	-13.97	-11.47	2.50
	Control 1 (N = 15)	87%	67%	13%	-17.94	-12.73	5.21
	Control 2 (N = 1)	100%	100%	0%	-13.30	-8.60	4.70
	Control 3 (N = 444)	73%	63%	37%	-11.26	-5.22	6.04
Type 2	Study (N = 0)	N/A	N/A	N/A	N/A	N/A	N/A
	Comparison (N = 137)	85%	69%	72%	14.97	8.53	-6.44
	Control 1 (N = 105)	72%	47%	77%	14.91	9.35	-5.56
	Control 2 (N = 1)	100%	100%	0%	6.90	-10.70	-17.60
	Control 3 (N = 1309)	52%	45%	88%	19.78	15.52	-4.26

.

Chart 1. Mean TNCE change for different Type 1 students between 2005 and 2006



For 2006, a Control 2 group was added for the sake of completeness and year-to-year

consistency. However with an N of only 1, this value cannot be considered generalized. Students in the study last year showed 6.72 mean TNCE point increase. This is the largest increase in all the Type 1 students as seen in Chart 1. When interpreted on a 100 point scale, this increase is substantial. However, all of the other groups also showed positive gain, though not as much. The Control 3 improvement almost matches that of the Study group. Further analysis will make the contrasts more apparent and serve to underscore the limitations of relying on purely descriptive analyses.

The results for 2007 are largely similar but with some notable variations as shown in Table 2. Data points identified as outliers by SPSS were removed from further analysis. Outliers were defined as any data point that had a standardized residual greater than 3 standard deviations from the predicted score using a linear regression of the data. It can be observed from the results that there was an even larger mean TNCE increase with Type 1 Study students (~8.5 points).

Table 2. 2007 Statistic Descriptives

		Minority	Low SES	Passed 2006	2006 TAKS TNCE	2007 TAKS TNCE	Change in TNCE
Type 1	Study (N = 236)	88%	67%	48%	-11.53	-3.04	8.49
	Control 1 (N = 32)	88%	72%	31%	-15.58	-10.41	5.17
	Control 2 (N = 188)	84%	66%	30%	-14.91	-7.71	7.20
	Control 3 (N = 257)	75%	62%	34%	-10.79	-7.87	2.92
Type 2	Study (N = 134)	75%	63%	86%	6.96	12.36	5.40
	Control 1 (N = 38)	87%	45%	84%	15.33	11.31	-4.02
	Control 2 (N = 584)	54%	42%	91%	18.3	16.02	-2.28
	Control 3 (N = 794)	49%	40%	85%	16.81	13.06	-3.75

As shown in Chart 2, all Type 1 students again showed positive growth with the result for Control 2 students now rivaling that of the Study students. Why Control 2 had similar growth as Study students warrants further investigating. Were there any other intervention going on at the study schools? This was not believed to be a contamination effect since Control 1 students, taught by the study teachers and who would be more likely to exhibit contamination effects than Control 2 students, did not show a similar magnitude of growth. Moreover, a significant element in the intervention was the use of specific network technology (TI-Navigator™) and because this tool was not available to students outside of the study, contamination effects are even less likely to account for the somewhat similar gains by Control 2 students.

Chart 2. Mean TNCE change for different groups of Type 1 students between 2006 and 2007

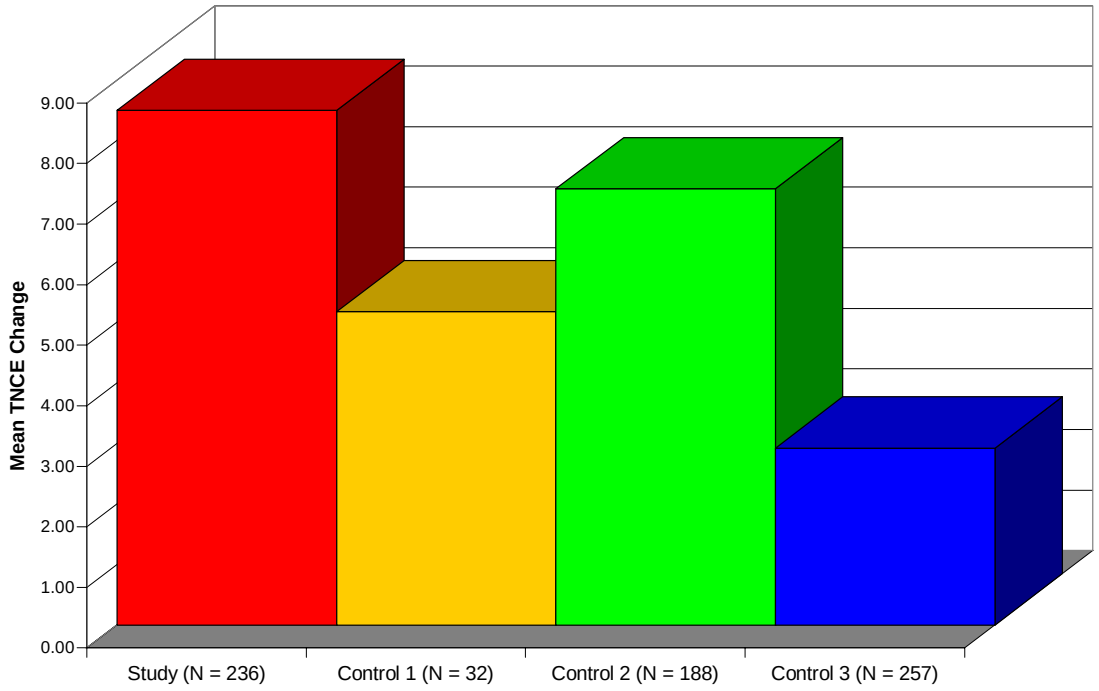
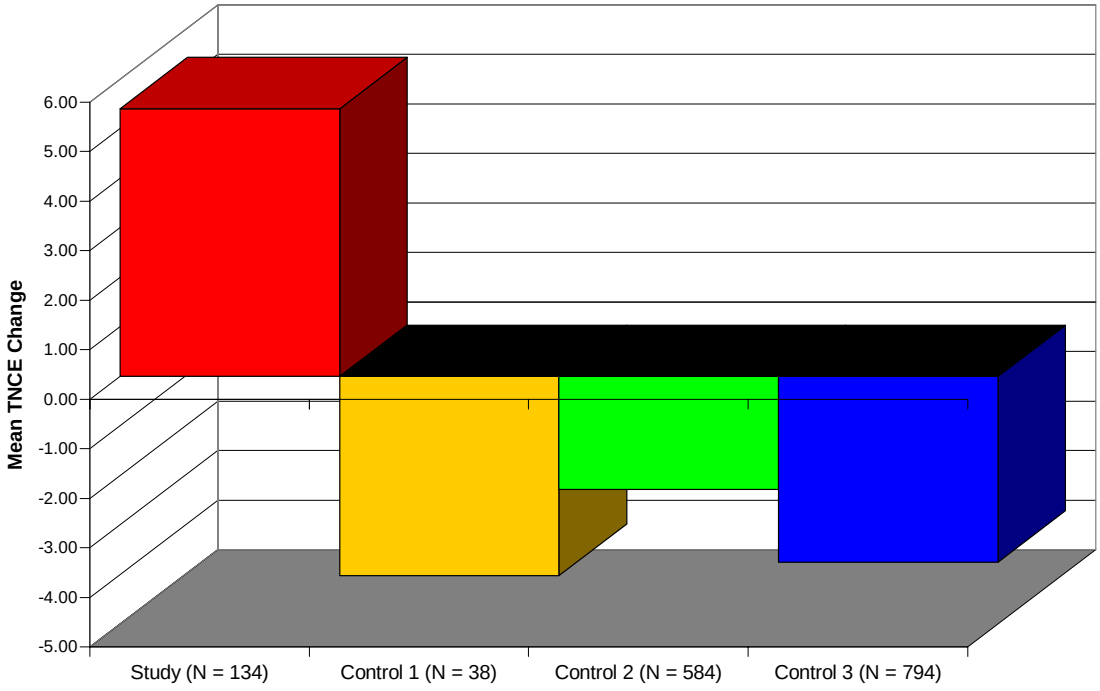


Chart 3. Mean TNCE change for different groups of Type 2 students between 2006 and 2007



To further highlight what may be happening in the classrooms where the Control 2 students made gains, it is revealing to plot the mean TNCE changes for all the Type 2 (passing) students. The *only* Type 2 students to have shown any positive gains were the Study students as depicted in Chart 3. This suggests that while the intervention was

clearly beneficial to *both* Type 1 and Type 2 students, whatever methods might have been employed to improve Type 1 student scores in the Control 2 classrooms these approaches only improved the results on the Type 1 students (and even then, not by as much as the intervention did for Type 1 Study students). Type 2 students were negatively impacted in the Control 2 classes. Even as the intervention was motivated primarily by the desire to improve the results of Type 1 students, it is important nonetheless to also report results for the passing students. In light of the gain for both Type 1 and Type 2 students in the intervention, additional effort might be expended in understanding the intervention efforts for students already achieving at the passing level. The pull-out approach used in 2006 means there could be no data available for this group in that year.

Ordinary Least Squares (OLS) Analyses

The following ordinary least squares regressions use transformed NCE scores. Again, using TNCE allows for comparison of the students across years and grades at the cutoff point. This allows for a more accurate analysis of the effects of the study intervention and its effects on students' passing rates on the TAKS. It is important to note that OLS regression analysis uses the complete data set of both Type 1 and Type 2 students of each group under consideration. This is especially significant for year two results since year one had no Type 2 Study students.

Table 3. OLS Regression for 2006 Study and Comparison students.

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
2005 TNCE Score	0.653	0.037	0.718	17.667	0.000
Study Treatment	4.130	1.558	0.108	2.650	0.008
Minority	-4.130	2.259	-0.070	-1.774	0.077
SES	-0.441	1.427	-0.012	-0.309	0.757

Dependent variable – 2006 TNCE
R^2 = 0.495, Durbin-Watson = 1.373, N = 352

Using an ordinary least squares analysis, the treatment effects were significant when compared to the comparison students as shown in Table 3. Minority and SES were not significant, though minority was trending towards significance. Study students were predicted to have ~ 4 NCE points higher than the comparison students.

Table 4. OLS Regression for 2006 Study and Control 1 students

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
2005 TNCE Score	0.668	0.062	0.763	10.815	0.000
Study Treatment	2.972	2.152	0.095	1.381	0.169
Minority	0.976	2.308	-0.024	0.423	0.673
SES	-0.992	1.720	-0.032	-0.577	0.565

Dependent variable – 2006 TNCE
R^2 = 0.496, Durbin-Watson = 1.342, N = 198

Table 4 shows that the Control 1 and study students were not statistically distinct. This lack of statistical significance could be accounted for by the smaller N value of Type 1 Study and Control 1 students as well as by the absence of Type 2 Study students causing statistical artifacts to appear in the OLS results. Even with a lack of significance, the OLS results do show that study students tended to have almost 3 TNCE points higher than Control 1 students and that study treatment effects can explain almost 10% of the variance seen in the data. A larger N value might well have allowed the study treatment to become significant. This larger study N was achieved in year two and is discussed below. Minority status and SES were not significant. This was likely a result of insufficient variation in the data due to the relative homogeneity of the sample used. For these variables, a small N value could have, once again, made getting to significance more difficult.

Table 5. OLS Regression for 2006 Study and Control 3 students.

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
2005 TNCE Score	0.611	0.016	0.670	38.667	0.000
Study Treatment	0.606	1.443	0.007	0.420	0.674
Minority	-4.912	0.673	-0.139	-7.301	0.000
SES	-0.611	0.649	-0.018	-0.942	0.347

Dependent variable – 2006 TNCE
R^2 = 0.524, Durbin-Watson = 0.680, N = 1831

When compared to the other schools in the district for 2006, the data is inconclusive (Table 5). Study effects were insignificant. This, again, is believed to be due to the small population in the Study (a situation that changes for 2007). Minority status proved to be significant while low SES was not. While these two variables are often co-incident, it is interesting to see them different from each other in these results. Both were found to be negative in their impact on scores.

Table 6. OLS Regression for 2007 Study and Control 1 students.

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
2006 TNCE Score	0.728	0.041	0.650	17.803	0.000
Study Treatment	5.443	1.500	0.132	3.629	0.000
Minority	-4.557	1.567	-0.110	-2.908	0.004
SES	-.790	1.194	-0.025	-0.662	0.509

Dependent variable – 2007 TNCE
R^2 = 0.448, Durbin-Watson = 1.854, N = 440

Table 6 is the OLS regression for 2007 Study and Control 1 students. Study effects were significant. This is different from 2006. As is noted earlier, this was most likely due to there being no Type 2 Study students in 2006. This resulted in a very limited sample with which to work. The larger N as well as having both Type 1 and 2 for the study data may have resolved study effects for Study and Control 1 students. Again minority status was found to negatively impact scores in ways that are statistically significantly.

Table 7. OLS Regression for 2007 Study and Control 2 students.

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
2006 TNCE Score	0.677	0.020	0.752	33.385	0.000
Study Treatment	2.966	0.752	0.085	3.945	0.000
Minority	-2.292	0.834	-0.066	-2.747	0.006
SES	0.285	0.750	-0.009	0.380	0.704

Dependent variable – 2007 TNCE
R^2 = 0.555, Durbin-Watson = 2.015, N = 1142

Study effects were also significant for Control 2 and Study students (Table 7). This is a group that was not represented in 2006. Considering how much the Type 2 students in both groups were observed to differ in the descriptives, this is not surprising despite the Type 1 students appearing very similar in the descriptive statistics. This contrast has important implications for the findings from regression discontinuity analyses. For this OLS analysis, minority status is again significant but SES is not.

Table 8. OLS Regression for 2007 Study and Control 3 students.

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
2006 TNCE Score	0.724	0.020	0.740	36.203	0.000
Study Treatment	6.486	0.742	0.173	8.741	0.000
Minority	-3.168	0.732	-0.093	-4.329	0.000
SES	-1.064	0.682	-0.032	-1.560	0.119

Dependent variable – 2007 TNCE
R^2 = 0.538, Durbin-Watson = 2.047, N = 1421

Finally, the study effects are significant relative to the Control 3 students. The study students had almost 6.5 NCE points increase over non-study students. This effect is very consistent with the result from last year but in 2006 significance was not achieved due to low numbers in the study. Again, minority status and not SES is observed to have a significant and negative impact on scores.

Regression Discontinuity Analysis

The last analyses done for this report are based on regression discontinuity design. This analysis allows for examination of study effects by looking for a discontinuity at a cut-score (in this case, the TAKS passing score) when this score is transformed to have a zero value. The mathematical rationale is that under this transformation all other factors play no role at this cutoff point and thus any difference must be due to study treatment alone. All analyses performed included testing for higher order as well as interaction effects. Unless presented below, all such effects were insignificant and thus were not included in this report.

For regression discontinuity, transformed NCE scores continued to be used. For 2006, SES was chosen as the variable to control for student difference. While minority status has more often than not proven to have a significant negative effect, the homogeneity and even smaller N values of the samples used in regression discontinuity makes it difficult to control for minority status. While this is not ideal, it is forced by the limitation of the available data and could have the effect of under-reporting the effectiveness of the intervention. The N values were larger in 2007, however, and so minority status was used as a variable in all models tested.

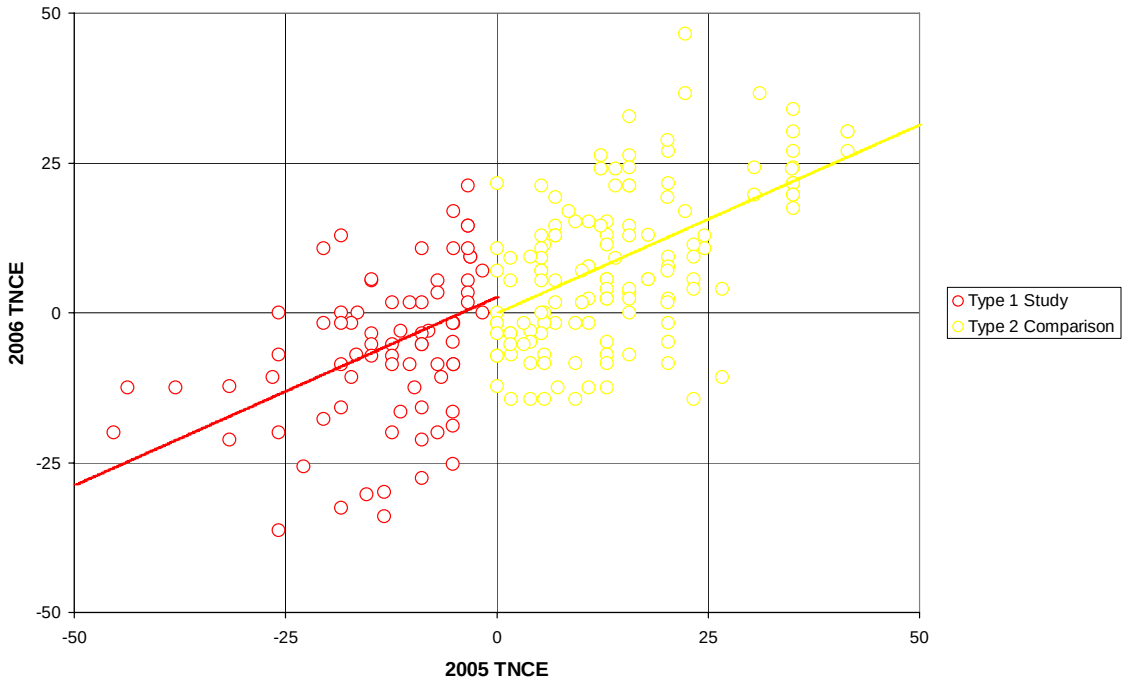
Table 9 is the regression discontinuity for 2006 Study and Comparison students. It is interesting to note that while the study treatment effect is ~3 NCE points and accounts for ~9% of the variance, it is still insignificant. This is most likely due to the low N values. Regression discontinuity requires a larger sample especially those close to the cutoff to be powerful. However, it is already known from the OLS that this effect should be significant. Since the OLS uses data from the whole sample, it is not as limited by the small N values as regression discontinuity. Following on these 2006 results, the 2007 data will be able to tell us more.

Table 9. Regression Discontinuity for 2006 Study and Comparison students.

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
2005 TNCE Score	0.629	0.070	0.730	8.994	0.000
Study Treatment	2.728	2.536	0.087	1.076	0.283
SES	-1.115	1.656	-0.35	-.673	0.501

Dependent variable – 2006 TNCE
R^2 = 0.443, Durbin-Watson = 1.313, N = 215

Graph 1. Regression Discontinuity for 2006 Study and Comparison groups



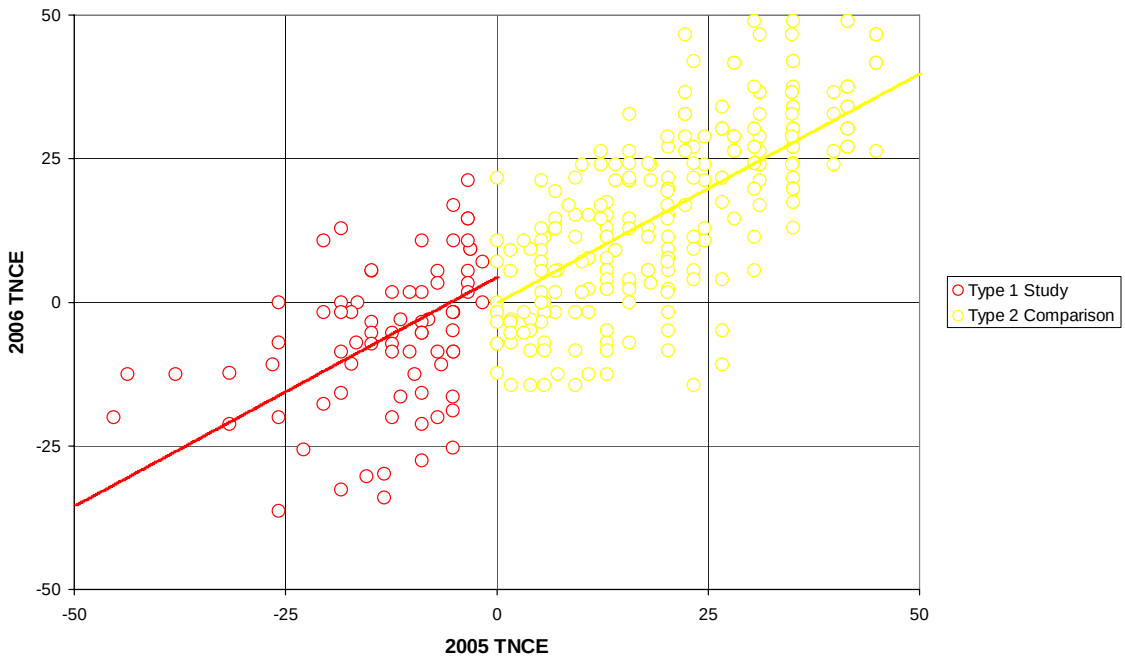
Returning to the 2006 results, the discontinuity at the cutoff is apparent in Graph 1. This discontinuity, however, is small and not significant. As explained earlier, this finding is different from last year's reported results because the NCE used in last year's report was generated using the frequency distribution of 2003. This was to create a baseline year for comparison. While this use of a baseline is often considered standard practice, given current test design (specifically the use of item response theory [IRT] for item development) it was decided this use of an arbitrary baseline would introduce distorting statistical artifacts into the analysis. This is seen most prominently in last year's report as a clustering of data points at the maximum NCE of 100. A baseline year was not used for this report and NCE scores were computed based on the frequency distributions for only the given administration of the test. In addition, the regression discontinuity last year used the pre-AP students in the Comparison group. For reasons outlined earlier, including this group of very distinctive students would introduce additional artifacts even if their inclusion would increase the overall N value (which was important in 2006). Just for comparison purposes, the pre-AP analysis using revised TNCE scores is included in Table 10 and Graph 2.

Table 10. Regression Discontinuity for 2006 Study and Comparison students including pre-AP

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
2005 TNCE Score	0.798	0.043	0.841	18.661	0.000
Study Treatment	4.500	2.136	0.091	2.107	0.036
SES	-5.098	1.293	-0.125	-3.942	0.000

Dependent variable – 2006 TNCE
R^2 = 0.688, Durbin-Watson = 1.187, N = 359

Graph 2. Regression Discontinuity for 2006 Study and Comparison groups with pre-AP students



As was seen in last year's report, this result is now significant. However, we no longer support their inclusion. Pre-AP students generally score much higher than non pre-AP students. This in turn changes the slope of the line to be much steeper such that when accounting for difference due to the study, the discontinuity would be increased. Thus, while removing the pre-AP students may tend toward under-reporting the effectiveness of the intervention, it is justified in terms of their very distinctive statistical attributes.

For the sake of completeness, the regression discontinuity for the Study and Control 1 was done even though it was insignificant on the OLS, shown in Table 11. It is not surprising then that results are not significant. It should be noted though that like the OLS, the result is trending towards significance.

Table 11. Regression Discontinuity for 2006 Study and Control 1 students.

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
2005 TNCE Score	0.653	0.084	0.745	7.763	0.000
Study Treatment	2.704	2.854	0.090	0.947	0.345
SES	-0.601	1.688	-0.020	-0.356	0.722

Dependent variable – 2006 TNCE
R^2 = 0.460, Durbin-Watson = 1.359, N = 183

Graph 3. Regression Discontinuity for 2006 Study and Control 1 groups

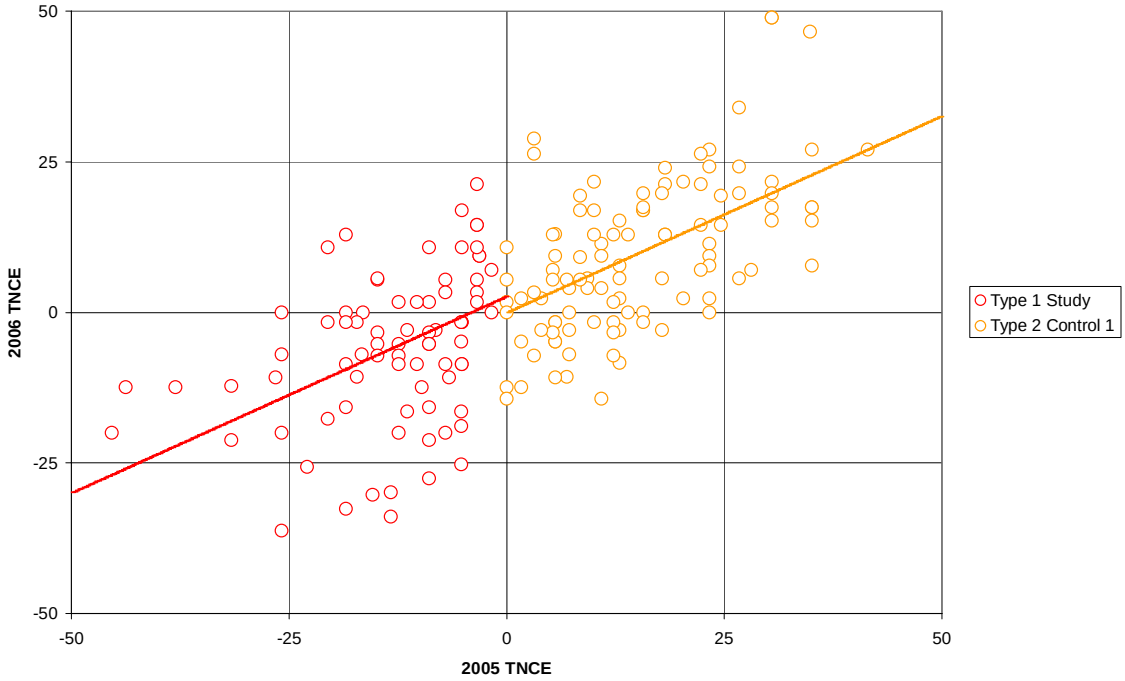


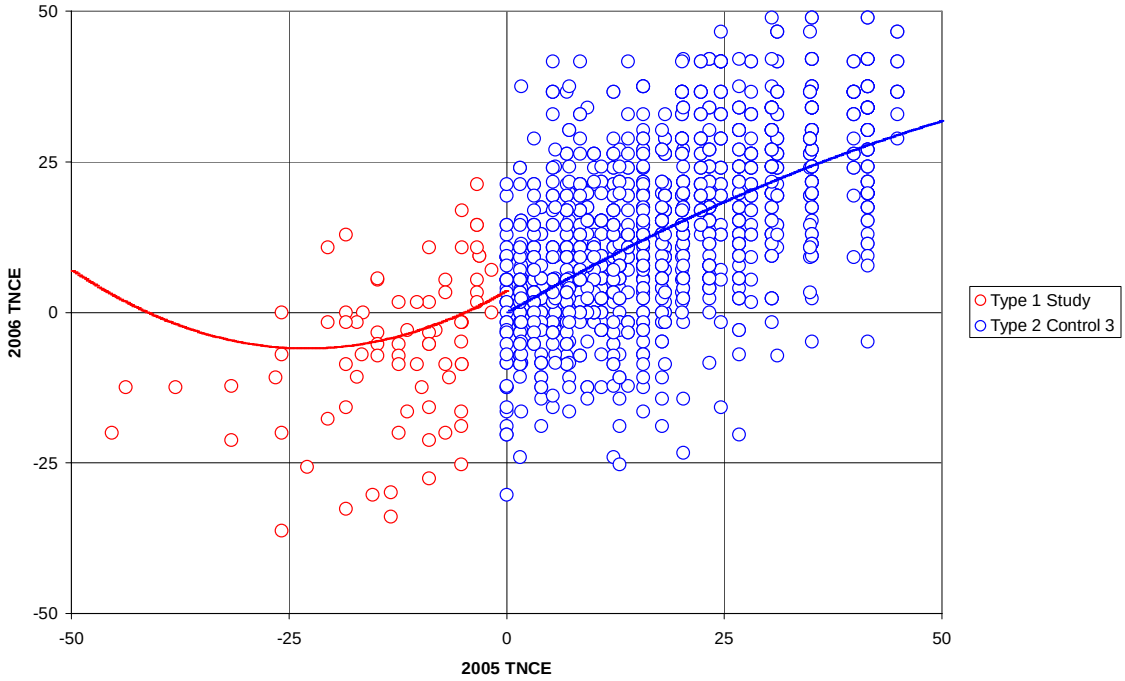
Table 12 is the regression discontinuity for the Study and Control 3 group, which again is insignificant as predicted by the OLS. Moreover, it is the only analysis to yield significant higher order and interaction effects.

Table 12. Regression Discontinuity for 2006 Study and Control 3 students

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
2005 TNCE Score	0.836	0.073	0.834	11.443	0.000
Study Treatment	3.659	3.609	0.054	1.014	0.311
SES	-3.011	0.652	-0.096	-4.619	0.000
Sq 2005 TNCE Score	-0.004	0.001	-0.193	-3.036	0.002
TNCE x Study Interaction	0.340	0.445	0.081	0.764	0.445
Sq Interaction	0.022	0.011	0.151	2.028	0.043

Dependent variable – 2006 TNCE
R^2 = 0.430, Durbin-Watson = 0.596, N = 1387

Graph 4. Regression Discontinuity for 2006 Study and Control 3 groups



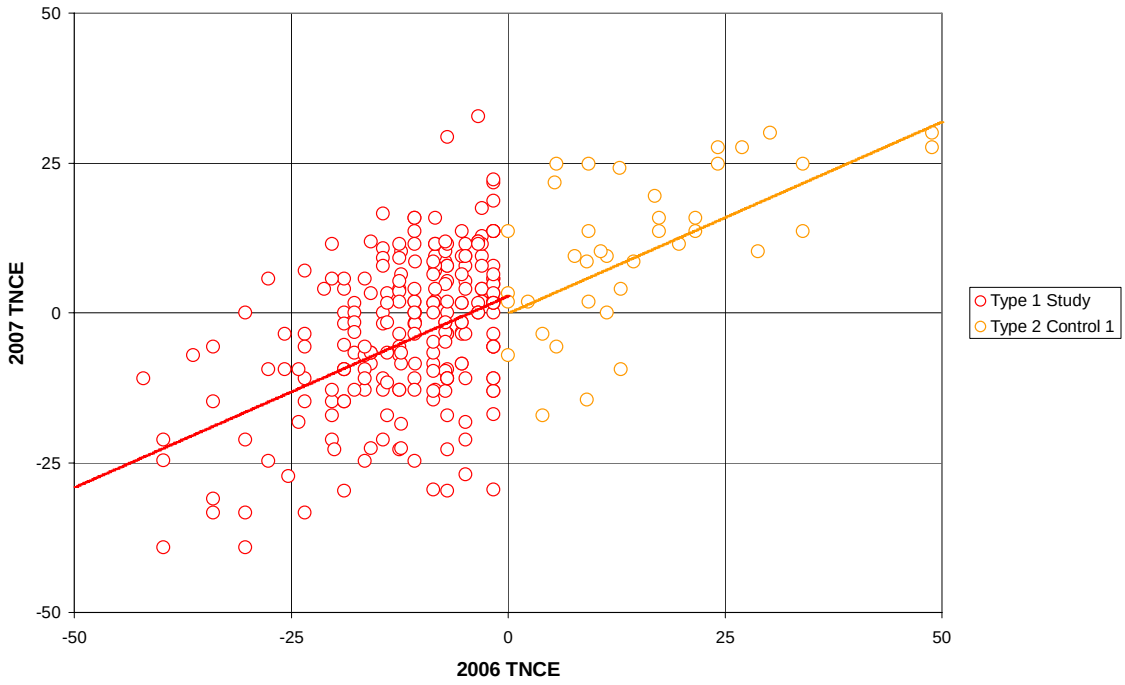
Next are the regression discontinuity results for the 2007 data. Table 13 shows that the study effect is not significant for Study and Control 1 students. This contradicts the OLS results where the study is indeed significant. While this particular analysis is trending towards significance (B = 2.594, explaining 7.6% of the variance), it is most likely due to low N values for the Type 2 Control 1 students. Graph 5 shows how few of those students there are from which the line is generated.

Table 13. Regression Discontinuity for 2007 Study and Control 1 students.

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
2005 TNCE Score	0.639	2.768	.623	9.000	0.000
Study Treatment	2.878	.071	0.074	1.073	0.284
Minority	-5.864	2.016	-0.142	-2.908	0.004

Dependent variable – 2007 TNCE
R^2 = 0.361, Durbin-Watson = 1.859, N = 274

Graph 5. Regression Discontinuity for 2007 Study and Control 1 groups



In addition, Type 2 Study students grew by over 5 NCE points whereas all other Type 2 students went down. Since OLS examines both Type 1 and Type 2 students for both Study and Control 1 groups, it is more able to make visible significant results, especially when combined with the fact that Type 1 Study students had the largest gains. To preserve the orthogonality needed for the regression discontinuity design, only the growth of Type 1 Study students are examined and compared to Type 2 Control 1 students.

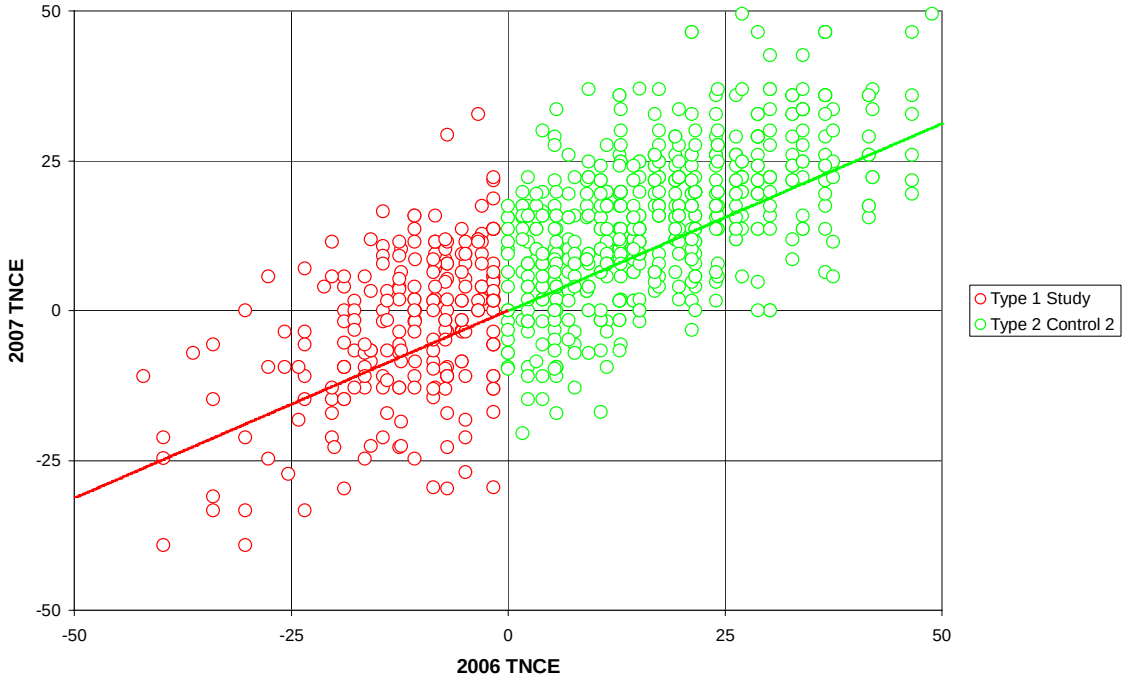
The analysis for Control 2 students gave curious results at first glance also. The OLS had indicated them to be significant. It should be recalled though that for Type 1 Study and Control 2 students, the change in NCE is much the same but that the Type 2 changes were drastically different with the Study going up by over 5 points and the Control 2 students going down over 2 points. It is probably for this reason that the OLS indicated significance. However, there is no significance in the regression continuity because as stated before, this type of analysis eliminates Type 1 Control 2 students and Type 2 Study students. This in effect cancels out the differences seen in the change from last year's NCE since the difference lies in the Type 2 students with the Type 1 students being almost the same for both groups.

Table 14. Regression Discontinuity 2007 Study and Control 2 students

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
2005 TNCE Score	0.626	0.032	0.724	19.534	0.000
Study Treatment	0.124	1.236	-0.004	0.101	0.920
Minority	-1.480	0.805	-0.047	-1.838	0.066

Dependent variable – 2007 TNCE
R^2 = 0.547, Durbin-Watson = 2.074, N = 820

Graph 6. Regression Discontinuity for 2007 Study and Control 2 groups



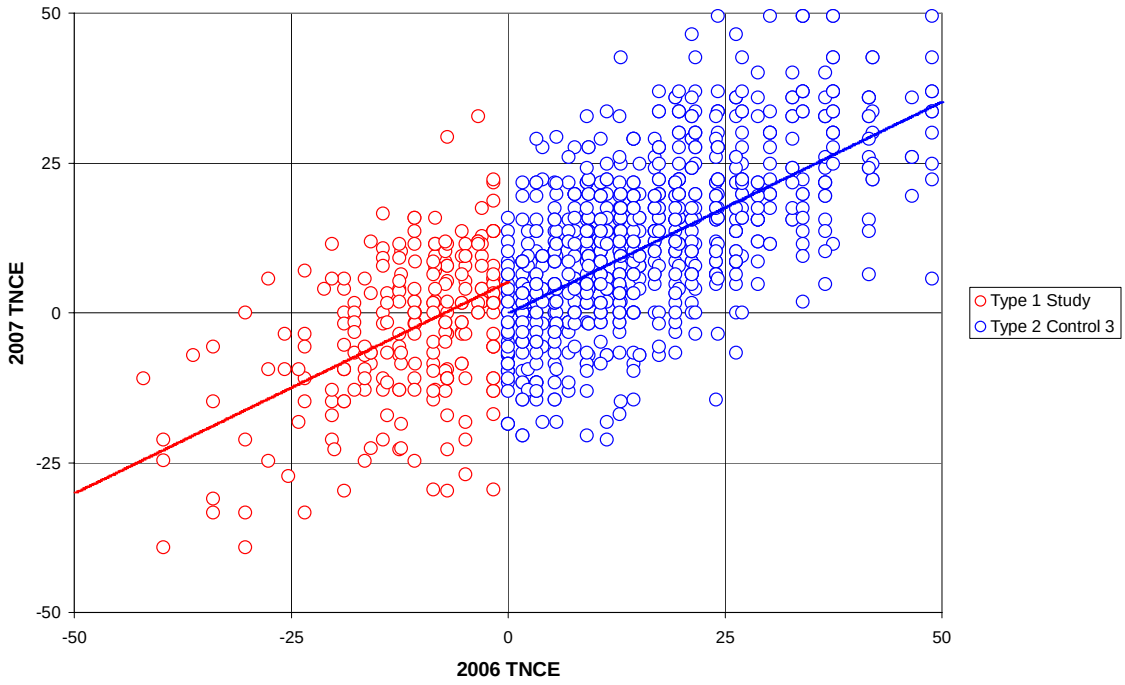
The last analysis is a regression discontinuity with the 2007 Study and Control 3 students. Inspection of the descriptive statistics indicates significant differences in outcomes for students. Correspondingly, the results for the regression discontinuity analysis is significant.

Table 16. Regression Discontinuity 2007 Study and Control 3 students

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
2005 TNCE Score	0.706	0.030	0.759	23.560	0.000
Study Treatment	5.263	1.166	0.143	4.512	0.000
Minority	-3.450	0.744	-0.110	-4.639	0.000

Dependent variable – 2007 TNCE
R^2 = 0.504, Durbin-Watson = 1.970, N = 1030

Graph 7. Regression Discontinuity for 2007 Study and Control 3 groups



Conclusions

In conclusion, under OLS analyses the study intervention is effective in raising both Type 1 (students who failed the previous year TAKS) and Type 2 (students who passed the previous year TAKS) students' mean NCE scores. This lends significant support for the versatility and inclusiveness of the intervention when it comes to classroom use. Due to this increasing of the Type 2 Study students' scores and lack of growth in all other Type 2 students, OLS regression analysis always yield significant results, but regression discontinuity often did not. The closer the Type 1 Control students were to the Type 1 Study students, the more likely the regression discontinuity would fail to find significance.

Future work, to validate some of the implications of these analyses, should examine what is happening in the Control classes. This is especially true for the Control 2 classes which in this analysis resemble the Study classes the most at the Type 1 level.

Regression discontinuity analyses did show significance at the district level comparison. In general across OLS and RDD analyses, when significance was found the effect of the intervention was in the four to six point range for improved NCE score on a 100 point scale. Even when significance was not reached, the results often were trending in this range. This convergence of results across complementary methodologies lends further credibility both these findings and to the methodologies developed for these analyses.

To conclude, the overall results indicate that the *MathForward* intervention resulted in scores of students below passing in one year improve their scores by 4-6.5 points in the subsequent year.

In contrast to other forms of intervention that result in some improvement in outcome for underperforming students but at the apparent expense of students scoring above the passing level, the results of this study suggest scores for all students in classes using the *MathForward* program improved. All students appeared to benefit from participation in the *MathForward* program.

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TI-RISD MathForward Intervention

2007 Year End Report

Prepared by

Winick & Lewis Research, LLC

August 15, 2007

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Executive Summary

- MathForward, a collaborative effort between Texas Instruments and Richardson Independent School District, expanded in the district this year to include five junior high schools and two high schools as targets for improvement in their mathematics instruction.

- At the junior high level, students who scored between 50% and 75% on initial district benchmarks were selected to join the MathForward block classes. Given the broader reach of the program this year, finding a valid comparison group posed a challenge, but students who were enrolled in regular, non-AP mathematics classes at the participating schools were used for comparison purposes. The MathForward group generally had a higher percentage of economically disadvantaged students but was otherwise demographically similar to the comparison group at most schools.

- Year-end TAKS results showed that the MathForward students made good gains in terms of their TAKS pass rates and percentage correct, although in general they scored below the overall school average. The seventh grade students performed much better than the eighth graders, as they more closely approached the average at most junior high schools.

- When focused on the performance of the most at-risk students over the past two years (those that had failed the previous year's TAKS), these students performed much better when placed in the MathForward classes where at each school (junior high and high schools) they were more likely to meet the minimum passing standard on the 2007 TAKS.

- In terms of average percent correct on the 2007 TAKS, the MathForward students also showed significantly more growth in their scores than comparable students. This pattern also held for the high school intervention classes.

- The RISD teachers' math knowledge, as measured by pre- and post-intervention CKTM assessments, dropped slightly at year's end. While the average was higher than reported in an assessment from the end of 2005, the drop was unexpected and may be a function of problems in the content focused teacher training offered to the schools.

- Growth in CKTM number operations scale scores was positively associated with the TAKS performance of their students.

- Turning to the stakeholder survey results, Teacher confidence improved since mid-year. The teacher confidence questions are clustered in the Learning Environment domain which at year-end was significantly correlated with student performance data.

- Across the campuses teachers reported that the math content sessions were not helpful. Many thought they were taught at a level too advanced to support pedagogical needs for struggling students.

- Reports of collegial support remained high across the year. All of the teachers agreed that there is an expert available with whom teaching strategies can be discussed.

- Teachers agree that assistance is readily available for implementing the TI Technology. Some disagree that they have sufficient curriculum materials (or materials that are of good quality) to effectively use TI Navigator, while nearly all agree that they could use additional training on the TI Navigator.

- While similarities are seen in teacher use of small group instruction, discussion and student collaboration across the campuses, teacher and student responses portray different classroom cultures.

- Teacher responses to the power block are positive but mixed, with most agreeing that the amount of content covered with the block has increased.

- Teacher attitudes about the value of benchmark data are mostly positive, although it is unclear to some, if the unit diagnostics are aligned to the district curriculum.

- Forest Meadow teachers report the most consistent use across the TI Navigator features (Quick Poll, Learn Check, Screen Capture, Activity Center) and the highest percentage of teachers (2-3 out of 3) using the technology.

- Technology pulse or perceived benefit is highest at Forest Meadow Junior High and Westwood Junior High, with the largest gain since mid-year at Liberty Junior High School. Student performance is significantly higher in classrooms where the teachers report more benefit from using the TI technology.

Year-End Assessment of the RISD-TI MathForward Intervention Model

Overview

During this past year, the Richardson Independent School District and Texas Instruments, Inc. expanded the MathForward intervention to classes across five junior high schools and two high schools in the district. Utilizing a block schedule class design, additional instruction time, more collaboration between teachers throughout the year, focused professional development sessions, and the employment of the TI-Navigator systems, the district sought to increase the passing rate of at-risk students enrolled in these schools. At the junior high schools, students selected for the intervention were primarily those who, coming into this year, scored on average between 50% and 75% on the district's mathematics benchmarks. The intervention at the high school level is more limited in scope and involved a smaller number of students, primarily those who participated in the pilot program last year at Lake Highlands Junior High School. For this reason, our attention will focus on junior high schools rather than the limited sample at the high school level, although numbers will be provided for all schools when available and appropriate.

2007 TAKS Results

A summary of this year's TAKS testing results can give us a better sense of the general context within the participating schools. Table 1 provides comparative data on demographic categories for all 7th and 8th graders at the junior high schools, and all 9th graders at the high schools. Listed in the table are the total number of students at those grades tested this year by school, the schools' ethnic group percentages, and proportion of each school's student body classified as economically disadvantaged. Note the high proportion of minority and economically disadvantaged students taking the TAKS at the junior high schools in the intervention group.

Table 1: Response Totals by Campus for 2007 TAKS testing period
(for schools overall – ethnic group and economic disadvantaged percentages)

Campus	Total tested	Native American	Asian	Afr. Amer.	Hispanic	White	Econ. Dis.
Lake Highlands Freshman Center	532	0%	2%	39%	23%	36%	41%
Pearce High School	476	1%	4%	6%	23%	65%	22%
Lake Highlands Junior High	568	0%	1%	41%	21%	37%	45%
Richardson West Junior High	547	1%	7%	17%	43%	33%	51%
Forest Meadow Junior High	522	0%	4%	45%	23%	27%	58%
Westwood Junior High	567	0%	7%	24%	30%	39%	41%
Liberty Junior High	587	0%	17%	39%	23%	20%	58%

The intervention classes were similar across all of the schools, with students enrolled in 100 minute block classes that employed the TI-Navigator system to assist in instruction. Within the schools, teachers assigned to these classes met frequently to develop and share their knowledge and solve problems, and these teachers also received additional professional development sessions with a math expert from Texas Instruments.

Table 2: Economic disadvantaged and ethnic group percentages across junior high schools and between classes

		Economically Disadvantaged	Asian	African American	Hispanic	White	Total
		Percent	Percent	Percent	Percent	Percent	Count
Lake Highlands Junior High	Comparison Class	55%	2%	55%	25%	19%	183
	Block Class	64%	0%	53%	27%	19%	172
Richardson West Junior High	Comparison Class	58%	5%	21%	50%	22%	216
	Block Class	74%	0%	17%	63%	20%	109
Forest Meadow Junior High	Comparison Class	72%	3%	57%	30%	9%	268
	Block Class	60%	0%	56%	24%	20%	82
Westwood Junior High	Comparison Class	58%	3%	29%	46%	22%	180
	Block Class	60%	1%	31%	51%	17%	98
Liberty Junior High	Comparison Class	62%	15%	36%	27%	20%	273
	Block Class	64%	12%	52%	26%	10%	181

To help assess the effects of the MathForward intervention, a comparison group of students at each school was constructed by selecting students who were not participating in the block classes, were not enrolled in Pre-AP mathematics courses, and who were taught by teachers other than those participating in the intervention. This left students who were not identified by the district benchmarks as being at risk but who also were not enrolled in the highest level math classes. As shown in table 2 above, the block and comparison classes had similar demographic characteristics, although for most schools the intervention group had a higher percentage of economically disadvantaged students (with Forest Meadow being the exception). In all, 642 students were enrolled in the MathForward classes taught by 22 teachers at the junior high schools, along with 60 9^{th} graders taught by five teachers at the high school sites. Additionally, 1120 junior high and 948 high school students not enrolled in Pre-AP mathematics courses were selected from the same schools to serve as comparisons for our analyses.

Turning to the 2007 TAKS results across all of the schools, we can summarize performance generally and for specific subgroups of interest. In table 3 below, the percentage of students in the 7^{th} and 8^{th} grades who met the minimum passing standard can be seen along with the percentage change from the 2006 results for each group at the schools. As can be seen in the table below, there is some degree of variation between the school and among the major ethnic groups within the schools.

Table 3: 2007 TAKS Met Minimum Percentage Pass Rate by Grade for comparison and block classes

Campus			Overall	African American	Hispanic	White	Economically Disadvantaged
7th Grade							
Lake Highlands Junior High		Comparison Classes	67%	58%	67%	89%	60%
		Block Classes	83%	73%	87%	96%	84%
Richardson West Junior High		Comparison Classes	81%	67%	82%	90%	79%
		Block Classes	79%	67%	86%	67%	80%
Forest Meadow Junior High		Comparison Classes	61%	56%	71%	64%	57%
		Block Classes	68%	75%	36%	89%	64%
Westwood Junior High		Comparison Classes	86%	82%	91%	86%	85%
		Block Classes	82%	40%	100%	100%	81%
Liberty Junior High		Comparison Classes	72%	61%	73%	89%	65%
		Block Classes	66%	56%	72%	78%	63%
8th Grade							
Lake Highlands Junior High		Comparison Classes	52%	47%	42%	76%	50%
		Block Classes	38%	41%	33%	40%	41%
Richardson West Junior High		Comparison Classes	73%	78%	68%	82%	72%
		Block Classes	39%	33%	35%	54%	37%
Forest Meadow Junior High		Comparison Classes	54%	54%	43%	79%	49%
		Block Classes	71%	68%	56%	100%	71%
Westwood Junior High		Comparison Classes	78%	58%	82%	95%	72%
		Block Classes	58%	67%	52%	67%	48%
Liberty Junior High		Comparison Classes	75%	54%	74%	93%	68%
		Block Classes	62%	55%	55%	80%	65%
9th Grade							
Lake Highlands Freshman Center		Comparison Classes	70%	47%	65%	94%	52%
		Block Classes	60%	50%	71%	100%	58%
Pearce High School		Comparison Classes	89%	68%	77%	95%	72%
		Block Classes	88%	n/a	100%	75%	100%
Total	7th	Comparison Classes	73%	62%	78%	86%	68%
		Block Classes	76%	65%	82%	89%	75%
	8th	Comparison Classes	66%	56%	63%	86%	60%
		Block Classes	54%	53%	46%	68%	53%
	9th	Comparison Classes	79%	50%	71%	95%	59%
		Block Classes	63%	50%	76%	88%	63%

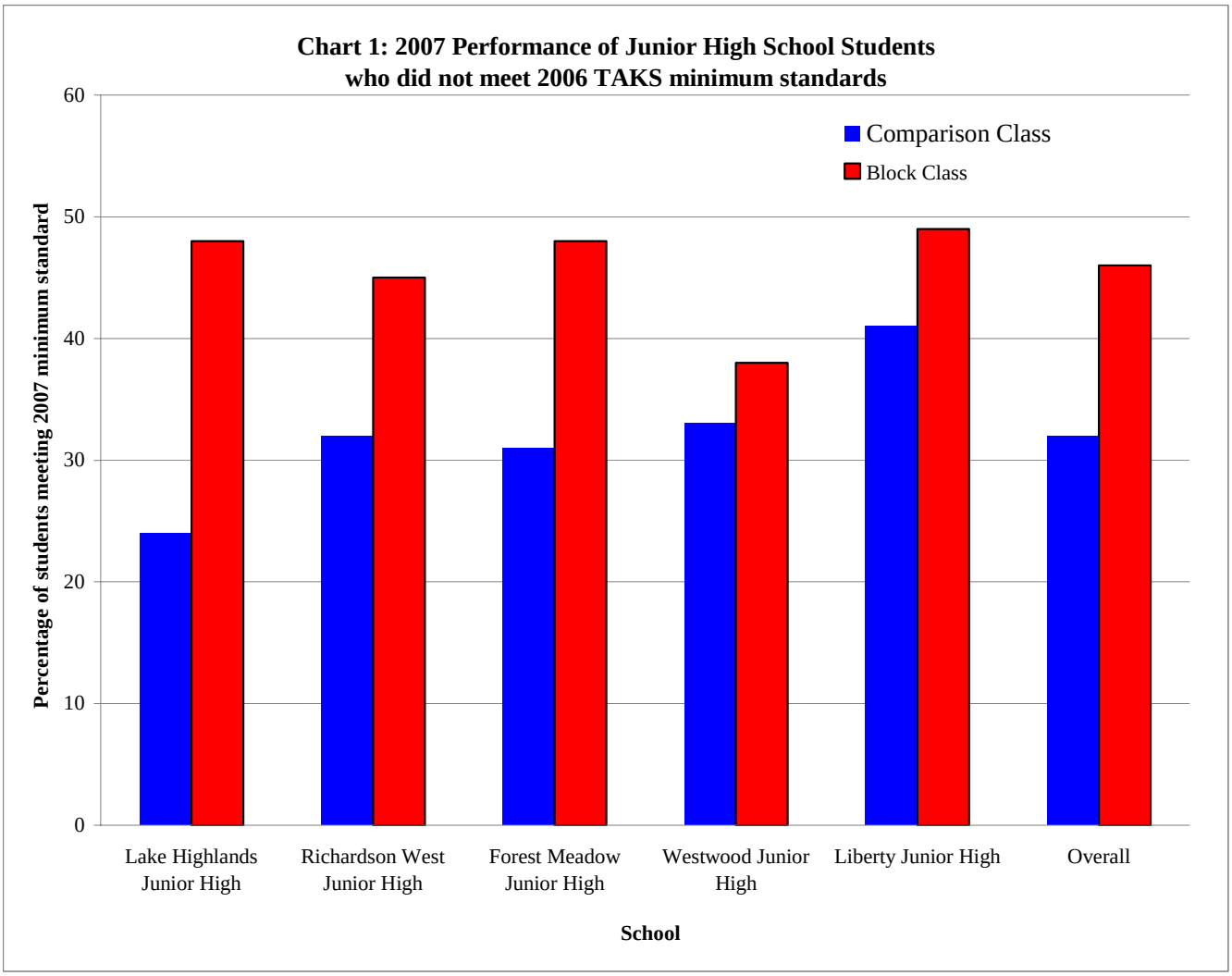
As table 3 illustrates, the intervention led to relatively better results for the 7th grade classrooms where the percentage of MathForward students meeting the minimum passing level approached or exceeded that of comparable students. In the eighth grade the comparison classes have a passing percentage that is greater at most schools, and in the ninth grade the pilot program at the high school level shows some promise. Finding an apt comparison group for these students is somewhat problematic, however, given that the most at-risk students were those primarily targeted for the intervention.

The next table attempts to give a more appropriate contrast. A comparison of results across campuses for combined 7th and 8th grade students who had data over the past two years is informative since the intervention was focused on students who did not pass the 2006 TAKS, or who were deemed at-risk for not passing this year.

Table 4: 2007 TAKS Math Performance by Students who did not meet 2006 minimum standard by school and class grouping across the junior high sites

			Did not meet 2007 TAKS minimum standard	Met 2007 TAKS minimum standard	Total
			Percent	Percent	Count
Lake Highlands Junior High	Comparison Classes	2006 Not Met	76%	24%	33
		2006 Met	13%	87%	82
	Block Classes	2006 Not Met	52%	48%	44
		2006 Met	13%	87%	91
Richardson West Junior High	Comparison Classes	2006 Not Met	68%	32%	19
		2006 Met	14%	86%	163
	Block Classes	2006 Not Met	55%	45%	58
		2006 Met	12%	88%	41
Forest Meadow Junior High	Comparison Classes	2006 Not Met	69%	31%	71
		2006 Met	13%	87%	105
	Block Classes	2006 Not Met	52%	48%	25
		2006 Met	15%	85%	52
Westwood Junior High	Comparison Classes	2006 Not Met	67%	33%	9
		2006 Met	7%	93%	136
	Block Classes	2006 Not Met	62%	38%	29
		2006 Met	7%	93%	54
Liberty Junior High	Comparison Classes	2006 Not Met	59%	41%	29
		2006 Met	9%	91%	174
	Block Classes	2006 Not Met	51%	49%	69
		2006 Met	18%	82%	90
Overall	Comparison Classes	2006 Not Met	68%	32%	161
		2006 Met	11%	89%	660
	Block Classes	2006 Not Met	54%	46%	225
		2006 Met	14%	86%	328

Table 4 shows the 2007 performance of students who either met or did not meet the minimum passing standard on the TAKS in 2006. Students are grouped by school, class assignment, and whether or not they met the TAKS minimum passing standard in 2006, and percentages are then reported in terms of 2007 TAKS performance. In all of the schools, students who had not met the minimum standards in 2006 were much better off in 2007 if they were enrolled in the block class participating in the intervention. Chart 1 below illustrates this in a graphic fashion.

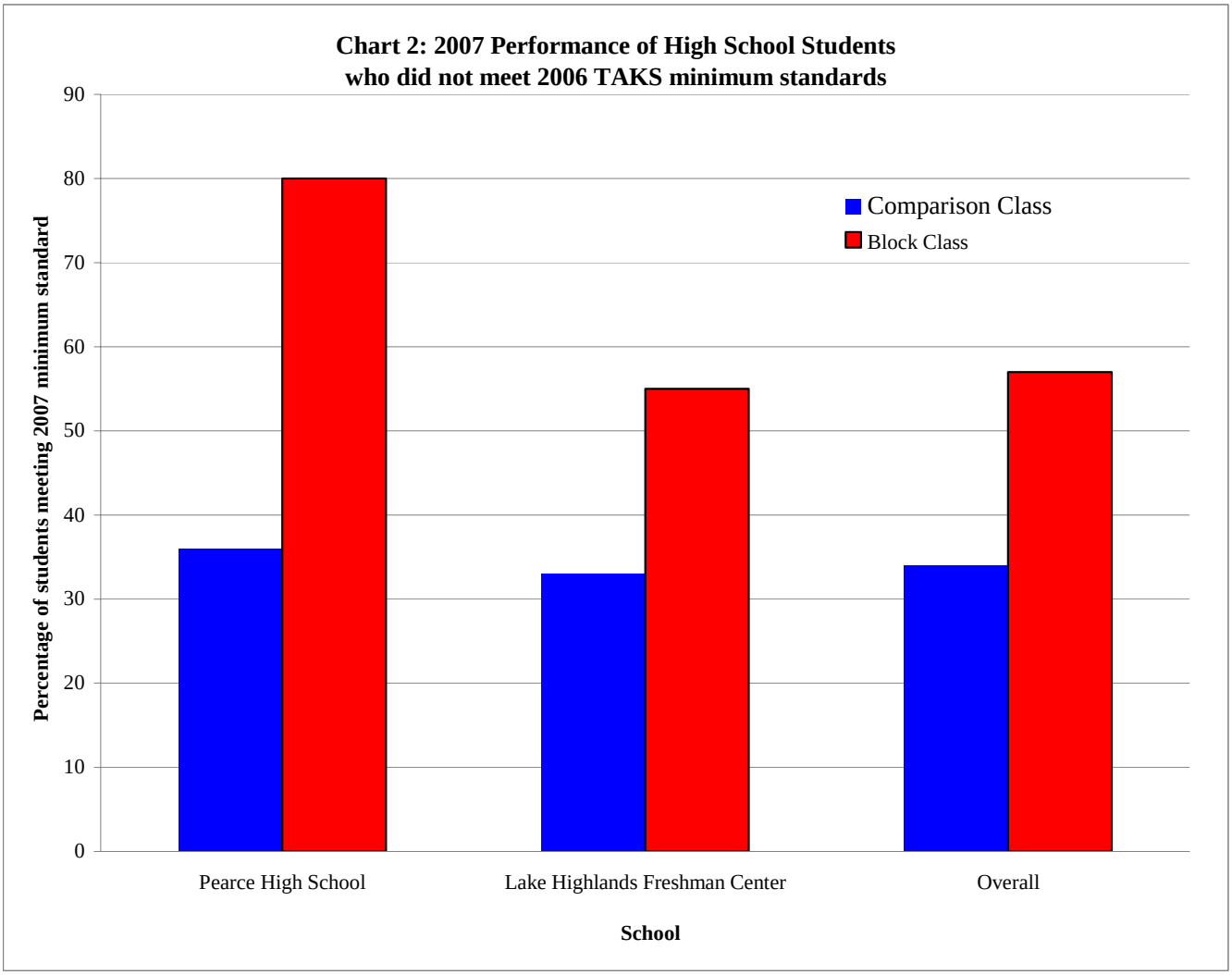


The high school sites also show a similar promising pattern, and while it is a small extension the expansion of the program past the junior high school level seems to work as well. Table 5 shows a pattern similar to the one illustrated above in table 4, with a much greater percentage of at-risk students meeting the minimum standard for passing the 2007 TAKS.

Table 5: 2007 TAKS Math Performance by Students who did not meet 2006 minimum standard by school and class grouping at the high school sites

			Did not meet 2007 TAKS minimum standard	Met 2007 TAKS minimum standard	Total
			Percent	Percent	Count
Pearce High School	Comparison Classes	2006 Not Met	64%	36%	39
		2006 Met	3%	97%	383
	Block Classes	2006 Not Met	20%	80%	5
		2006 Met	n/a	100%	3
Lake Highlands Freshman Center	Comparison Classes	2006 Not Met	67%	33%	95
		2006 Met	7%	93%	267
	Block Classes	2006 Not Met	45%	55%	42
		2006 Met	13%	88%	8
Overall	Comparison Classes	2006 Not Met	66%	34%	134
		2006 Met	5%	95%	650
	Block Classes	2006 Not Met	43%	57%	47
		2006 Met	9%	91%	11

Note that there was a difference in assignment methods here as students who had participated in the block classes last year at Lake Highlands Junior High School were included in block classes at Lake Highlands Freshman center. Chart 2 below illustrates this consistent pattern at the high schools in a graphic form.



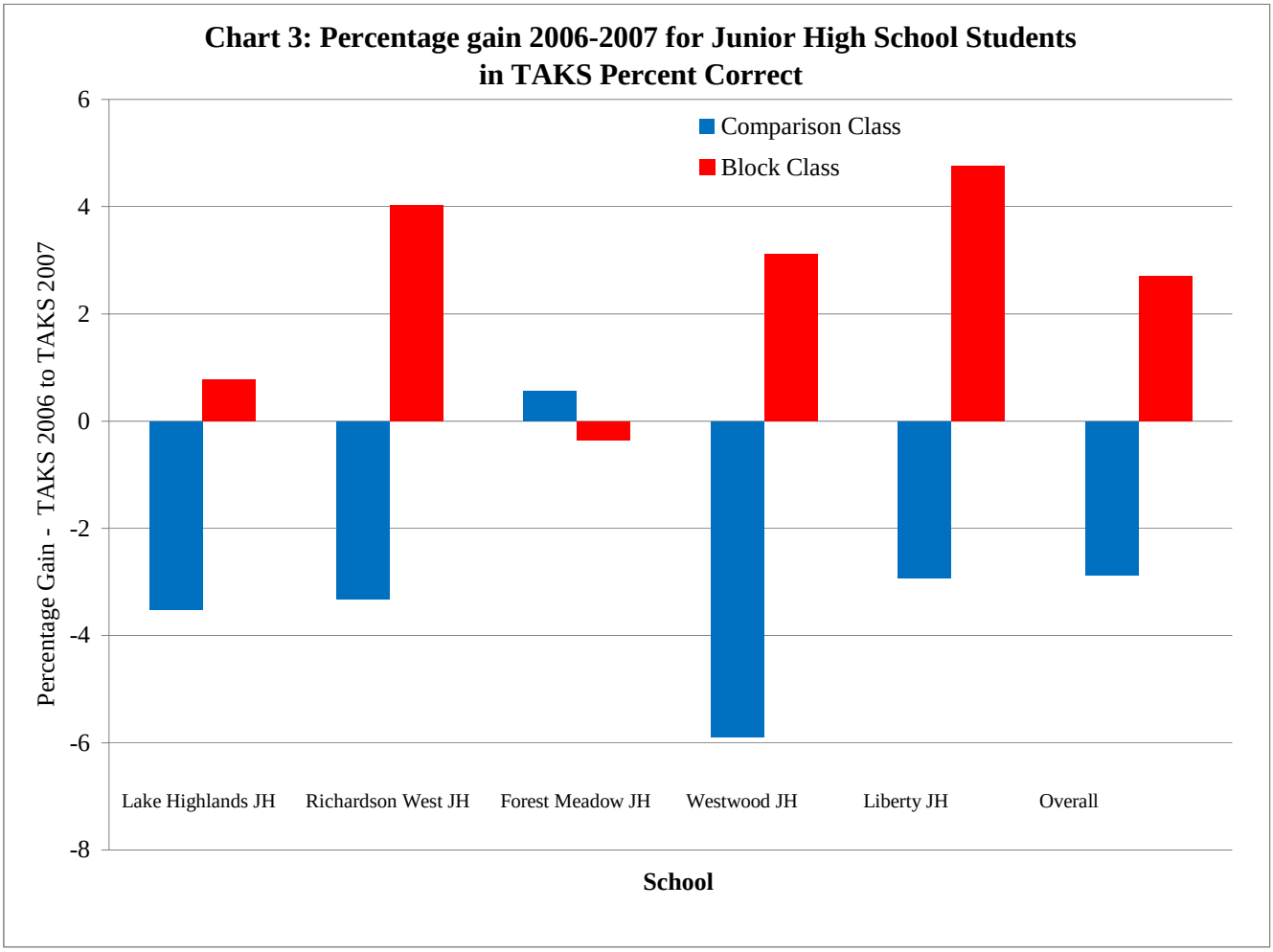
A comparison can also be made across schools contrasting gains in the percentage of correct responses made by students in the block classes and those in regular (non-AP) mathematics classes. Again, using the students where data are available from both 2006 and 2007, the change in percent correct on the TAKS assessment was calculated for each student in the block and comparison classes. The averages for the groups were then compared, summarized below in table 6.

Table 6: Average TAKS Percentage Correct Growth from 2006 to 2007 for Block and Regular Mathematics Classroom Students across schools

School	Block versus Comparison Classes	Average	Standard Deviation	Number of Students
Lake Highlands Junior High	Comparison Classes	-3.52	13.20	115
	Block Classes	0.78	13.31	135
	Total	-1.20	13.41	250
Richardson West Junior High	Comparison Classes	-3.32	11.32	182
	Block Classes	4.02	13.63	99
	Total	2.40	12.22	148
Forest Meadow Junior High	Comparison Classes	0.56	15.50	176
	Block Classes	-0.35	15.40	77
	Total	0.28	15.44	253
Westwood Junior High	Comparison Classes	-5.89	10.86	145
	Block Classes	3.11	11.68	83
	Total	-2.61	11.95	228
Liberty Junior High	Comparison Classes	-2.93	13.92	203
	Block Classes	4.76	14.96	159
	Total	0.45	14.87	362
Total	Comparison Classes	-2.88	13.28	821
	Block Classes	2.70	14.03	553
	Total	-0.63	13.85	1374

The results in Table 6 show that students in the block classes made gains at four of the schools, while students in comparison mathematics classes at four of the schools lost ground on this year's test. Only Forest Meadow Junior High deviates from this trend, where relative gains by 8th grade block classes

were offset by a slightly larger deficit in the 7th grade. Interpreting gain scores can be problematic given pre-existing score differences in the groups at the start of the school year, as the Block class students started out with lower initial scores. Using an Analysis of Covariance (ANCOVA) test, the relative gains illustrated by these groups could be assessed while statistically controlling for any initial differences[1]. When the 2006 percentage correct TAKS total for each student is used as a covariate, the ANCOVA analysis revealed that the Block Class Students gained significantly more in their TAKS scores over the year ($\mathbf{F}_{(1,1353)} = 13.08$, $\mathbf{p} < .001$). Chart 3 illustrates the pattern graphically.

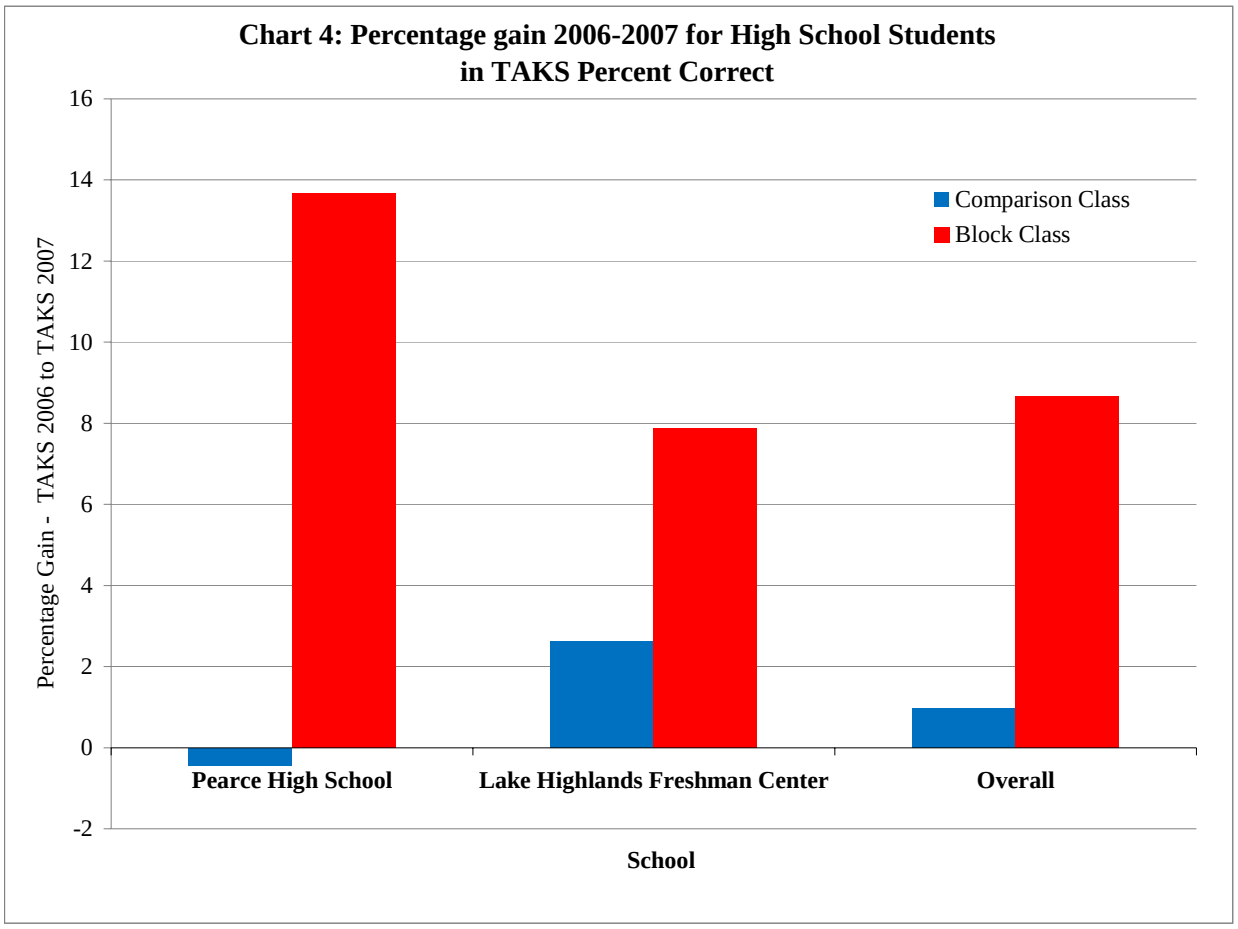


This analysis can also be repeated for the high school sites, and while the any results from this small sample should be taken as preliminary, they show promise and illustrate the same pattern seen at the junior high school level. Table 7 and chart 4 below show the average correct percentage comparison for the two participating high schools. Utilizing the same ANCOVA analysis strategy, these reported differences also are statistically significant when the initial starting level is controlled for through the use of the 2006 TAKS correct percentage as a covariate ($\mathbf{F}_{(1,837)} = 8.102$, $\mathbf{p} = .005$).

[1] To verify the suitability of an ANCOVA analysis strategy, the null hypothesis assumption that the error variance of the dependent variable is equal across groups was not rejected; $\mathbf{F}_{(19,1354)} = 1.505$, $\mathbf{p} = .075$ for junior high schools and $\mathbf{F}_{(3,838)} = 1.591$, $\mathbf{p} = .19$

Table 7: Average TAKS Percentage Correct Growth from 2006 to 2007 for Block and Regular Mathematics Classroom Students across high schools

School	Block versus Comparison Classes	Average	Standard Deviation	Number of Students
Pearce High School	Comparison Classes	-0.45	9097	422
	Block Classes	13.67	11.66	8
	Total	-0.19	10.17	430
Lake Highlands Freshmen Center	Comparison Classes	2.63	10.72	362
	Block Classes	7.88	9.15	50
	Total	3.26	10.67	412
Total	Comparison Classes	0.97	10.43	784
	Block Classes	8.68	9.63	58
	Total	1.50	10.56	842



Teacher Content Knowledge

The TI-RISD intervention also focused on improving teacher knowledge, using professional development opportunities and collaborative sessions to assist the mathematics teachers. The impact in this area can be seen in the teachers' scores on the Content Knowledge for Teaching Mathematics (CTKM) project assessment (Ball, Bass, & Hill, 2003) that was administered prior to this year and then again after the TAKS testing period. Table 8 lists the CKTM averages for the 20 mathematics teachers participating in the intervention program who had complete data from the beginning of the school year in 2006 to the end in 2007, along with the growth illustrated on each CKTM domain. Note that the CKTM scores are represented in standard deviation units and are normalized in line with a national sample of mathematics teachers who completed the CKTM measures over the last three years. The average score is calibrated to zero, and scores can be negative or positive in value, representing results that would be below (negative) or above (positive) average. As part of a different study (Winick, Lewis and Toenjes, 2005 – *Study of Mathematics Practice, Policy and Instruction in the Richardson Independent School District*), mathematics teachers across RISD's junior high schools completed the CTKM, and at that time were essentially at the average level (.0001 for the Number Operations Scale and .0008 for the Patterns, Functions and Algebra Scale). While some of the teachers from that initial study are not included here and new teachers have also joined to be part of the present sample, these numbers help to place this year's results in a broader context.

Table 8: CKTM Averages and change from 2006 to 2007 in Richardson ISD overall

LMT Dimension	Average	Standard Deviation	Range
2006 Numbers and Operations domain	.2679	.809	2.62
2007 Numbers and Operations domain	.2294	.800	2.85
Growth in Numbers and Operations score, 2006-07	-.1244	.829	3.22
2006 Patterns, Functions, and Algebra domain	.3118	.686	2.02
2007 Patterns, Functions, and Algebra domain	.3953	.584	2.05
Growth in Patterns, Functions, and Algebra score, 2006-07	-.0228	.430	1.72

Focusing on this year, on average no growth was seen on the content knowledge scales over this time period, with the average scores falling by year's end. This may related to a number of factors highlighted in the teacher surveys, reported below. Gains in the Numbers Operations Scale were positively correlated with the percentage of students in a teacher's class meeting the minimum TAKS standards ($\mathbf{r}_{(19)} = .43$, $\mathbf{p} = .033$) and a positive trend was also seen between gains in Number Operations and the class average percentage correct ($\mathbf{r}_{(19)} = .37$, $\mathbf{p} = .058$). The following charts graphically illustrate these associations. No associations were found between the Patterns, Functions and Algebra Scale Score and student outcomes, but for comparison graphs of those findings can be found in the appendices section.

Chart 3: Association between CKTM Number Operations Scale Score and Met Minimum TAKS Standard

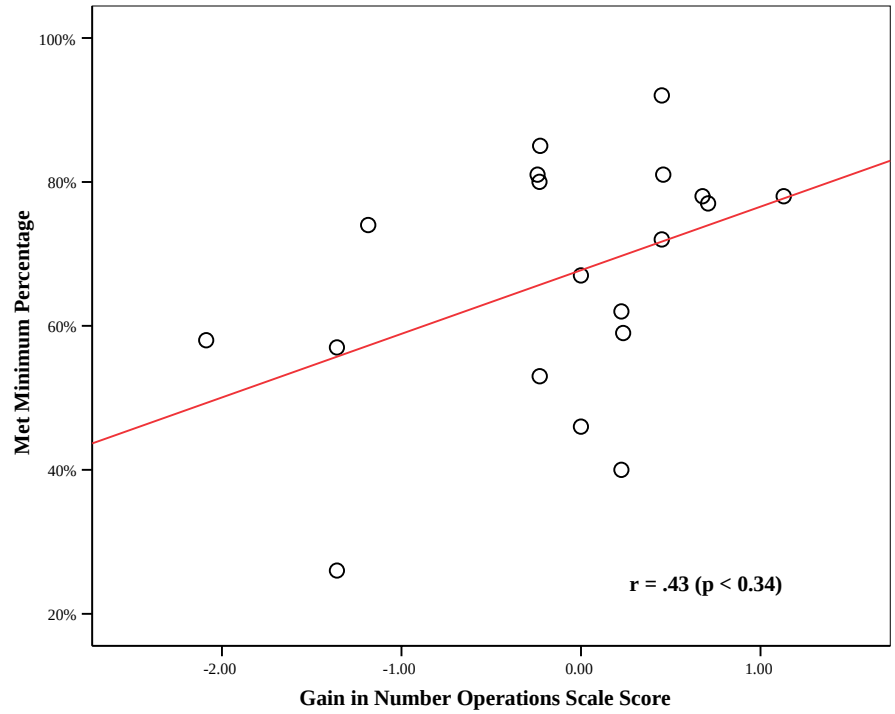
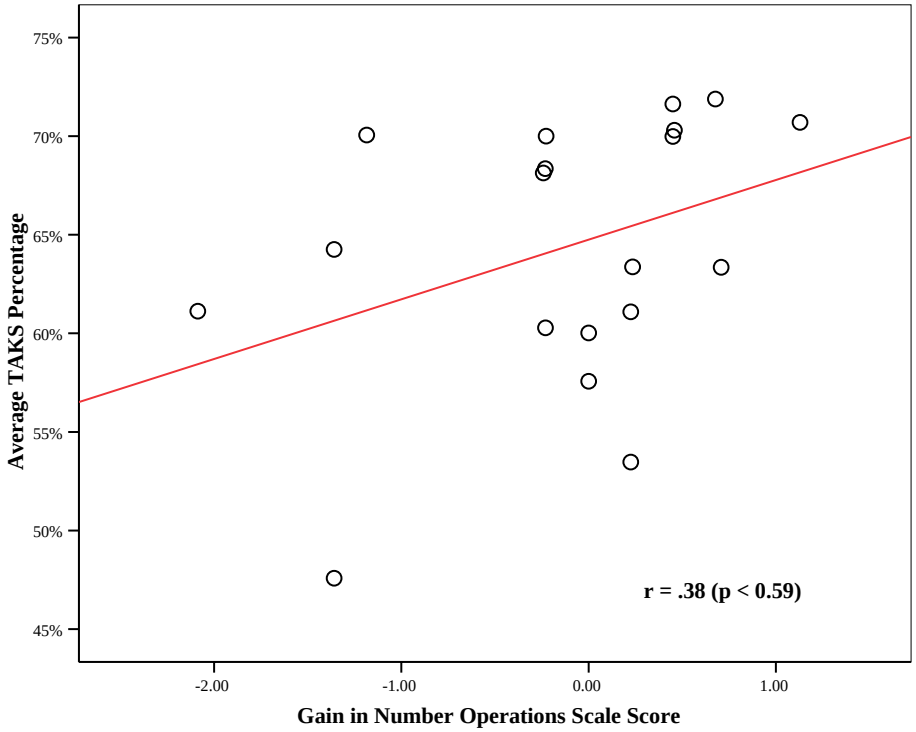


Chart 4: Association between CKTM Number Operations Scale Score and average TAKS correct percentage



The patterns in growth measures for Number Operations show a positive trend with teachers scoring higher or showing more growth on the domains also having classes with a higher percentage meeting the minimum passing level on the TAKS.

Teacher Perceptions - Overview

Thirty-five classrooms across five junior high campuses participated in the MathForward Program from the Richardson Independent School District (RISD), and all the stakeholders connected to these classes (students, parents and teachers) were asked to complete a year-end survey. Five junior high schools and two high schools completed a mid-year survey, while only 16 teachers, 367 students, and 157 parents from four of the junior high schools completed the year-end survey. At each point teacher, parent and student feedback were collected on the intervention components. Summarized below are findings from the junior high sites in RISD. Attached separately are reports for each site.

Teacher Confidence
Teacher confidence improved since mid-year. Changes can be seen at Westwood Junior High, Forest Meadow Junior High and Liberty Junior High where teachers who previously reported not being able to teach grade level math agreed at year-end that they could. Maintaining order in the classroom continues to be a problem at most campuses. Westwood Junior High may be the exception.

In terms of expected student outcomes, the percentage of teachers at Richardson West Junior High and Forest Meadow Junior High who were confident that students would master grade level content as measured by the year-end state mathematics test rose from mid-year to year-end.

The teacher confidence questions are clustered in the Learning Environment domain which at year-end was significantly correlated with student performance data. Learning Environment domain averages at the schools correlated significantly with percentage of students in each class who met the minimum TAKS passing standard ($\mathbf{r}_{(15)} = .58$, $\mathbf{p} = .013$) and with the classroom average correct percentage ($\mathbf{r}_{(15)} = .46$, $\mathbf{p} = .044$).

Math Content Support
Across the campuses teachers reported that the math content sessions were not helpful. Many thought they were taught at a level too advanced to support pedagogical needs for struggling students. While some improvement is noted at one site from mid-year to year-end, it is not clear that the sessions improved during the year. Lake Highlands Junior High School appears to have found the sessions most useful; half of the teachers at mid-year found value in the meetings.

Collegial & Administrative Support
Reports of collegial support remained high across the year. All of the teachers agreed that there is an expert available with whom teaching strategies can be discussed.

Most campuses report feeling valued by their administrators, although the reviews by teachers at Westwood Junior High School remain mixed. At mid-year many teachers reported that their

administrators did not understand the demands of teaching the TI Intervention, while only a fourth of the teachers responding at year-end suggested the same. Specific requests for additional support from the district include:

• Refrain from placing students with behavioral problems in the block classes.
• Make a serious decision about the dress code.
• Provide more planning time to create Learn Checks, work on lesson plans and activities.
• Assure good content coverage prior to implementation
• Provide opportunities to share teaching strategies
• Limit the block classes to 20 students

Technological Support
The teachers responding to the year-end survey agree that assistance is readily available for implementing the TI Technology. In fact, Betty Gasque received enthusiastic reviews.
Some disagree that they have sufficient curriculum materials (or materials that are of good quality) to effectively use TI Navigator, while nearly all agree that they could use additional training on the TI Navigator. Additional requests include:

• Assistance in the room at the beginning of the year to troubleshoot
• A pull-out planning day every six weeks
• TI Navigator teachers placed physically close to one another
• More specific outlined curriculum, step-by-step planning of a lesson from start to finish
• More lessons and lessons better aligned to TEKS that also meet lower level student needs
• Additional training on Activity Center
• Answer keys to notes and homework

Support listed as most critical to student performance includes monthly updates, TI Activity Navigator ideas, Betty Gasque and the support and ideas from teachers at other schools in the full day session. Table 9 captures the averages in the support domains across the schools. The numbers are derived from the year-end survey where teachers responded to a 5 point likert scale. A lower score denotes disagreement that support exists, whereas a higher score suggests agreement that particular support is present.

Table 9: Teacher Development and Support Indicators
Year End 6-07

School	Type of Support			
	Technical	Math Content	Collegial	Administrator
Forest Meadow Junior High	3.92	2.25	3.92	4.33
Westwood Junior High	3.38	3.17	3.88	2.50
Liberty Junior High	3.95	2.44	4.25	4.0
Richardson West Junior High	3.0	1.38	4.19	3.75

Pedagogy
While similarities are seen in teacher use of small group instruction, discussion and student collaboration across the campuses, teacher and student responses portray different classroom cultures. For example, Liberty Junior High teachers report being more focused on lecture, drill and practice than other sites. Liberty Junior High also is the only school where teachers mostly agree that it is important that they appear to know everything about math and technology in class. The students at Liberty Junior High do not show the enthusiasm of other RISD students for the way math is being taught. Even so, the percentage reporting enthusiasm has risen from 44% at mid-year to 56% by year-end with a larger percentage of students noticing an improvement in their grades over mid-year.

At Richardson West Junior High several teachers disagree that students regularly explore multiple solutions in class, apply concepts to real world problems or explain the steps they use to solve a problem. Discussion is critical and rooms are not organized for lecture. Both teachers and students describe a classroom culture that is less lecture-based and more team oriented than other RISD junior high campuses.

Westwood Junior High and Forest Meadow teachers more consistently report learning that is based upon students being able to explain, compare and apply their work. At Westwood student reports suggest that class time is more focused on learning facts, definitions and formulas. At Forest Meadow a higher percentage of students report knowing the learning goals, feel comfortable asking questions and report trying to solve real world problems than other RISD junior high sites.

The Power Block
Teacher responses to the power block are positive but mixed, with most agreeing that the amount of content covered with the block has increased. Of the four sites responding to the year-end survey, Richardson West Junior High teachers are most likely to agree that the block has made a real difference in how students approach difficult problems, where Forest Meadow Junior High shows the most concern about the session being too long to keep students focused. Richardson students also provide the most positive feedback on the block.

Assessment
Teachers report that unit benchmarks are aligned to the district curriculum and the district curriculum is aligned to the state mathematics standards. It is unclear to some, if the unit diagnostics are aligned to the district curriculum. Less than half agree that standardized tests accurately measure what students are taught in math class.

Teacher attitudes about the value of benchmark data are mostly positive, although some, mostly at Liberty and Westwood Junior High, suggest that the data they receive is not based upon district benchmark data.

Technology Use and Pulse (Perceived Benefit)
Forest Meadow teachers report the most consistent use across the TI Navigator features (Quick Poll, Learn Check, Screen Capture, Activity Center) and the highest percentage of teachers (2-3 out of 3)

using the technology. Depending on the type of activity, 56% to 82% of the teachers report using TI Navigator with the largest use occurring during Problem Solving. Please refer to Tables 2 and 3 for summary data on technology use.

Table 10: Technology Use - Teacher Self Report
Year End 6-07

School	Technology Use (Domain Avg.)	Learn Check (Daily Use)	Quick Poll (Daily Use)	Screen Capture (Non-specified Use)	Activity Center (Use Often)
Forest Meadow Junior High	3.75	67%	100%	100%	33%
Westwood Junior High	3.0	0%	50%	75%	50%
Liberty Junior High	3.0	40%	60%	40%	40%
Richardson West Junior High	2.5	0	50%	25%	25%

Derived from the year-end survey where teachers are asked about specific technology use with likert response options per Table 9.

Table 11: TI Navigator Use - Teacher Self Report
Year End 6-07

School	Use During Warm-Up	Use for Main Activity	Use During Problem Solving	% of Teachers Reporting Use
Forest Meadow Junior High	56%	67%	82%	56 – 82%
Westwood Junior High	58%	69%	58%	58 – 69%
Liberty Junior High	60%	44%	49%	44 – 60%
Richardson West Junior High	33%	38%	22%	22 – 38%

Derived from tables where teachers selected the type of activity for which TI Navigator is used and when. Please find specific behavior for nine types of use in the individual school reports.

At Westwood Junior High 58% to 69% of the teachers report using TI Navigator during Warm-Up, the Main Activity or Problem Solving. Half of the teachers report using Quick Poll daily.

Forty-four to 60% of the teachers at Liberty Junior High report using the TI Navigator, with the highest use during Warm-Up.

Richardson West Junior High shows the lowest usage across teachers with only one in four using Screen Capture or Activity Center and none using Learn Check. Twenty-two to 38% of the teachers at Richardson West Junior High report using the TI Navigator with the highest use occurring during the Main Activity.

Technology pulse or perceived benefit is highest at Forest Meadow Junior High and Westwood Junior High, with the largest gain since mid-year at Liberty Junior High School. The Forest Meadow teachers all report being able to modify instructional strategies for individual students based on real-time data collected through TI Navigator. The teachers do not agree that the TI Navigator more successfully engages students who have experienced difficulty in math though.

At Westwood Junior High where technology use is lower, but perceived benefit perhaps higher, teachers view the relationship between technology use and student engagement more positively. Of course, Westwood is the campus where teachers are most optimistic about the classroom environment and thus report the least difficulty with discipline. Table 12 provides summary data on Technology Pulse.

Table 12: Technology Pulse –Teacher Self Report
Year End 6-07

School	Technology Pulse (Perceived Benefit) Domain Averages	Selected Specific Benefits from TI Technology Use		
		Teacher modifies instruction	Student learning is accelerated	Students with difficulty in math are better engaged
Forest Meadow Junior High	3.4	100%	67%	33%
Westwood Junior High	3.6	50%	75%	100%
Liberty Junior High	3.2	40%	40%	60%
Richardson West Junior High	3.2	50%	25%	75%

Column 1 represents the domain average score for a set of nine questions about the value of TI Navigator or the TI technology. A likert scale of 1 to 5 is used where 5 represents strong agreement that a particular benefit is found. Columns 2 through 4 capture the percentage of teachers who agree to have noticed these specific benefits.

Student performance is significantly higher in classrooms where the teachers report more benefit from using the TI technology. Technology Impact domain averages at the schools correlated significantly with percentage of students in each class who met the minimum TAKS passing standard ($\mathbf{r}_{(16)} = .45$, $\mathbf{p} = .041$) and with the classroom average correct percentage ($\mathbf{r}_{(16)} = .48$, $\mathbf{p} = .029$).

Parent Inclusion

Most teachers do not think their students' parents know how to help their child in math. Few, if any of the parents have attended a session to learn about the math program.

Individual Site Year-End Reports

Forest Meadow Junior High 6-07

Five classrooms participated in the study. Three teachers, 20 parents and 72 students completed a year-end survey about their experiences.

Teacher Input

Teacher views of their ability to teach grade level math and of student performance may have shifted since the mid-year survey. One teacher appears less confident, while two are more confident. Maintaining order in class continues to be a challenge, while two of the teachers do not think students accept responsibility for their role in learning.

At Forest Meadow Junior High (FMJH) administrative support is rated high by all the teachers and higher than at other RISD sites. Similar to other sites most of the teachers find the collegial meetings have improved their teaching, while all report that an expert is available with whom to discuss teaching strategies. One teacher reports that the math content sessions have increased his/her understanding. Another writes, "the level of math is too high for middle school". Additional content requested includes "new research (strategies of math teaching)".

Even though technology use at FMJH is high and assistance readily available, all of the teachers desire additional training on TI Navigator. In addition, one teacher requests an assistant in the room at the beginning of the year to troubleshoot, explaining that it is hard to get going with kids whining about not being able to log in as everyone waits impatiently.

In terms of district support teachers request to be physically near other TI Navigator teachers and to have a pull-out planning day every 6 weeks. The support that has been most critical to increasing student performance include monthly updates, TI Navigator activity ideas and perhaps Betty. One teacher writes, "I love Betty!"

The teacher responses characterize a learning environment that consistently uses more advanced pedagogy. Discussion is critical to learning, students explore multiple solutions in class, and regularly explain steps used to solve a problem. Compared to other classroom processes, FMJH students are less likely to solve problems on their own in class, more likely to collaborate in pairs or groups. At mid-year the teachers reported using more advanced pedagogy as well.

Teachers at FMJH are less enthusiastic about the block. Several report that it is too long to keep students focused. These concerns also surfaced in the open-ended responses at mid-year.

The teachers tend to think that benchmark data and real-time feedback have helped them improve student learning. They report that students enjoy "seeing the difference in their scores before and after a unit", that participation has increased and real-time feedback prevents incorrect reasoning from becoming a bad habit". One teacher disagrees, but seems to disagree across the board that the intervention components have been useful.

Teachers are less clear about the benefits of the TI technology than some RISD sites. One agrees that students have more "aha' moments, one agrees that the technology more successfully engages students experiencing difficulty in math. In the open-ended remarks a teacher states, "I honestly cannot imagine going back to teaching without it". The other teachers provide positive feedback mostly relating to immediate assessment and re-teaching.

Technology use at FMJH is high particularly during the problem solving portion of the class. All of the teachers report using Quick Poll daily to check student answers, all report using Screen Capture. One reports using Activity Center often. The teachers report using TI technology to discuss the same object/concept using more than one representation, for class analysis and to encourage student collaboration.

One teacher reports communication with parents about the math program.

Parent Input

Most of the twenty parents who completed the survey agree that their child's performance is better this year. Half agree that they have attended a session to learn about the math program. Far fewer report knowing what they can do to help their child be successful in math (58% verses 82% or higher at other sites).

Student Input

Student responses suggest that technology use and efficacy as well as positive experience of the block is much lower for one of the three teachers. Even so on average at FMJH more students are confident about passing the year-end math test and report that their teacher believes they can learn at FMJH than other RISD sites. A higher percentage of students report knowing the learning goals, feel comfortable asking questions in class and report trying to solve real world problems with math. Roughly sixty percent of the students report using Quick Poll each day or Activity Center often.

In the open-ended comments students mostly provide positive comments about the TI graphing calculator. They suggest that learning math is more fun and exciting and that they learn faster.

Forest Meadow Junior High
(3 teacher responses)

How TI Navigator Is Used	Warm-Up	Main Activity	Problem Solving	Total
a) Collect homework or assignments	3	1	2	6
b) Give an assignment/quiz/test (e.g. Learning Check)	3	2	2	7
c) Send learning materials for students to work with (e.g. apps, models, worked examples, visualizations)	1	2	3	6
d) Send questions/prompts for immediate student response (e.g. Quick Poll)	2	2	3	7
e) Monitor student progress (e.g. look at screen shots of what is on the student device)	1	2	2	5
f) Encourage students to collaborate, discuss answers or develop shared solutions in pairs or groups	1	2	3	6
g) Work with the whole class sharing student data (e.g. class analysis)	1	3	2	6
h) Discuss the same mathematical object/concept using more than one representation	2	2	3	7
i) Modify instruction based on student understanding	1	2	2	5
Total selections	15	18	22	
Average use for class portion	56%	67%	81.5%	

Note: Teachers were asked to place an “x” in the boxes above to note when and how they use TI Navigator. TI Navigator use that is selected by at least 2 out of 3 teachers is highlighted, while percentage use by portion of the block is noted as percentages across the bottom row. Three teachers responding to 9 possible TI Navigator uses provides a denominator of 27 in computing the percentage.

Liberty Junior High 6-07

Nine classrooms participated in the study. Five teachers, 89 parents and 174 students completed a year-end survey about their experiences.

Teacher Input

At Liberty Junior High School collegial and administrative support receive high marks while classroom use of technology has increased. The classroom and learning environments are less optimistic than other RISD campuses, but have improved. At Liberty Junior High (LJH) the math teachers generally report that students do not want to learn math, maintaining order in the classroom is an on-going challenge, and students will not do well on district benchmarks or the year-end state test. In fact, at mid-year two thirds of the teachers did not believe they could teach grade level math successfully to their students, nor were they confident that almost all students in class could learn grade level math. This percentage dropped from 67% at mid-year to 40% at year-end.

The Liberty teachers report positive administrative, collegial and technological support. An expert is readily available to discuss teaching strategies and assistance is available for use of the TI technology. Meetings with colleagues appear to include conversations about alternative teaching strategies and math content, not technology per se; "that's mostly individual". There is some disagreement over the quality of the curriculum materials for TI Navigator. All teachers report that they could use additional training on TI Navigator.

Math content support provides a different picture. Only one of the five teachers appears to have benefited from the sessions. Most report that the sessions have not increased their knowledge; they don't feel comfortable asking questions and would NOT benefit from additional sessions. Comments included: "If you mean Dr. Schar, he totally frustrated me", and "The content of the sessions was not really for lower level struggling students". One teacher remarks throughout how the various sessions helped refresh her/his understanding of math content and teaching strategies that she/he had not used in a number of years; how she was able to learn effective strategies from more experienced teachers.

Liberty teachers report different attitudes about teaching math than other RISD math teachers. At Liberty, all of the teachers agree that lecture, drill and practice are critical to learning in their classes, where at other campuses, one teacher out of several agrees with this statement. A second dimension appears to distinguish Liberty. All but one teacher agrees that it is important that one "appears to know everything about math and technology in class". This is not the case at other campuses. Otherwise, three or four teachers report using discussion, having students apply concepts to real world problems and exploring multiple solutions in class, although less so the later.

Small group instruction and collaborating in pairs or small groups appears important to teacher learning strategies at LJH. While all agree that the Block time has increased the amount students are able to cover in a year, some think it is too long to keep students focused. In the open-ended remarks though, four out of five comment on the increased opportunities for learning.

At mid-year teachers seemed split on the benefits of benchmarking. This split seems to have shifted where 3 out of five teachers find the benchmark data helpful at year-end. While benchmarks are aligned

to the district curriculum and the curriculum to the state standards, it is not clear that unit diagnostics are aligned to the district curriculum. Teacher open-ended comments provide a similar pattern with three mentioning benefits of using diagnostic data, while two do not. One remarks:

> "I do not like to use the diagnostics. They don't do well on what we did yesterday, much less perform successfully on the diagnostics. I think they just make the students feel worse about their abilities."

Technology use appears to vary at LBJ. Teachers use Learn Check and Quick Poll, as well as Navigator to share student data with the whole class or to discuss the same mathematical concept using more than one representation. According to the teacher self reports, TI Navigator is used most frequently at LJH for warm-up (60% use), verses for main activity (44%) and problem solving (49%).

Technology pulse at LJH is mixed with some teachers reporting that they are able to modify instructional strategies based on real time data or that the feedback has accelerated learning, but less than half report this. Teachers seem to find the most benefit from the TI technology in terms of covering more material in depth, more "aha" moments by students, increased participation and/or motivation, as well as use of the real-time feedback. The one especially negative teacher admits, that he/she is" still learning how to use the technology" and "hopes to incorporate it more successfully next year", but that it "does keep them on track." Others notice changes in student performance, especially by those who really try.

The technology pulse for teachers (adjusted) moved from 2.99 at mid-year to 3.2 at year-end.

One of the five teachers report that parents understand what they can do to help their child in math. None of the parents have seen the TI Navigator in use or attended a session to learn about the math program.

In terms of what the district or school can do better to support the math program, several teachers comment on the inappropriateness of students with behavioral problems in the block classes. "They interfere with those who want to learn." Teachers write in the closing section again about behavioral problems presenting additional challenges when utilizing the TI Navigator system.

Teachers request more planning time to create Learn Checks, work on lesson plans and activities. One writes, "The district needs to make a serious decision about the dress code. It would help to be able to teach".

Requested support from TI includes more specific outlined curriculum, step by step planning of a lesson from start to finish and more training on Activity Center.

The support listed as most critical to the project includes tech support for when there are failures, monthly meetings with TI, individual observations with the district specialist, and meetings with Betty ("They were GREAT")

Parent Input

More parents completed surveys at LBJH than other RISD schools. Parent assessment of the learning environment and their child's performance is slightly lower than other intervention schools, while student outlook is similar. Three-fourths of the parents are confident their child will pass the year-end test in math this year. While 71% of the parents at LBJH report that their child's performance is better this year than last. Finally, the parents at LBJH mostly believe that they know how to help their child be successful in math.

Student Input

Liberty math students do not show the enthusiasm of other RISD students for the way math is being taught this year. A larger percentage of students report behavioral problems in class, technology use is lower and team-work is less likely. If we view LBJH student perceptions at year-end verses mid-year, some changes can be seen. For example, those enthusiastic about the way math is being taught has risen from 44% to 56% and a larger percentage of students have noticed improvements in their grades.

The student open-ended remarks are mixed in all of the classes with two classes leaning to the positive, one to the negative and two split. At mid-year four classes tended to the negative.

Perhaps these comments capture student perceptions of the math program at year-end and the challenges that LBJH faces:

> I don't really if it has changed learning math for me because learning math is anything I don't know care where I or who I learn things from
>
> It help me by doing problem if I know about and learn about this year
>
> It has not I just do my problems on the calculator and move on
>
> It helps me because it's hands on and I like to type. And knowing that I can learn and type that what's up.

At mid-year less than a third of the students reported using the TI Graphing calculator daily. Students were asked at year-end about specific Navigator use. Less than a third reported using Learn Check each day, half reported using Activity Center often. While half or more of the students at other RISD sites agreed that learning math is easier using the TI calculators, 30% agree at LBJH.

Liberty Junior High
(5 teacher responses)

How TI Navigator Is Used	Warm-Up	Main Activity	Problem Solving	Total
a) Collect homework or assignments	2	1	2	5
b) Give an assignment/quiz/test (e.g. Learning Check)	5	2	1	8
c) Send learning materials for students to work with (e.g. apps, models, worked examples, visualizations)	1	2	2	5
d) Send questions/prompts for immediate student response (e.g. Quick Poll)	3	3	4	10
e) Monitor student progress (e.g. look at screen shots of what is on the student device)	3	2	2	7
f) Encourage students to collaborate, discuss answers or develop shared solutions in pairs or groups	1	2	4	7
g) Work with the whole class sharing student data (e.g. class analysis)	4	3	2	9
h) Discuss the same mathematical object/concept using more than one representation	4	4	3	11
i) Modify instruction based on student understanding	4	1	2	7
Total selections	27	20	22	
Average use for class portion	60%	44%	49%	

Note: Teachers were asked to place an “x” in the boxes above to note when and how they use TI Navigator. TI Navigator use that is selected by at least 2 out of 3 teachers is highlighted, while percentage use by portion of the block is noted as percentages across the bottom row. Five teachers responding to 9 possible TI Navigator uses provides a denominator of 45 in computing the percentage.

Richardson West Junior High 6-07

Six classrooms participated in the study. Four teachers, 50 parents and 103 students completed a year-end survey about their experiences.

Teacher Input

Teacher confidence has improved somewhat at Richardson West Junior High (RWJH). While one teacher at mid-year agreed that he/she could successfully teach grade level math, three of the four agreed to being able to do so at year-end. The teachers are still uncertain about which strategies work best for struggling students and only one expects students to do well on district diagnostics or on the state math test. The teachers do not generally believe that the standardized tests accurately measure what students are taught in math class.

Maintaining order in the TI block classes continues to be a problem for most teachers. Only one teacher reports that students accept responsibility for their role in learning.

The teachers feel valued by the administration; some think that the administrators understand the demands of teaching the TI Intervention. Teachers are positive about collegial support, but negative about math content support. No one agrees that the math content sessions have been beneficial.

One of the teachers would like additional training on TI Navigator, two suggest that the curriculum materials are inadequate. Other support requests for TI include lessons better aligned to TEKS and lower level students, more lessons and wires that do not break so easily.

Most of the RWJH math teachers suggest that discussion is critical to learning in their class, their rooms are not organized for lecture and students often collaborate in pairs. Some ask students to apply concepts to real world problems or to regularly explain steps used for solving a problem. The teachers don't feel that they must be the experts in math and technology.

Furthermore, teachers are enthusiastic about the block time. All agree that it has made a real difference in how students approach difficult problems. One teacher writes, " I love the increased time! Lower level students show more understanding." One teacher asks for smaller block classes, classes limited to 20.

The impact of the technology on learning is perhaps less clear to teachers, although most agree that the TI Navigator more successfully engages students who are experiencing difficulty in math. One teacher does not seem to find benefit in the technology. Review of the self-report data on how Navigator is used shows much lower usage at RWJH than other RISD sites. The technology is mostly used to send questions/prompts or to monitor student progress. The teachers write about the impact of the TI technology on their teaching:

> It has helped me reach all of my students, especially during Quick Polls

> I wasn't comfortable with it at first but it has helped with time management and discovery learning

It has allowed more opportunities for students to discuss common mistakes, methods for solving etc.

As for the impact on learning one writes, "with this first class it has only helped with their interest". Another comments that providing students with another representation of the objectives, increases student chances for success.

Again, all teachers but one agree that benchmark data has helped them improve student learning. It is unclear to the teachers if the unit diagnostics are aligned to the district curriculum. The teachers write that the unit diagnostics data does not generally impact their teaching. Since most students have not mastered the TEKS on the diagnostic, one teacher reports that she teaches all the objectives anyway. Another suggests that there is not enough data to impact teaching or simply that the data is not helpful. Teachers are appreciative of the real-time feedback. They write that they are better able to assess the quiet student, have the ability to re-teach and can immediately assess student needs.

As at most other RISD campuses teachers report keeping parents informed, but none of the parents have seen TI Navigator or attended any session about the math program. Most teachers do not think parents know what to do to help their child in math.

Finally in writing about the support from this project that is most critical to increasing students performance teacher respond: time, and meeting with other teachers.

Parent Input

Parents believe that they know what their child must do and how they can help them be successful in math. Almost half suggest that they have been to a session to learn about their child's math program, even though the teachers do not agree that there is such an opportunity. Seventy-six percent expect their child to pass the year-end state mathematics test.

Student Input

More students at RWJH than other RISD sites tend to be excited about the way math is being taught this year and are confident that their teacher knows how to help them.

The student responses also describe a math classroom setting that has less lecture and is more discussion and team oriented than most other RISD sites. This appears to be reflected by the way TI Navigator is used. At RWJH students are more likely than other sites to use Screen Capture to compare work and Activity Center to receive new problems.

The students are more excited at RWJH than other sites about the TI calculator. Sixty-eight percent agree that it helps them learn new concepts. The open-ended comments are mostly positive. Students write that "seeing what they are doing" is helpful and that sometimes they "can find the mistakes they are doing by themselves".

While the lowest percentage of students expect to go to college at RWJH, a significantly larger percent than other sites agree that they have noticed improved grades in math this year and that they understand math better this year.

Similar to the teachers, the students are also more excited about the block at this site than others. Eighty-four percent suggest it has helped them do better, verses 56-67% at other sites.

Richardson Junior High
(3 teacher responses)

How TI Navigator Is Used	Warm-Up	Main Activity	Problem Solving	Total
a) Collect homework or assignments	1	0	1	2
b) Give an assignment/quiz/test (e.g. Learning Check)	2	0	0	2
c) Send learning materials for students to work with (e.g. apps, models, worked examples, visualizations)	1	1	0	2
d) Send questions/prompts for immediate student response (e.g. Quick Poll)	2	3	3	8
e) Monitor student progress (e.g. look at screen shots of what is on the student device)	1	3	2	6
f) Encourage students to collaborate, discuss answers or develop shared solutions in pairs or groups	2	1	1	4
g) Work with the whole class sharing student data (e.g. class analysis)	2	1	0	3
h) Discuss the same mathematical object/concept using more than one representation	0	3	0	3
i) Modify instruction based on student understanding	1	2	1	4
Total selections	12	14	8	
Average use for class portion	33%	38%	22%	

Note: Teachers were asked to place an “x” in the boxes above to note when and how they use TI Navigator. TI Navigator use that is selected by at least 2 out of 3 teachers is highlighted, while percentage use by portion of the block is noted in percentages across the bottom row. Three teachers responding to 9 possible TI Navigator uses provides a denominator of 27 in computing the percentage.

Westwood Junior High 6-07

Six classrooms participated in the study. Four teachers, 18 parents and 90 students completed a year-end survey about their experiences.

Teacher Input

At Westwood Junior High (WJH) School the teachers' survey responses suggest that the learning environment is different from other RISD sites in several ways: 1) Discipline is not an on-going challenge for most, 2) teachers view students as accepting responsibility for their role in learning and that 3) all teachers report that their students are able to learn grade level math. Administrative support is low compared to other sites and technology pulse is high.

The teachers are split on their views of administrative support with two agreeing there is support and two disagreeing strongly. Three of the four teachers rate collegial and technological support positively, while one is dissatisfied. Two of the teachers agree that they would benefit from additional training on the TI Navigator.

Reviews of sessions with the mathematician are more positive than for most other junior high sites. While teachers are mostly uncomfortable asking questions, some report increased understanding from the sessions. This is an improvement from mid-year where three out of four rated the sessions negatively.

At WJH the teachers do not feel that it is important to "appear to know everything about math and technology in class". Furthermore, they describe a classroom culture where discussion is critical, students solve problems on their own and apply concepts to real world problems. Teachers report that students explore multiple solutions during class and often collaborate in pairs. The student views of the classroom environment suggest that learning time is more focused on learning facts, definitions and formulas.

While the teachers agree that more content can be covered during the block, it is unclear to them, if it makes a difference to students' approach to difficult problems. Several comment on not feeling rushed when answering student questions and posing questions during the block. One teacher continues to find the format too long.

The teachers value the benchmark data, real time feedback and the use of diagnostics. They agree that the benchmarks and unit diagnostics are aligned to the district curriculum and the curriculum to the state math standards, but not that the standardized tests accurately measure what students are taught in class.

The teachers do not report using Learn Check daily to collect homework at WJH. Rather they seem to use Learn Check for quizzes. They use Screen Capture to compare student work and Quick Poll to check answers. Some use Activity Center to distribute new problems. The activities the teachers suggest they pursue most on the TI Navigator are monitoring of student progress, modifying instruction, sending prompts for response and giving quizzes. Even so, only two teachers agree that they are able to modify instructional strategies for individual students based upon real-time data.

In the open-ended responses the teachers write that technology has changed student behaviors: students are apt to take more time solving a problem, accept more responsibility for their work and enjoy math more. The use of TI technology has allowed teachers to "use different methods based on student analysis" and use warm-up to assess student understanding before beginning a lesson. One teacher reports being new at using the TI system, commenting: "my skills are limited."

Two of the teachers agree that the parents have seen the TI Navigator in use. They do not generally think that parents understand how to help their child in math.

As for support, a teacher asks again for answer keys. Another requests more training from TI. One writes that the full day Friday/Saturday sessions are great and that good content prior to implementation and opportunity to share teaching strategies comprise the kinds of district support that make a difference to success in teaching math. Support from the project that has been most critical to increasing student performance includes "support and ideas from teachers at other schools in the full day session". Finally, one teacher remarks that the "Quick Polls were frequently not so quick, missing from one to two students" and that "Activity Centers did not flow nearly as well with kids as with a room of teachers, but were still good."

Parent Input

Two to seven parents completed a survey for each class. Eighteen percent of those attended math night or another session to learn about their child's math program.

Student Input

By the students view two of the four teachers use more small group, technologically based learning environments, while one uses less technology. Compared to other RISD schools WJH students report class time that is more focused on learning facts, definitions and formulas.

Half the students suggest that Learn Check and Quick Poll are being used daily in class, and over half report that they are more excited about learning math since using the TI calculators.

The percentage of students that have noticed an improvement in their grade this year jumped from just over 60% at mid-year to 75% at year-end. Seventy-seven percent report that they understand math better this year.

Open-ended student remarks about use of the TI graphing calculator are positive for three of the four teachers, mixed for the fourth. Students mostly report that the TI graphing calculator has made learning math easier and more fun, particularly when "work gets complicated or hard to understand" on ones own.

At mid-year there were more student comments about others not seeing their grade, learning by going over problems and understanding why ones answers are different from other students.

Westwood Junior High
(4 teacher responses)

How TI Navigator Is Used	Warm-Up	Main Activity	Problem Solving	Total
a) Collect homework or assignments	3	1	0	4
b) Give an assignment/quiz/test (e.g. Learning Check)	3	2	3	8
c) Send learning materials for students to work with (e.g. apps, models, worked examples, visualizations)	3	2	2	7
d) Send questions/prompts for immediate student response (e.g. Quick Poll)	1	4	3	8
e) Monitor student progress (e.g. look at screen shots of what is on the student device)	4	3	3	10
f) Encourage students to collaborate, discuss answers or develop shared solutions in pairs or groups	0	4	3	7
g) Work with the whole class sharing student data (e.g. class analysis)	2	3	2	7
h) Discuss the same mathematical object/concept using more than one representation	2	2	2	6
i) Modify instruction based on student understanding	3	3	3	9
Total selections	21	25	21	
Average use for class portion	58%	69%	58%	

Note: Teachers were asked to place an “x” in the boxes above to note when and how they use TI Navigator. TI Navigator use that is selected by at least 2 out of 3 teachers is highlighted, while percentage use by portion of the block is noted as percentages across the bottom row. Four teachers responding to 9 possible TI Navigator uses provides a denominator of 36 in computing the percentage.

Appendix A: Additional Charts

Chart 5: Association between CKTM Patterns, Functions, and Algebra Scale Score and Met Minimum TAKS Standard

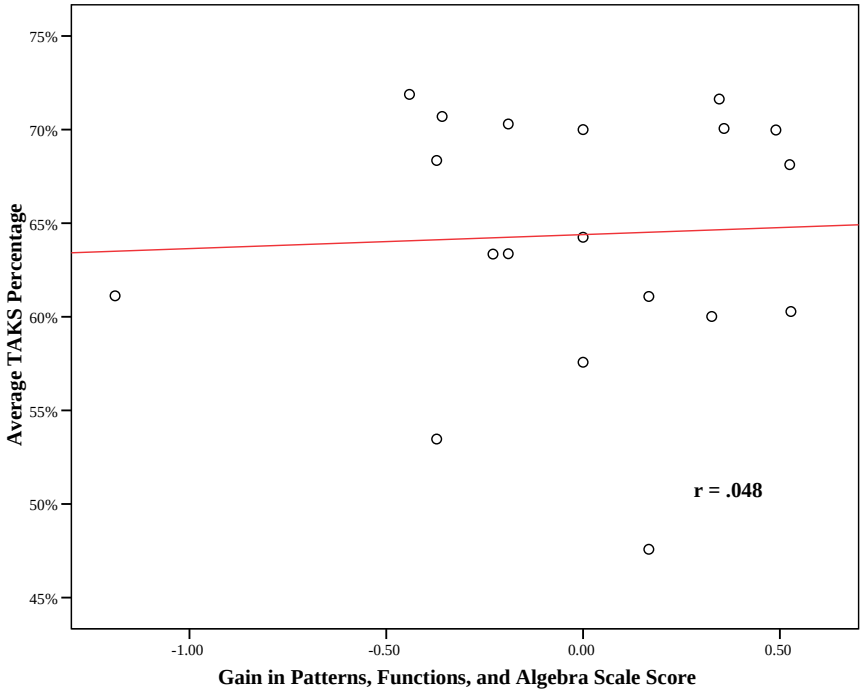
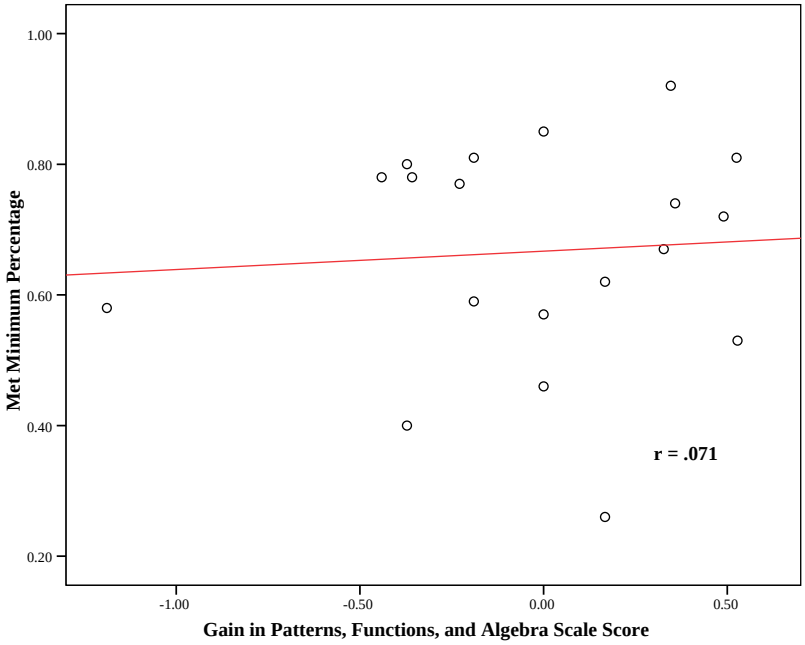


Chart 6: Association between CKTM Patterns, Functions, and Algebra Scale Score and average TAKS correct percentage



Appendix B: Teacher Perception Survey

Identifying Components of Effective Mathematics Programs

Teacher Consent Form

Texas Instruments Inc. is partnering with your school to improve math education. The attached survey asks you to reflect on the teaching and learning of math in your classroom. The survey is part of a larger study designed by university researchers to help TI and others in the learning community identify and understand the many components of middle school math education. Over the next week, teachers, parents and students participating in the study will all be asked to assesses their (or their child's experience) of math this year.

At the end of the study, a report will be sent to the district office and information will be sent to the schools' principals and mathematics specialists for dissemination.

Any information that is obtained in connection with this study and that can be identified with you will remain confidential and will be disclosed only with your permission or as required by law. Some tracking identification tied to assessments of mathematics knowledge and practices will be kept by the researchers to allow for future program evaluation. After deciding to participate, you are free to withdraw your consent and discontinue participation at any time without penalty. The procedures here involve no or minimal risk to the participants. If you have any questions regarding the research, please feel free to contact Mara Winick (mara_winick@redlands.edu) or Jeffrey Lewis (jeff_lewis@pitzer.edu or 909-792-9380).

Your signature indicates that you have read and understand the information provided above, that you willingly agree to participate, may withdraw your consent at any time and discontinue participation without penalty, may receive a copy of this form, and that you are not waiving any legal claims, rights or remedies.

Name _____

Signature _____ Date _____

Teacher & Student Practices for Learning Math
The Texas Instruments School Partnership
April 2007 Survey

Please respond to the statements below by circling your level of agreement or disagreement.	**Strongly Disagree**	**Disagree**	**Uncertain**	**Agree**	**Strongly Agree**
1. Learning Environment					
a) Students in my class want to learn math.	SD	D	U	A	SA
b) I can successfully teach grade level math to almost every student in class.	SD	D	U	A	SA
c) I know which strategies work best for teaching struggling mathematics students.	SD	D	U	A	SA
d) I am confident that almost every student in my class can learn grade level math.	SD	D	U	A	SA
e) I am confident my students will do well on the district benchmarks.	SD	D	U	A	SA
f) I am confident that my students will master grade level content, measured by the year-end state mathematics test.	SD	D	U	A	SA
2. Classroom Environment					
a) Maintaining order in my TI block class(es) is an on-going challenge.	SD	D	U	A	SA
b) My students feel comfortable asking questions in math class.	SD	D	U	A	SA
c) My students accept responsibility for their role in learning math.	SD	D	U	A	SA
d) Students in my class know the learning goals for each unit of study.	SD	D	U	A	SA
3. Pedagogy (New Items)					
a) Lecture, drill and practice are critical to learning in my class.	SD	D	U	A	SA
b) Our class time is mostly focused on learning facts, definitions and formulas.	SD	D	U	A	SA
c) My students regularly formulate problems on their own.	SD	D	U	A	SA
d) My students regularly explain their reasoning for a solution.	SD	D	U	A	SA
e) Discussion is critical to learning in my class.	SD	D	U	A	SA
f) My students regularly apply concepts or skills to real world problems.	SD	D	U	A	SA
g) Students often explore multiple solutions during class.	SD	D	U	A	SA

Please respond to the statements below by circling your level of agreement or disagreement.	**Strongly Disagree**	**Disagree**	**Uncertain**	**Agree**	**Strongly Agree**
4. Grouping (New Items: B-D)					
a) Small group instruction is especially effective for my students.	SD	D	U	A	SA
b) I usually design the daily warm-up for a whole-class activity.	SD	D	U	A	SA
c) Students often collaborate in pairs or groups during the main activity in class.	SD	D	U	A	SA
d. My classroom is arranged for lecture during much of the block class.	SD	D	U	A	SA
5. Assessment (New/edited items)					
a) Our unit benchmarks for assessing student growth are aligned to the district curriculum.	SD	D	U	A	SA
b) Our unit diagnostics are aligned to the district curriculum.	SD	D	U	A	SA
c) The district curriculum is aligned to the state mathematics standards.	SD	D	U	A	SA
d) Our math teachers agree on what students should be able to do to meet grade level standards.	SD	D	U	A	SA
e) Standardized tests accurately measure what students are taught in math classes.	SD	D	U	A	SA
f) Benchmark data has helped me improve student learning.	SD	D	U	A	SA
g) The immediate availability of benchmark data is especially important to my teaching.	SD	D	U	A	SA
h) The feedback I receive on student learning is based upon district benchmark data.	SD	D	U	A	SA

i) Please explain how the use of unit diagnostic data impacts your teaching.

j) Please explain how the use of real time feedback changes student learning.

6. Please help the researchers understand how and when you use TI Navigator by placing "X" in all boxes that apply and by completing the "other" sections.

How TI Navigator Is Used	When TI Navigator Is Used			
	Warm-Up	Main Activity	Problem Solving	Other Please list:
a) Collect homework or assignments				
b) Give an assignment/quiz/test (e.g. Learning Check)				
c) Send learning materials for students to work with (e.g. apps, models, worked examples, visualizations)				
d) Send questions/prompts for immediate student response (e.g. Quick poll)				
e) Monitor student progress (e.g. look at screen shots of what is on the student device)				
f) Encourage students to collaborate, discuss answers or develop shared solutions in pairs or groups				
g) Work with the whole class sharing student data (e.g. class analysis)				
h) Discuss the same mathematical object/concept using more than one representation				
i) Modify instruction based on student understanding				
j) Other (please describe):				

k) Please explain how the use of TI technology has changed your teaching, if at all.

l) Please explain how the use of TI technology has changed student performance, if at all.

Please respond to the statements below by circling your level of agreement or disagreement.	**Strongly Disagree**	**Disagree**	**Uncertain**	**Agree**	**Strongly Agree**
7. Technology Use					
a) I use the TI graphing calculator daily to help students understand mathematics content.	SD	D	U	A	SA
b) I use the TI Navigator every day in class.	SD	D	U	A	SA
8. Technology Impact (New: D, G, K; drop 1 or 2 items)					
a) I am able to modify instructional strategies for individual students based on real time data collected through the TI Navigator.	SD	D	U	A	SA
b) Real-time feedback from the TI Navigator is increasing students' willingness to work through complex items.	SD	D	U	A	SA
c) Real-time feedback from the TI Navigator has improved classroom dialogue.	SD	D	U	A	SA
d) Student willingness to learn new concepts has increased with the use of the TI technology.	SD	D	U	A	SA
e) When I use the TI technology in my classroom fewer behavioral problems arise.	SD	D	U	A	SA
f) Students definitely have more "aha" moments when using the TI Navigator.	SD	D	U	A	SA
g) The TI Navigator more successfully engages students who have experienced difficulty in learning math.	SD	D	U	A	SA
h) The use of real-time feedback from the TI Navigator has accelerated learning in my class.	SD	D	U	A	SA
k) Use of the TI Navigator has allowed our class to cover more material in depth.	SD	D	U	A	SA
9. The Block Class (C is new)					
a) The block time has increased the amount of content students are able to cover during the year.	D	D	U	A	SA

b) The block time has made a real difference in how students approach difficult problems.	SD	D	U	A	SA
c) The block time is too long to keep students focused on math.	SD	D	U	A	SA
d) Please comment on any changes you have noticed in student performance as a result of the 100 minute power block.					

Please respond to the statements below by circling your level of agreement or disagreement.	**Strongly Disagree**	**Disagree**	**Uncertain**	**Agree**	**Strongly Agree**
10. Parental Involvement (New: C-E)					
a) I frequently communicate learning expectations to parents.	SD	D	U	A	SA
b) My students' parents know what their child must do to be successful in math.	SD	D	U	A	SA
c) My students' parents attend math night or another sessions to learn about their child's math program.	SD	D	U	A	SA
d) My student's parents have seen the TI Navigator in use.	SD	D	U	A	SA
e) My students' parents understand what they can do to help their child be successful in math.	SD	D	U	A	SA
f) Please share comments made by parents regarding the TI intervention model.					
11. Administrative Support					
a) Our administrators understand the demands of teaching the TI Intervention.	SD	D	U	A	SA
b) I feel valued by the administration at this school.	SD	D	U	A	SA
11. Collegial Support					
a) Our teachers meet weekly to plan lessons and discuss teaching strategies for meeting the needs of all learners.	SD	D	U	A	SA
b) Teacher meetings are used to align the curriculum we teach with the district math standards.	SD	D	U	A	SA
c) There is an expert available with whom I can regularly discuss teaching strategies.	SD	D	U	A	SA

d) The weekly planning sessions with colleagues have improved my teaching.	SD	D	U	A	SA

e) How, if at all, have the meetings with colleagues changed what you know about math?

f) How, if at all have the meetings with colleagues changed the way you teach math?

Please respond to the statements below by circling your level of agreement or disagreement.	**Strongly Disagree**	**Disagree**	**Uncertain**	**Agree**	**Strongly Agree**
12. Math Content Support (New: D)					
a) Content sessions with the mathematician have increased my mathematical understanding.	SD	D	U	A	SA
b) I feel comfortable asking questions in the sessions with the mathematician.	SD	D	U	A	SA
c) Training with the mathematician occurs in time for me to use the information.	SD	D	U	A	SA
d) I would benefit from additional math content sessions.	SD	D	U	A	SA

e) How, if at all, have the math content sessions changed what you know about math?

f) How have the math content sessions changed the way you teach math?

g) What other math content, if any, would you like included in the math content sessions or weekly planning meetings with colleagues.

13. Technological Support (New: D)

a) The curriculum materials I have for use with the TI Navigator are of good quality.	SD	D	U	A	SA
b) Assistance is readily available to me for implementing the TI technology.	SD	D	U	A	SA
c) I have sufficient curriculum materials to effectively use TI Navigator in my class.	SD	D	U	A	SA
d) I could use additional training on TI Navigator.	SD	D	U	A	SA

e) What kinds of additional support from TI would make a difference to your success in teaching math?

f) What kinds of additional support from the district would make a difference to your success in teaching math?

g) What types of support from this project have been most critical to increasing student performance in your classrooms?

h) Finally, is there any other information that you would like to share with the researchers about the TI project

Thank you for taking the time to help math educators learn from one another.

Appendix C: Student Perception Survey

Student TI School Partnership Survey
Student Consent Form

The attached survey asks you to reflect on your experience of learning math this year. The survey is part of a larger university study and school partnership with Texas Instruments to improve middle school math education. Over the next week, teachers, parents and students will all be asked to complete a similar survey.

While information from this study will be sent to the principal and mathematics specialists as well as the district office, the source of the information remains confidential. No student or parent can be identified.

If you have any questions regarding the research, please feel free to contact Mara Winick (mara_winick@redlands.edu) or Jeffrey Lewis (jeff_lewis@pitzer.edu or 909-792-9380).

By signing below, you indicate that you have read and understand the information above and that you willingly agree to participate. You may withdraw your consent at any time and discontinue participation without penalty, and you may request to receive a copy of this form. Finally, your consent does not waive any legal claims, rights or remedies.

Name _____ Signature _____ Date _____

Please understand that there are no wrong or right answers to the survey.

Please respond to the statements below by circling your level of agreement or disagreement.	**Strongly Disagree**	**Disagree**	**Uncertain**	**Agree**	**Strongly Agree**
1. Learning Environment					
a) I am excited about the way math is being taught this year.	SD	D	U	A	SA
b) My teacher knows how to help me if I am having difficulty in learning math.	SD	D	U	A	SA
c) I like trying to solve tough math problems.	SD	D	U	A	SA
d) My teacher believes that I can learn grade-level math.	SD	D	U	A	SA
e) I am confident that I can pass the year-end state mathematics test.	SD	D	U	A	SA
2. Classroom Environment					
a) Students often behave badly in math class.	SD	D	U	A	SA
b) I feel comfortable asking questions in math class.	SD	D	U	A	SA
c) How much I learn in math class is mainly up to me.	SD	D	U	A	SA
d) I know the learning goals each day for my work in math.	SD	D	U	A	SA
3. Pedagogy					
a) Our math teacher lectures most days in class.	SD	D	U	A	SA
b) Our class time is usually focused on learning facts, definitions and formulas.	SD	D	U	A	SA
c) I often solve problems on my own in class.	SD	D	U	A	SA

d) My teacher expects me to explain the steps I use to solve a problem.	SD	D	U	A	SA
Please respond to the statements below by circling your level of agreement or disagreement.	**Strongly Disagree**	**Disagree**	**Uncertain**	**Agree**	**Strongly Agree**
e) My math teacher encourages the class to talk about what we are learning.	SD	D	U	A	SA
f) We often try to solve real world problems with math information.	SD	D	U	A	SA
4. Grouping					
a) We often work in teams of two or small groups in math class.	SD	D	U	A	SA
5. Technology Use					
a) Our teacher uses Learn Check each day to collect our homework.	SD	D	U	A	SA
b) We use Quick Poll each day to send our answers to the teacher.	SD	D	U	A	SA
c) We use Screen Capture in class to compare our TI calculator screens.	SD	D	U	A	SA
d) We often use Activity Center to receive new problems to work on in class.	SD	D	U	A	SA
6. Technology					
a) The TI calculator helps me learn new concepts in class.	SD	D	U	A	SA
b) Fewer students behave badly in math class when we use the TI calculators.	SD	D	U	A	SA
c) Learning math is easier for me with the TI calculator.	SD	D	U	A	SA
d) I am more excited about learning math since using the TI calculators.	SD	D	U	A	SA
e) Use of the TI calculator helps me talk more about my work in math class.	SD	D	U	A	SA
f) Please explain how use of the TI graphing calculator has changed learning math for you, if at all.					
7. The Block Class					
a) The block time has helped me do better in math class.	SD	D	U	A	SA
8. Outlook					
a) I have noticed that my grades are better in math this year.	SD	D	U	A	SA
b) I understand math better this year.	SD	D	U	A	SA
c) I can help others learn in math class	SD	D	U	A	SA
d) I will graduate from high school.	SD	D	U	A	SA
e) I plan to go to college.	SD	D	U	A	SA

Appendix D: Parent Perception Survey

Identifying Components of Effective Mathematics Programs
Parent Consent Form

The attached survey asks you to reflect on the math education your child is receiving this year as part of the Texas Instruments School Partnership. Over the next week, teachers, parents and students will be asked to complete a similar survey. While the study includes several components you may be most familiar with the increased block time for math.

The information from this study will be sent to the principal, school mathematics specialists and the district office. Any information that is obtained in connection with this study and that can be identified with you will remain confidential and will be disclosed only with your permission or as required by law. If you have any questions regarding the research, please feel free to contact Mara Winick (mara_winick@redlands.edu) or Jeffrey Lewis (jeff_lewis@pitzer.edu or 909-792-9380).

By signing below, you indicate that you have read and understand the information above and that you willingly agree to participate. You may withdraw your consent at any time and discontinue participation without penalty, and you may request to receive a copy of this form. Finally, your consent does not waive any legal claims, rights or remedies.

Thank you for helping to improve math education for all children.

Child's Name _____ Parent Signature _____ Date_____

Parent Math Survey-April 2007
The Texas Instruments School Partnership

Please respond to the following statements by circling your level of agreement or disagreement.	**Strongly Disagree**	**Disagree**	**Uncertain**	**Agree**	**Strongly Agree**
1) I frequently receive information about my child's performance in math.	SD	D	U	A	SA
2) The teacher knows how to help my child if he/she is having difficulty in learning math.	SD	D	U	A	SA
3) The teacher expects my child to learn grade level math.	SD	D	U	A	SA
4) I am confident that my child will pass the year-end state mathematics test.	SD	D	U	A	SA
5) I expect my child to graduate from high school.	SD	D	U	A	SA
6) My child performance in math is better this year than last.	SD	D	U	A	SA
7) My child is excited about learning math this year.	SD	D	U	A	SA
8) I feel comfortable speaking with the teacher about my child's performance in math.	SD	D	U	A	SA
9) I know what my child must do to be successful in math.	SD	D	U	A	SA
10) I have attended math night or another session to learn about my child's math program.	SD	D	U	A	SA
11) My child plans to go to college.	SD	D	U	A	SA
12 I know what I can do to help my child be successful in math.	SD	D	U	A	SA

Please complete the below, then fold and return to the drop envelope in your child's math class.

Math teacher name _____ School name _____ Grade level ____

TI-Euclid City School District MathForward Intervention

2007 Year End Report

Prepared by

Winick & Lewis Research, LLC

August 15, 2007

Table of Contents

Year-end report: 2006-07
TI-Euclid City School District MathForward Intervention

Overview

Texas Instruments Inc. and Euclid City School District in Euclid, OH have partnered to improve mathematics instruction, engaging two middle schools with their district in the change effort. Utilizing a block schedule class design, additional instruction time, more collaboration between teachers throughout the year, focused professional development sessions, and the employment of the TI-Navigator systems, the district sought to increase the passing rate of at-risk students enrolled in these schools.

At the middle schools, students selected for the intervention were primarily those who, coming into this year, were deemed at risk for not passing the annual state achievement test and were in need of more focused mathematics instruction. Ten teachers offering 11 classes at the 7^{th} or 8^{th} grade level began the year with an assessment of their own knowledge of mathematical content and pedagogy, and at the end of this year, 8 of the teachers completed the math knowledge post-assessment and a group of teachers from one of the schools completed a survey that explored their views on a variety of domains related to the intervention.

This report provides a summary of the academic outcomes for the students participating in the MathForward intervention along with a contrast provided by a comparison group of matched students at the two middle schools. After this summary, we will then turn to a review of the results of the math knowledge assessment and a report of the teachers' perceptions of the intervention experience.

2007 Ohio Achievement Test (OAT) Results

The Euclid City School District offers a prime opportunity for Texas Instruments and the MathForward initiative. One primary goal for this effort is focused on improving the mathematics performance of minority students as we strive to close the gap in performance that is common in schools across the country. In order to assess the effectiveness of the intervention over the past year, change in the annual mathematics assessment test, the Ohio Achievement Test (OAT), will be calculated. The OAT is offered in grade 3-8, and at every grade level scores are scaled so that a 400 point scale score would deem that student as performing at the proficient level. While the tests are designed at this point to be compared only at the same level, we can use the previous year's test level to help control for pre-existing differences in students[1]. The performance of the students participating in the intervention classes will then be compared with a group of students similar in terms of their background characteristics but who are instead enrolled in regular, non-AP mathematics classes at the schools.

The schools chosen for the intervention are an apt testing ground, where the majority of students are economically disadvantaged and predominantly African American. Ten teachers (five at each of the schools) teaching a total of 11 classes were selected to offer the MathForward classes. In table 1 we can

[1] Ohio plans to move to a *value-added* model of assessment where the accountability system will be centered on year to year gains in student performance. The calculation of the value-added gains has not yet been finalized but will incorporate what students of differing abilities and backgrounds typically would be expected to gain from year to year given normal instruction. Until this is available, statistical techniques using covariates or longitudinal models will have to substitute for the final numbers.

see the ethnic and economic disadvantaged percentages across the participating school, while table 2 shows the gender breakdown across the classes. The student groups were quite comparable in terms of economic disadvantage at Central Middle School, while at Forest Park, the intervention group had a somewhat higher percentage of economically disadvantaged students. The intervention groups also seemed to have more African Americans and fewer Whites, and more female students in the 8th grade. In all, 226 students were enrolled in the MathForward classes and 796 students were selected as a comparison group.

Table 1: Ethnic group and economic disadvantaged percentages across junior high schools and between classes

			Other	African American	White	Economically Disadvantaged	Total
			Percent	Percent	Percent	Percent	Count
Central Middle School	7	Comparison Classes	5%	81%	14%	58%	201
		Block Classes	2%	93%	5%	64%	42
	8	Comparison Classes	6%	79%	15%	63%	227
		Block Classes	1%	86%	13%	65%	69
Forest Park Middle School	7	Comparison Classes	7%	77%	16%	59%	178
		Block Classes	6%	82%	12%	68%	60
	8	Comparison Classes	5%	78%	17%	61%	190
		Block Classes	8%	87%	5%	91%	55
Overall	7	Comparison Classes	6%	79%	15%	58%	379
		Block Classes	5%	86%	9%	67%	102
	8	Comparison Classes	5%	79%	16%	62%	417
		Block Classes	4%	86%	10%	77%	124

Table 2: Gender percentages across junior high schools and between classes

			Female	Male	Total
			Percent	Percent	Count
Central Middle School	7	Comparison Classes	46%	54%	201
		Block Classes	45%	55%	42
	8	Comparison Classes	52%	48%	227
		Block Classes	64%	36%	69
Forest Park Middle School	7	Comparison Classes	48%	52%	178
		Block Classes	52%	48%	60
	8	Comparison Classes	43%	57%	190
		Block Classes	62%	38%	55
Overall	7	Comparison Classes	47%	53%	379
		Block Classes	49%	51%	102
	8	Comparison Classes	48%	52%	417
		Block Classes	63%	37%	124

In many ways, the Euclid schools could be seen as a challenging context for the MathForward intervention. According to the Ohio Department of Education Website (https://webapp2.ode.state.oh.us/reportcard/archives/RC_IRN.ASP?irn=043950), these schools are behind their goals for mathematics achievement and performing below the state targets. In addition, when we compare the MathForward group to other students at their school not enrolled in the block classes, their scores on the previous year's assessment test is significantly lower (Math Forward average = 389.37, Comparison Students average = 397.29, $\mathbf{F}_{(1,816)} = 15.21$, $\mathbf{p} < .001$). To get a better sense of the impact of the MathForward intervention, a comparison of mathematics achievement of the targeted students over the past two years would be useful.

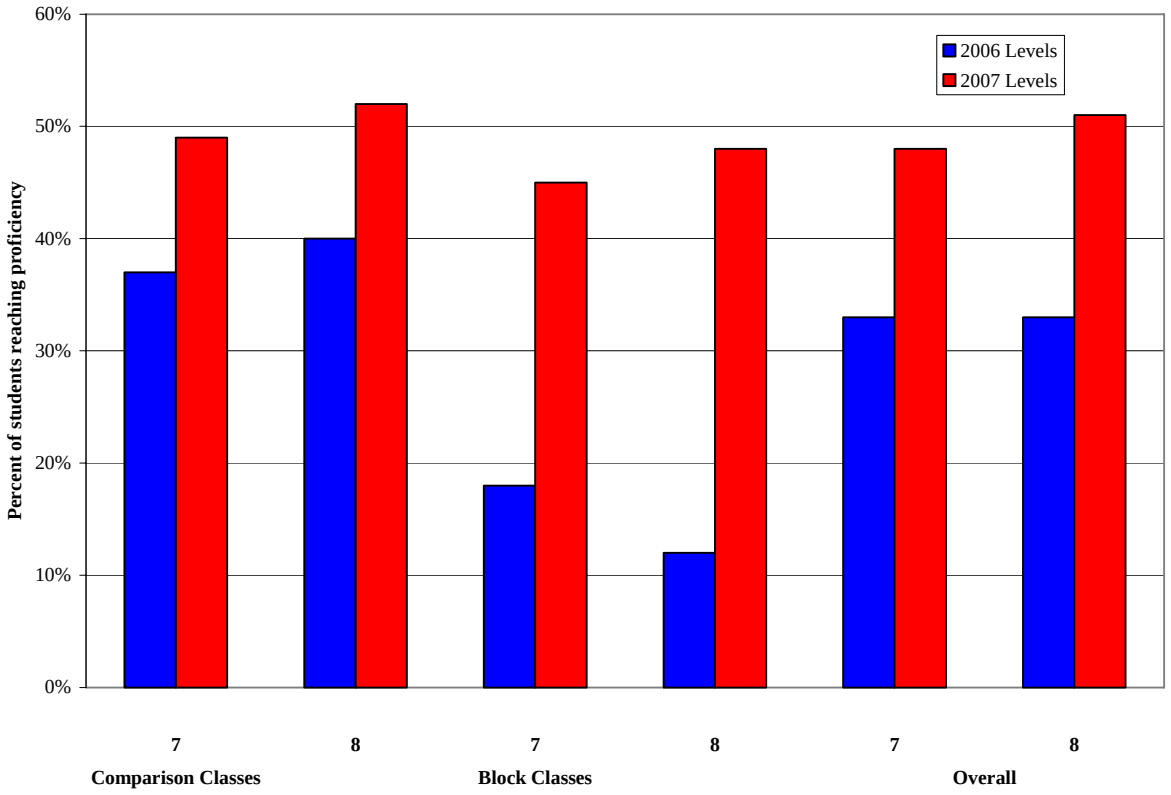
In order to assess the impact of the intervention, we can contrast the proportion of students who reach the desired target level in mathematics and how this has changed from last year with the gains on the state assessment made by the students in the comparison classes. First we can look at the percentage of students who reach the proficient level in their mathematics assessment (obtaining a scaled score of 400 on the OAT), and how those percentages changed. Table 3 shows the percentages for the grades in each of the class groups in both 2006 and 2007. While still below the current Ohio target of 75%, all classes made gains in comparison from 2006 to 2007 in terms of the number of students who reached the proficient level on the OAT. The gains made by the MathForward classes were dramatic, as we see a 250% increase for 7th graders and a 400% increase for 8th graders.

Table 3: Percentage of Students reaching the proficient level in 2006 and 2007 for Block and Regular Mathematics Classroom Students

		Percent reaching Proficient in 2006	Percent reaching Proficient in 2007
Class Group	Grade	Percent	Percent
Comparison Classes	7	37%	49%
	8	40%	52%
Block Classes	7	18%	45%
	8	12%	48%
Overall	7	33%	48%
	8	33%	51%

Chart 1 below shows the same data in a graphic representation.

Chart 1: Percent of students reacing Proficient Level in 2006 and 2007 for MathForward and Comparinson Classes



To better test the difference between the two groups, a repeated measures Analysis of Variance (ANOVA) test using 2006 OAT Scale Scores as the time 1 measure and 2007 OAT Scale Scores as the time 2 measure can be used to compared the change in test scores from 2006 to 2007 while controlling for the starting point of each group was calculated[2].

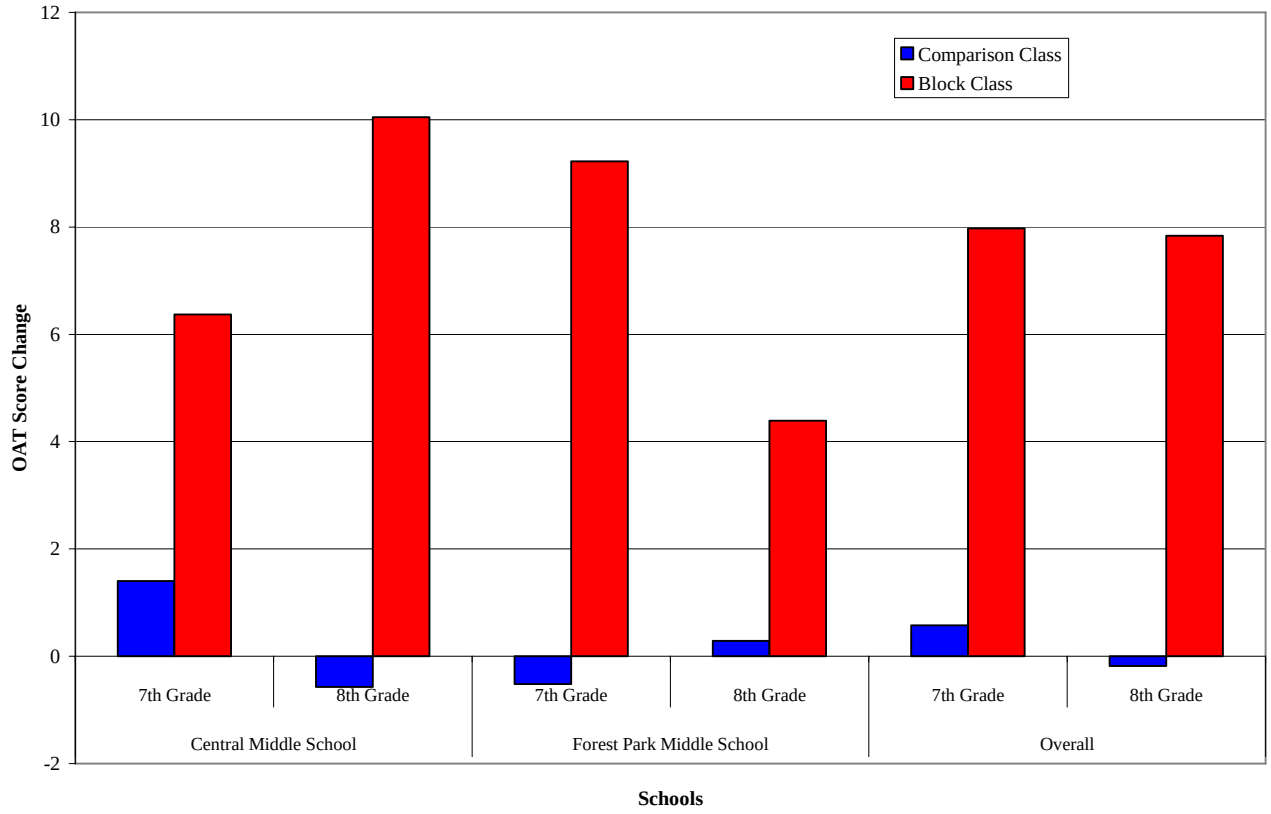
Table 4 and chart 2 below show the results of this comparison. Table 4 shows the observed gains in scale scores from 2006 to 2007 in the MathForward and Comparison groups across the schools and grades in the intervention. The MathForward students demonstrated significantly higher gains in their test scores over this period ($\mathbf{F}_{(1,776)} = 8.779$, $\mathbf{p} = .003$).

[2] An Analysis of Co-Variance (ANCOVA) strategy might be seen as a more straightforward approach to this question, but testing of necessary assumptions rejected the hypothesis that the error variance of the dependent variable was equal across the groups, and so an ANCOVA would not be appropriate here.

Table 4: Average Ohio Achievement Test Mathematics Scale Score Assessment Growth from 2006 to 2007 for Block and Regular Mathematics Classroom Students across schools

School	Grade	Math Class	Mean	Std. Deviation	N
Central Middle School	7	Comparison Classes	1.4025	23.61321	159
		Block Classes	6.3684	11.81255	38
		Total	2.3604	21.90161	197
	8	Comparison Classes	-.5706	34.10423	170
		Block Classes	10.0469	13.88665	64
		Total	2.3333	30.30276	234
	Total	Comparison Classes	.3830	29.47621	329
		Block Classes	8.6765	13.21353	102
		Total	2.3457	26.76215	431
Forest Park Middle School	7	Comparison Classes	-.5167	34.45567	120
		Block Classes	9.2245	15.58480	49
		Total	2.3077	30.49551	169
	8	Comparison Classes	.2867	38.16931	143
		Block Classes	4.3902	14.39944	41
		Total	1.2011	34.33279	184
	Total	Comparison Classes	-.0798	36.45542	263
		Block Classes	7.0222	15.16722	90
		Total	1.7309	32.51107	353
Total	7	Comparison Classes	.5771	28.74010	279
		Block Classes	7.9770	14.05800	87
		Total	2.3361	26.18447	366
	8	Comparison Classes	-.1789	35.96205	313
		Block Classes	7.8381	14.29169	105
		Total	1.8349	32.10428	418
	Total	Comparison Classes	.1774	32.73258	592
		Block Classes	7.9010	14.14938	192
		Total	2.0689	29.47168	784

Chart 2: Ohio Achievement Test Growth for MathForward and Comparison Students - 2006 to 2007



Teacher Content Knowledge

The TI-Euclid intervention also focused on improving teacher knowledge, using professional development opportunities and collaborative sessions to assist the mathematics teachers. The impact in this area can be seen in the teachers' scores on the Content Knowledge for Teaching Mathematics (CTKM) project assessment (Ball, Bass, & Hill, 2003) that was administered prior to this year and then again after the TAKS testing period. Table 4 lists the CKTM averages for the mathematics teachers participating in the intervention program from the beginning of the school year in 2006 to the end in 2007, along with the change illustrated on each CKTM domain. Note that the CKTM scores are represented in standard deviation units and are normalized in line with a national sample of mathematics teachers who completed the CKTM measures over the last three years. The average score is calibrated to zero, and scores can be negative or positive in value, representing results that would be below (negative) or above (positive) average. On average no growth was seen on the content knowledge scales over this time period, with the average scores basically flat or falling by year's end. Unlike other sites where the MathForward program was implemented, no continuing professional development was offered to the teachers. Past work had demonstrated that scores on the CKTM will increase with effective training in mathematics knowledge and pedagogy. The district did not allow the release of teacher identification connected to the student test results, so an exploration of the association between these scores and student achievement was not possible.

Table 5: CKTM Averages and change from fall, 2006 to spring, 2007 in Euclid Schools overall

School		Number Operations Scale Score	Number Operations Pretest Score	Number Operations change	Patterns, Functions, & Algebra Scale Score	Patterns, Functions, & Algebra Pretest Score	Patterns, Functions, & Algebra change
Central Middle School	Average	.36900	.42960	.0053	.24967	.25960	-.1650
	Standard Deviation	.861089	.555430	.60135	.542767	1.065598	.35680
	N	3	5	3	3	5	3
Forest Park Middle School	Average	.01640	.29460	-.2782	.18920	.46000	-.2708
	Standard Deviation	.370383	.650215	.67466	.751543	.336886	.93637
	N	5	5	5	5	5	5
Total	Average	.14863	.36210	-.1719	.21188	.35980	-.2311
	Standard Deviation	.568808	.574523	.62044	.638672	.752504	.73511
	N	8	10	8	8	10	8

Teacher Perceptions – Overview

Eleven classrooms across two campuses participated in the MathForward Program from the Euclid City School District. Only teachers from Forest Park Middle School completed the year end survey, so only their results will be reported.

Individual Site Reports (note: no report received from Central Middle School)

Forest Park Middle School

Six classrooms at this school participated in the study. Five teachers, 18 parents and 89 students completed a year-end survey about their experiences.

Teacher Input

Forest Park continues to stand out as the school with perhaps the most variance between teacher perceptions of the learning environment. At mid-year Forest Park teachers tended to suggest that the students can learn, but that they could not teach. By year-end and with an additional teacher responding to the survey, teacher expectations are less uniform. Several teachers believe their students can learn grade level math and that they can teach them, but at least two do not. One teacher out of five is confident that his/her students will do well on district benchmarks or master grade level content measured by the year-end state test.

Maintaining order in class is an on-going problem. None of the teachers agree that their students accept responsibility for their role in learning math.

Most teachers agree that administrative support makes them feel valued and that weekly sessions with colleagues have been helpful. Only one agrees, however that there is an expert with whom they can regularly discuss teaching strategies. One teacher has found the sessions with the mathematician beneficial, three write that there have been no sessions with a mathematician. Note, however, that there were no sessions with a mathematician in the Euclid schools to further these teachers' mathematics knowledge.

The teachers describe a classroom environment where discussion is critical to learning, students apply concepts to real world problems and regularly explore multiple solutions in class. Students often collaborate, working in pairs or groups during the main activity. None of the teachers agree that it is important to appear to know everything about math and technology in class.

Teachers agree that the district curriculum is aligned to the state mathematics standards, not necessarily unit benchmarks or diagnostics to the district curriculum. Two of the five teachers appear to be using benchmark data with success. It does not appear that the feedback teachers receive is based upon district benchmark data.

The teachers write that they are not using diagnostic data, perhaps one does. There may be bias against using the data:

> The idea of using it is a good one, but until the students and their families take responsibility to learn on their own, the use of diagnostics is as effective as a dripping faucet is for washing dishes

Two of the five teachers agree to using Learn Check or Quick Poll daily. More use Activity Center. The teacher's enthusiasm for the TI technology is mixed but positive, four out of five note benefits in teaching, such as being able to cover more material in depth. Noted performance changes appear to relate to student involvement. One comments, "it is impossible for students to hide in my classroom". Teachers list using TI Navigator somewhat more during warm-up with the most use occurring for assignments/quizzes, sending questions/prompts, sharing data for class analysis, and to modify instruction.

All of the teachers agree that they could use additional training on the TI Navigator. Most report that neither assistance, nor sufficient curriculum materials are available to effectively use TI Navigator in class. At mid-year and year-end teachers asked for additional support:

- Activity Center plans and ideas
- Training in the classroom
- More lessons that incorporate TI
- Additional applications and learn checks

One comments, "it would be helpful to have a TI rep in the classroom more". Additional support requested from the district includes fewer students and alternative schooling.

While most agree that the block has increased the amount of content students are able to cover during the year, several continue to think it is too long to keep students focused on math.

The teachers do not frequently communicate learning expectations to parents, although some report that parents know what their child must do to be successful, even though they do not know how they might help them.

Parent Input

Three of the five classes provided parent surveys, two from one class, eleven from a second class and five from the third. Most of these parents are confident their child will pass the year-end state test in mathematics. Fifty percent agree that their child is excited about learning math this year.

Student Input

The percentage of students who report being excited about the way math is being taught and who have noticed an improvement in their grades has risen by nearly 10 percentage points since mid-year. It is unclear if the change is due to a smaller sample.

Over half agree that the teacher uses Learn Check and Quick Poll daily. Over 60% agree that they use Screen Capture and Activity Center in class, and separately that the TI calculator helps them learn new concepts, and makes learning math easier. In the open-ended comments the remarks tend to be quite positive:

> It is raw.
>
> It changed learning math for me because I am not afraid of getting a wrong answer.
>
> It makes me pay more attention because there is more interesting things on the calculators, than listening to someone explain it to you or talk.

Half the students agree that the block time has helped them do better in math.

TI-DISD MathForward Intervention

2007 Year End Report

Prepared by

Winick & Lewis Research, LLC

August 15, 2007

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Year-End Assessment of the DISD-TI MathForward Intervention Model

Overview

During this past year, the Dallas Independent School District and Texas Instruments, Inc. introduced the MathForward intervention to classes taught by six teachers across two junior high schools in the district. Utilizing a block schedule class design, additional instruction time, more collaboration between teachers throughout the year, focused professional development sessions, and the employment of the TI-Navigator systems, the district sought to increase the passing rate of at-risk students enrolled in these schools. Students selected for the intervention were primarily those who were deemed at risk for failing the state's year-end assessment, the Texas Assessment of Knowledge and Skills (TAKS).

2007 TAKS Results

A summary of this year's TAKS testing results can give us a better sense of the general context within the participating schools. Table 1 provides comparative data on demographic categories for all 7th and 8th graders at the junior high schools. Listed in the table are the total number of students in 7th and 8th grades with valid tests reported this year sorted by school, the schools' ethnic group percentages, and proportion of each school's student body classified as economically disadvantaged. Note the high proportion of minority and economically disadvantaged students at the junior high schools in the intervention group.

Table 1: Response Totals by Campus for 2007 TAKS testing period (for schools overall – ethnic group and economic disadvantaged percentages)

Campus	Total 7th & 8th graders with reported scores	African American	Hispanic	Economically Disadvantaged
Billy Earl Dade Middle Learning Center	215	73%	27%	89%
Pearl C Anderson Middle Learning Center	279	87%	13%	89%

The structure of the intervention classes were similar across all of the schools, with students enrolled in 100 minute block classes that employed the TI-Navigator system to assist in instruction. Within the schools, teachers assigned to these classes were to meet frequently to develop and share their knowledge and solve problems, and these teachers also were to receive additional professional development sessions with a math expert from Texas Instruments. To help assess the effects of the MathForward intervention, a comparison group of students at each school was constructed by selecting students who were not participating in the block classes and who were taught by teachers other than those participating in the intervention. As shown in table 2 above, the block and comparison classes had

similar demographic characteristics, although the comparison group had a slightly higher percentage of economically disadvantaged students (those students qualified for free and reduced lunch assistance at the schools) and somewhat more African American than Hispanic students.

Table 2: Economic disadvantaged and ethnic group percentages across junior high schools and between classes

			Economically Disadvantaged	African American	Hispanic	Other Ethnicity	Total
			Percent	Percent	Percent	Percent	Count
Billy Earl Dade Middle Learning Center	7th Grade	Comparison Classes	94%	83%	17%		81
		MathForward Classes	89%	50%	50%		36
	8th Grade	Comparison Classes	83%	73%	27%		52
		MathForward Classes	89%	74%	26%		46
	Combined Grades	Comparison Classes	89%	79%	21%		133
		MathForward Classes	89%	63%	37%		82
Pearl C Anderson Middle Learning Center	7th Grade	Comparison Classes	95%	88%	12%		59
		MathForward Classes	88%	88%	12%		50
	8th Grade	Comparison Classes	90%	88%	12%		108
		MathForward Classes	87%	82%	16%	2%	62
	Combined Grades	Comparison Classes	92%	88%	12%		167
		MathForward Classes	87%	85%	14%	1%	112
Overall	7th Grade	Comparison Classes	94%	85%	15%		140
		MathForward Classes	88%	72%	28%		86
	8th Grade	Comparison Classes	87%	83%	17%		160
		MathForward Classes	88%	79%	20%	1%	108
	Combined Grades	Comparison Classes	91%	84%	16%		300
		MathForward Classes	88%	76%	24%	1%	194

In all, 194 students were enrolled in the MathForward classes taught by the 6 teachers at the junior high schools, while 300 junior high students not enrolled in these courses were selected from the same schools to serve as comparisons for our analyses.

Turning to the 2007 TAKS results across all of the schools, we can summarize performance generally and for specific subgroups of interest. In table 3 below, the percentage of students in the 7th and 8th

grades who met the minimum passing standard can be seen along with the percentage change from the 2006 results for each group at the schools.

Table 3: 2007 TAKS Met Minimum Percentage Pass Rate by Grade for comparison and block classes

			Overall	African American	Hispanic	Economically Disadvantaged
			Percent	Percent	Percent	Percent
Billy Earl Dade Middle Learning Center	7th Grade	Comparison Classes	57%	54%	71%	57%
		MathForward Classes	39%	33%	44%	44%
	8th Grade	Comparison Classes	42%	37%	57%	44%
		MathForward Classes	57%	59%	50%	59%
Pearl C Anderson Middle Learning Center	7th Grade	Comparison Classes	68%	69%	57%	68%
		MathForward Classes	68%	70%	50%	77%
	8th Grade	Comparison Classes	44%	44%	38%	42%
		MathForward Classes	61%	57%	90%	59%
Total	7th Grad	Comparison Classes	61%	61%	67%	61%
		MathForward Classes	55%	60%	46%	59%
	8th Grade	Comparison Classes	43%	42%	48%	43%
		MathForward Classes	59%	58%	68%	59%

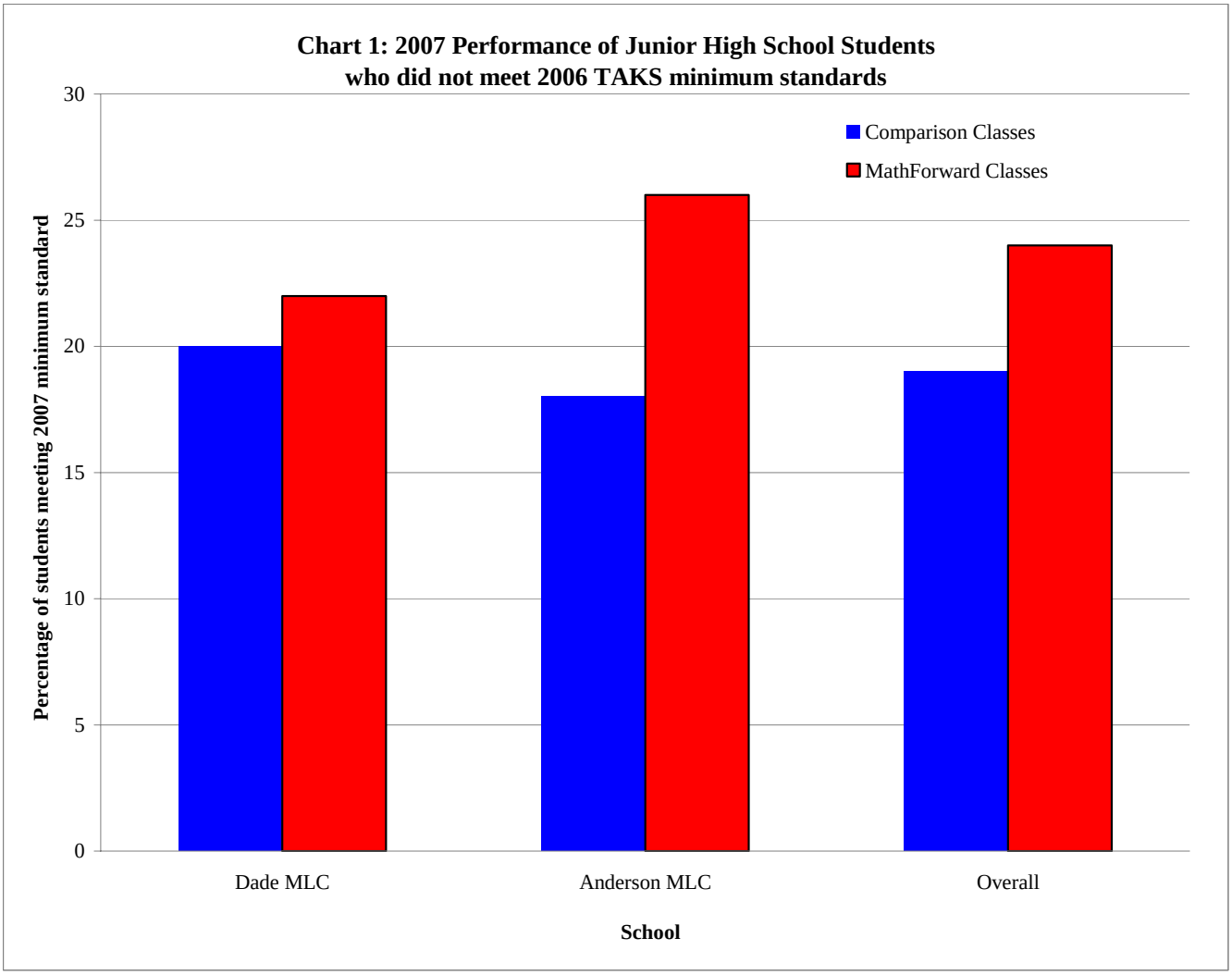
As table 3 illustrates, the intervention led to relatively better results for the 8th grade classrooms where the percentage of MathForward students meeting the minimum passing level exceeded that of comparable students. In the 7th grade, the comparison classes have a passing percentage that is greater at Dade MLC, while the 7th graders at Anderson MLC attained the same level. Finding an apt comparison group for these students is somewhat problematic, however, given that the most at-risk students were those primarily targeted for the intervention. This pattern of results is essentially mirrored across the ethnic groups at both the schools, while only the 7th grade MathForward classes at Dade lag when economically disadvantaged students are selected.

The next table attempts to give a more appropriate contrast. A comparison of results across campuses for students who had data over the past two years is informative since the intervention was focused on students who did not pass the 2006 TAKS, or who were deemed at-risk for not passing this year.

Table 4: 2007 TAKS Math Performance by Students who did not meet 2006 minimum standard by school and class grouping across the junior high sites

				Did not meet 2007 TAKS minimum standard	Met 2007 TAKS minimum standard	Total
				Percent	Percent	Count
Billy Earl Dade Middle Learning Center	7th Grade	Comparison Classes	2006 Not Met	86%	14%	21
			2006 Met	23%	77%	52
		MathForward Classes	2006 Not Met	100%	0%	10
			2006 Met	38%	62%	21
	8th Grade	Comparison Classes	2006 Not Met	74%	26%	23
			2006 Met	30%	70%	20
		MathForward Classes	2006 Not Met	68%	32%	22
			2006 Met	10%	90%	20
	Overall	Comparison Classes	2006 Not Met	80%	20%	44
			2006 Met	25%	75%	72
		MathForward Classes	2006 Not Met	78%	22%	32
			2006 Met	24%	76%	41
Pearl C Anderson Middle Learning Center	7th Grade	Comparison Classes	2006 Not Met	71%	29%	7
			2006 Met	24%	76%	50
		MathForward Classes	2006 Not Met	88%	13%	8
			2006 Met	18%	83%	40
	8th Grade	Comparison Classes	2006 Not Met	84%	16%	49
			2006 Met	22%	78%	41
		MathForward Classes	2006 Not Met	69%	31%	26
			2006 Met	11%	89%	27
	Overall	Comparison Classes	2006 Not Met	82%	18%	56
			2006 Met	23%	77%	91
		MathForward Classes	2006 Not Met	74%	26%	34
			2006 Met	15%	85%	67
Overall	7th Grade	Comparison Classes	2006 Not Met	82%	18%	28
			2006 Met	24%	76%	102
		MathForward Classes	2006 Not Met	94%	6%	18
			2006 Met	25%	75%	61
	8th Grade	Comparison Classes	2006 Not Met	81%	19%	72
			2006 Met	25%	75%	61
		MathForward Classes	2006 Not Met	69%	31%	48
			2006 Met	11%	89%	47
	Overall	Comparison Classes	2006 Not Met	81%	19%	100
			2006 Met	24%	76%	163
		MathForward Classes	2006 Not Met	76%	24%	66
			2006 Met	19%	81%	108

Table 4 shows the 2007 performance of students who either met or did not meet the minimum passing standard on the TAKS in 2006. Students are grouped by school, classroom assignment, and whether or not they met the TAKS minimum passing standard in 2006, and percentages are then reported in terms of 2007 TAKS performance. While overall there seems to be an advantage for the MathForward classes, the effect is primarily carried by Anderson MLC and the 8th graders in particular. The MathForward classes at Dade MLC performed only slightly better than the comparison classes overall, and any advantage observed is due entirely to the 8th grade classes as the 7th graders under-performed their comparison group. Chart 1 below illustrates this in a graphic fashion.



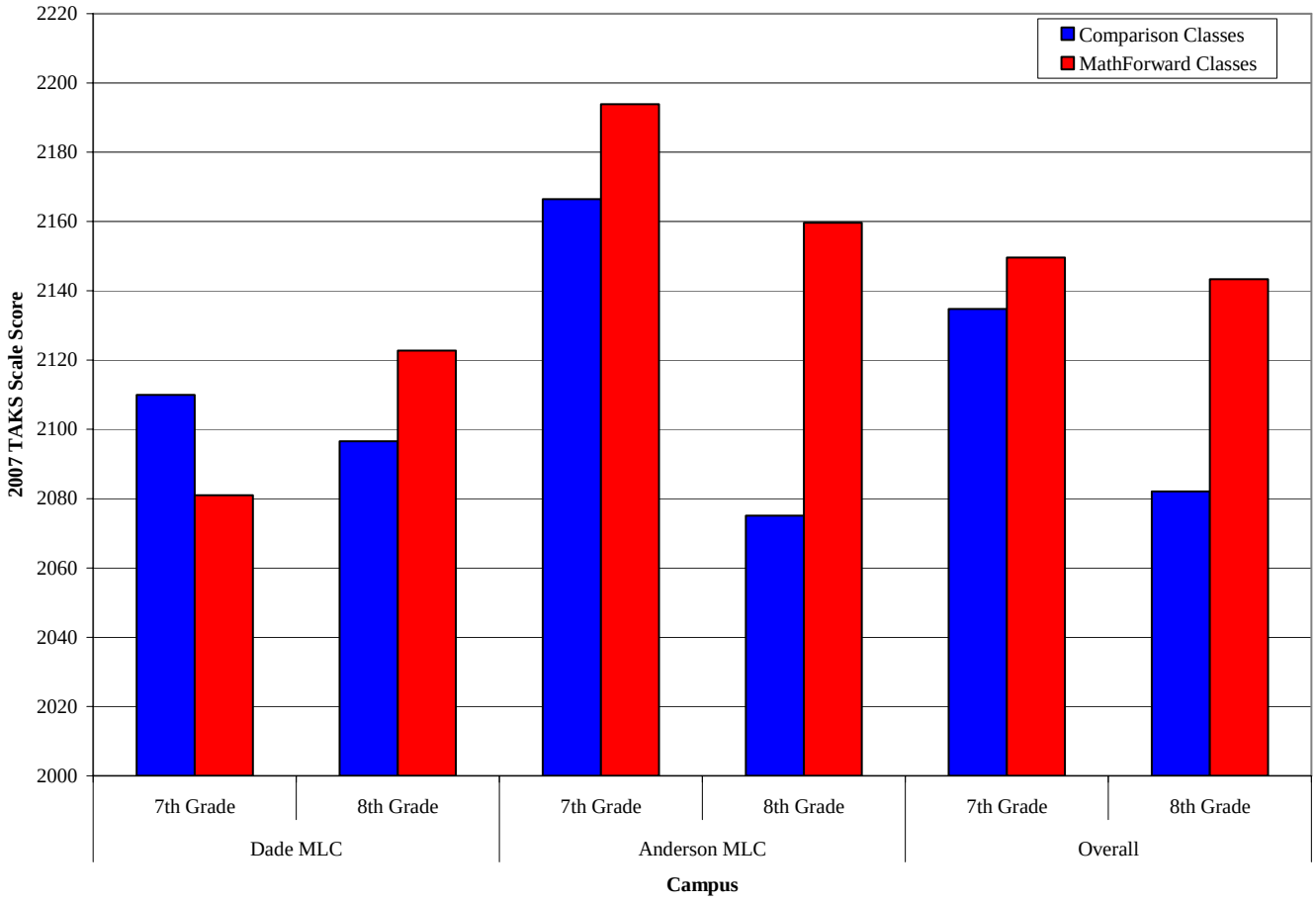
A comparison can also be made across schools contrasting the TAKS 2007 Scale scores made by students in the block classes and those in regular mathematics classes. Again, using the students where data are available from both 2006 and 2007, this year's TAKS scale was calculated for each student in the block and comparison classes. The averages for the groups were then compared, summarized below in table 5.

Table 5: Average TAKS Percentage Correct Growth from 2006 to 2007 for Block and Regular Mathematics Classroom Students across schools

School Name	Grade	Class Comparison	Average 2007 Scale Score	Std. Deviation	Count
Billy Earl Dade Middle Learning Center	7	Comparison Class	2109.97	152.909	73
		MathForward Classes	2081.03	144.432	31
		Total	2101.35	150.323	104
	8	Comparison Class	2096.53	133.293	43
		MathForward Classes	2122.76	145.530	42
		Total	2109.49	139.265	85
	Total	Comparison Class	2104.99	145.499	116
		MathForward Classes	2105.04	145.546	73
		Total	2105.01	145.129	189
Pearl C Anderson Middle Learning Center	7	Comparison Class	2166.44	140.758	57
		MathForward Classes	2193.88	167.339	48
		Total	2178.98	153.336	105
	8	Comparison Class	2075.13	158.018	90
		MathForward Classes	2159.68	195.571	53
		Total	2106.47	177.018	143
	Total	Comparison Class	2110.54	157.522	147
		MathForward Classes	2175.93	182.605	101
		Total	2137.17	170.890	248
Total	7	Comparison Class	2134.73	149.806	130
		MathForward Classes	2149.59	167.246	79
		Total	2140.35	156.396	209
	8	Comparison Class	2082.05	150.299	133
		MathForward Classes	2143.36	175.317	95
		Total	2107.60	163.649	228
	Total	Comparison Class	2108.09	152.076	263
		MathForward Classes	2146.19	171.235	174
		Total	2123.26	160.874	437

The results in Table 5 show that students in the MathForward classes averaged higher scores on this year's test overall. Only the 7th grade MathForward classes at Dade MLC lagged behind their comparison, and the relative advantage of the 8th grade block classes here offset the 7th grade deficit. Interpreting this year's scale scores can be problematic given possible pre-existing score differences in the groups at the start of the school year. Using an Analysis of Covariance (ANCOVA) test, the relative differences illustrated by these groups could be assessed while controlling for any initial differences[1]. When the 2006 TAKS Scale Score for each student is used as a covariate, the ANCOVA analysis revealed that the Block Class Students gained significantly more in their TAKS scores over the year ($\mathbf{F}_{(1,428)} = 5.038$, $\mathbf{p} = .025$). In addition, the MathForward 8th graders seemed perform significantly better (a significant class by grade interaction – $\mathbf{F}_{(1,428)} = 3.921$, $\mathbf{p} < .048$, with 8th grade MathForward students showing a much larger advantage over their comparison group) and students at Anderson seemed to outperform those at Dade overall($\mathbf{F}_{(1,428)} = 4.255$, $\mathbf{p} = .040$). Finally, 7th grade scale score averages in general were significantly higher overall ($\mathbf{F}_{(1,428)} = 28.545$, $\mathbf{p} < .001$). Chart 2 illustrates the scale scores by class type and grade at each school graphically.

Chart 2: 2007 TAKS Scale Score Averages by School, Grade and Class grouping



[1] To verify the suitability of an ANCOVA analysis strategy, the null hypothesis assumption that the error variance of the dependent variable is equal across groups was not rejected; $\mathbf{F}_{(7,429)} = 0.602$, $\mathbf{p} = .754$.

Teacher Content Knowledge

The TI-DISD intervention also focused on improving teacher knowledge, using professional development opportunities and collaborative sessions to assist the mathematics teachers. The impact in this area can be seen in the teachers' scores on the Content Knowledge for Teaching Mathematics (CTKM) project assessment (Ball, Bass, & Hill, 2003) that was administered prior to this year and then again after the TAKS testing period. Table 6 lists the CKTM averages for the 5 mathematics teachers participating in the intervention program who had completed at least some of the assessment from the beginning of the school year in 2006 to the end in 2007, along with the change illustrated on each CKTM domain. Note that the CKTM scores are represented in standard deviation units and are normalized in line with a national sample of mathematics teachers who completed the CKTM measures over the last three years. The average score is calibrated to zero, and scores can be negative or positive in value, representing results that would be below (negative) or above (positive) average.

Table 6: CKTM Averages and change from 2006 to 2007 in Dallas ISD overall

LMT Dimension	Average	Standard Deviation	Range
2006 Numbers and Operations domain	-.1068	.651	1.36
2007 Numbers and Operations domain	-.0756	.676	1.82
Growth in Numbers and Operations score, 2006-07	-.0593	.390	0.92
2006 Patterns, Functions, and Algebra domain	.3164	.750	1.78
2007 Patterns, Functions, and Algebra domain	-.0200	.422	0.89
Growth in Patterns, Functions, and Algebra score, 2006-07	.0425	.212	0.50

Focusing on this year, on average no growth was seen on the content knowledge scales over this time period, with the average scores falling by year's end. This may related to a number of factors highlighted in the teacher surveys received from Anderson MLC, reported below.

Teacher Perceptions - Overview

The six teachers who participated in the MathForward Program from the Dallas Independent School District (DISD) were asked to complete year end surveys that assessed their perception of what they experienced this year in the program. Unfortunately, no surveys were received from the teachers at Dade Middle Learning Center, so only the responses from Anderson MLC are summarized below.

Individual Site Reports (note: no report received from Dade Middle Learning Center)

Pearl C. Anderson Middle Learning Center

Four classrooms participated in the study. Two teachers, 17 parents and 79 students completed a year-end survey about their experiences.

Teacher Input

At Pearl C. Anderson (PCA) two of the four teachers completed a survey. The two responded with different views of the learning and classroom environment, pedagogy, assessment, the block class, parent involvement, administrative and collegial support. While the two teachers agree that their students want to learn math and that they can successfully teach them, neither are confident that their students can learn grade level math. This pattern of response, where teachers report that students cannot learn (and which was also present at mid-year) is characteristic of the lowest performing schools.

While teacher responses to questions about the learning environment are discouraging and there is much to be discouraged about: no weekly meetings, no expert available to discuss teaching strategies, math sessions that are not available for all, the teacher open-ended written remarks about the technology are positive. Both teachers write about the benefits of using real-time feedback. One comments that immediate feedback has helped the most with homework, tests and daily assignments. The other writes that use of the TI technology has changed "discipline because it is hands-on, motivates the students, (provides) collaborative learning and accountable talk". The teachers write that the technology has motivated students to turn in homework that will be checked, helped improve grades of those really struggling through the aid of the technology, and "improved attendance because students want to come to class and log in".

In the closed-ended (likert) questions, both teachers agree to benefits from the use of TI Navigator, namely fewer behavioral problems, improved classroom dialogue and more successful engagement of students who have experienced difficulty in learning math.

Both teachers report that class time is mostly focused on learning facts, definitions and formulas and that students often apply concepts to real world problems. Students often collaborate in pairs or groups in class. The teachers do not feel that it is important to appear to know everything about math and technology in class.

It continues to be unclear if unit benchmarks or diagnostics are aligned to the district curriculum, while these two teachers report that the district curriculum is aligned to the state mathematics standards and that teachers agree on what students should be able to do to meet grade level standards. The teachers responding agree that benchmark data and diagnostic data are important to their teaching; one agrees that it impacts learning.

Teacher self report of TI Navigator is highest during problem solving and most likely used for sending questions/prompts and for sharing student data with the full class. Neither teacher reports using TI Navigator to discuss the same mathematical concept using more than one representation and use is low for giving quizzes/assignments and for assigning work in pairs.

While the teachers do not find the block time too long to keep students focused, only one agrees that is has made a difference in the amount of content covered or student approach to problem solving. One explains that he/she was so focused on learning how to use the equipment that there was not time to learn how to use the block effectively yet. At mid-year teachers were mixed about the benefits of the power block as well.

Both teachers report that their students' parents have seen the TI Navigator in use. The teachers write that those who saw TI Navigator were impressed and that the parents want every teacher to have it.

The teachers feel valued by the administration, but have different views of how well the administrator understands the demands of teaching the intervention. Neither reports that there is an expert available with whom to discuss teaching strategies. One writes that because of schedule changes the teachers were unable to have weekly planning meetings.

Perhaps the most agreement is found in the teacher views of technological support. Both agree that technological assistance is available, curriculum materials are of good quality and that additional training would be useful. At mid-year the three teachers providing feedback provided a more mixed view.

The teachers ask for additional support: math content sessions that address how to teach measurements and their relationship to the real world, continued work with Activity Center, district lessons in advance of one week, and more teacher planning time to practice presenting and to collaborate. The types of support that have been most critical to increasing student performance include the meetings with Betty Gasque and "following by the district expert". One teacher writes, "Betty Gasque was awesome!"

Parent Input

The parent response rate at PCA continues to be quite low, so the results are unlikely representative. Anywhere from 2 to 12 parents participated in each of three classes.

Of those who responded, over 90% suggest their child's teacher knows how to help their child, if having difficulty in math, and expects their child to learn grade level math. The teachers are not similarly confident.

Half report that they have attended math night or another session to learn about their child's math program. Ninety-four of the participating parents expect their child to go to college.

Student Input

Student reports of technology use at mid-year, suggest high use in one class, moderate use in another and lower use in two classes. This cannot be determined at year-end.

On average over 50% of the students continue to report daily TI Navigator use, with higher use suggested for Learn Check than Quick Poll.

Student open-ended responses at mid-year were positive with many comments about the benefits of using the graphing calculator. There are few comments at year-end and they are mixed with some noting benefit, but most providing little feedback at all.

Over 40% of the students at year-end agree that students often behave badly in class. Student responses suggest that pedagogy varies by teacher, but most are using small groups, try to solve real world problems with math and expect students to explain the steps they use to solve a problem.

Over 80% of the students agree that they feel confident they can pass the year-end state mathematics test.

Student enthusiasm about the way math is being taught this year including use of the TI calculators and the block class is not as high at year–end as mid year, but a higher percentage of students have noticed better grades since mid-year. The sample size is similar.

Ninety-two percent of the students expect to go to college.

Texas Instruments MathForward Intervention

2007 Overall Year End Report

Prepared by

Winick & Lewis Research, LLC

August 15, 2007

MathForward 2007 Intervention Report: Year-end Overview

In the school year 2006-2007, the Richardson, TX Independent School District (RISD) assumed management of their MathForward program. Over the past year, Texas Instruments, Inc.'s MathForward intervention helped to change the way mathematics was taught to 7th through 9th grade students in three states across the country. Working with ten junior high and middle schools along with two high school sites, the MathForward program utilized simultaneous modifications in curriculum, training, teaching and technology to improve mathematics outcomes for students enrolled in the classes. While this intervention differed in terms of the personnel delivering the instruction and the degree of implementation across the classes, the program delivered similar, significant results across the sites. The consistency in the replication is striking, and at the end of this year we have seen positive movement towards improving mathematics scores for at-risk students.

Review of RISD 2005-2006 Results

- When the systemic intervention was applied to middle school math students who had previously failed the state math test (TAKS), the result was a 33% pass rate, vs. 19% for a comparison group from a similar campus.
- Average scores increased at a time when comparison groups and the district as a whole experienced a decline in scores.
- Effect size of the TI MathForward systemic intervention is very strong.
- The positive effect is shown in four statistical analyses, including regression discontinuity analysis, a "gold standard" methodology.
- Teachers reported many positive effects on their classes. A number of suggestions were made for improving the interventions

Overview of 2006-2007 Results

Implementation steps in each of the four participating districts varied somewhat from last year's pilot at RISD, and from each other. These issues, as well as the non-comparability of test scores across states, and relatively small numbers of students in the "new" pilot site districts preclude a meta-analysis of this year's data. However, the variation across the sites also allows us to naturally test how robust the intervention might be when aspects of the program change.

Because RISD's pilot year practice was to assign students to MathForward who had not reached proficiency on last year's state test, our researchers drew a distinction in analysis of this year's data between students who were below proficiency in the previous year, and those who were above proficiency. The researchers also eliminated from most analyses the pre-Advanced Placement (pre-AP) students who were enrolled in MathForward in RISD, again to make the data sets more comparable.[1]

Creating an appropriate comparison group from each district's data was an additional challenge. In each district, our researchers created demographically similar groups who attended other classes, with other teachers,

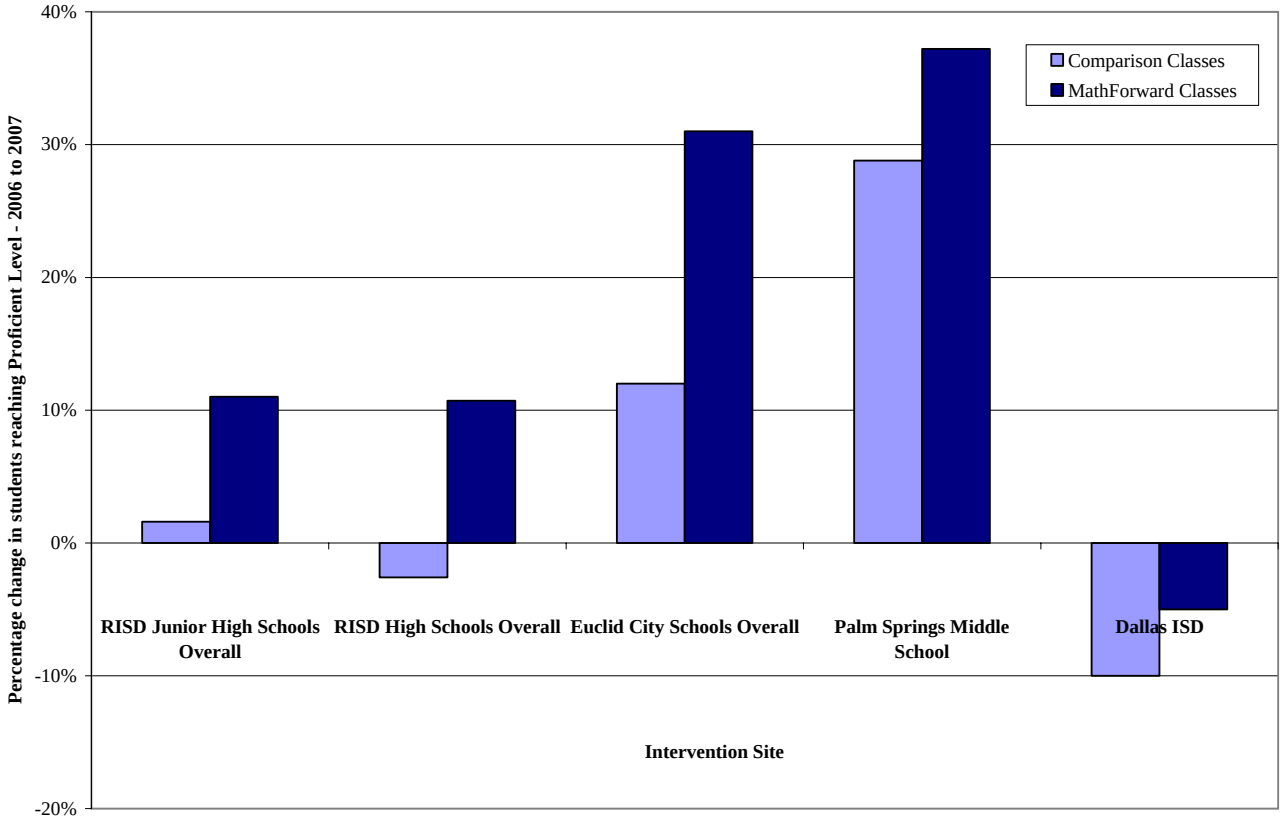
[1] The full report on RISD also examines gains in percent correct responses and uses a somewhat different strategy with a more complex system of comparison groups. While the findings are parallel and consistent, they are not relevant to the results reported here.

and in Palm Springs Middle School in other schools enrolled in the same grade level class, but who were not part of MathForward[2].

General Patterns

The chart below shows the performance of the students in the MathForward classes, charting the change in the percentage of those students scoring at the Proficient level across the intervention sites from the 2006 year end assessments to 2007. For comparison purposes, similar students are also represented so we can see how their performance changed as well. At all of the sites, more MathForward students moved into the Proficient level and this change in terms of percentage growth of proficient students is significant across all of these sites.

Percentage change in proportion of students scoring at proficiency from 2006 to 2007: MathForward classes versus Comparison Classes



The comparison students are selected from non-AP classes and are generally similar in terms of starting point on the mathematics assessment and general demographic characteristics such as economic disadvantage and ethnic background.

Details of each district are discussed below, and additional analyses of test scores and percentage gains, with significance tests, are included in the detailed reports for each district. In general, the observed gains are

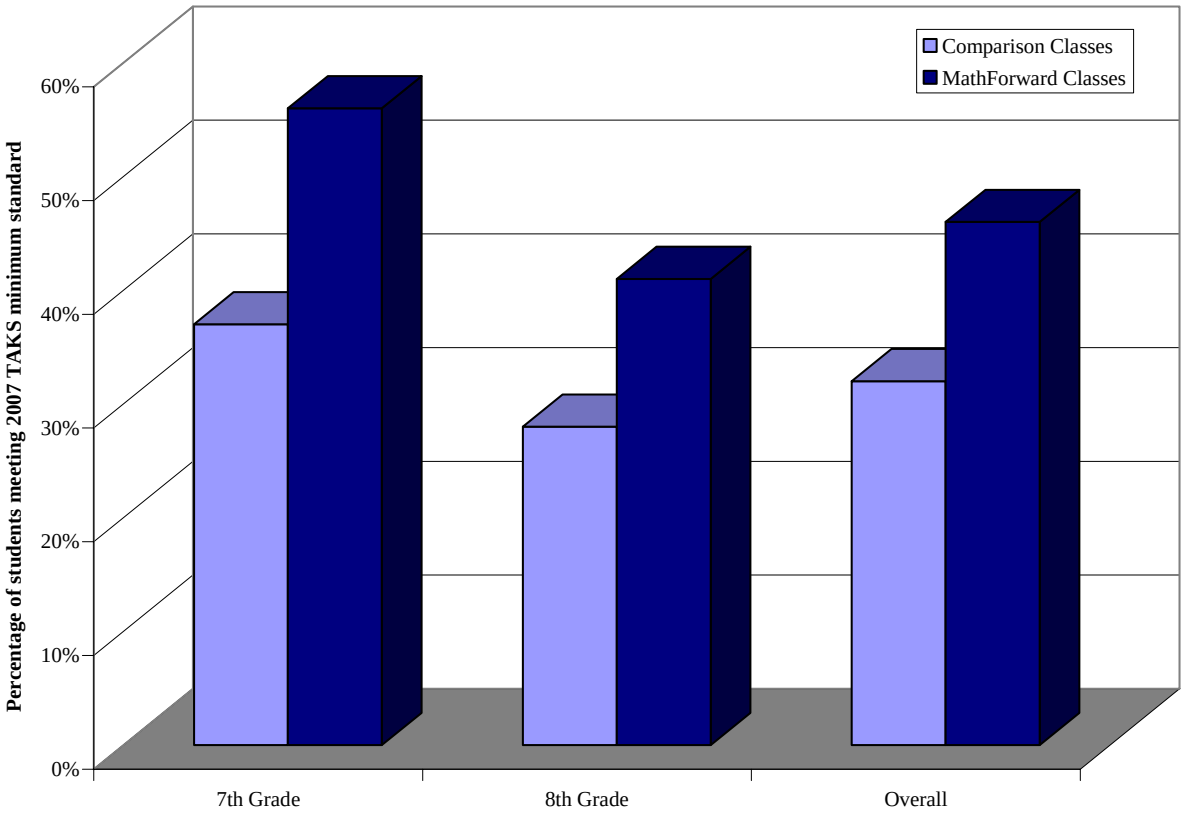
[2] Again, in the RISD analysis, the spread of the program presents additional challenges, resulting in a more complex comparison group strategy. See the detailed report for discussion.

statistically significant, despite relatively small *n*'s in the first-year districts' pilot programs. DISD is a partial exception, and is discussed separately below.

RISD

The grade 7-8 MathForward program at RISD was expanded from one school last year to five schools this year. In addition, class composition was intentionally more heterogeneous this year: students were selected because they performed l between 50% and 75% on the incoming district benchmarks, and then other slots were filled in with students above that range, including some pre-AP students. Recall that last year the pilot program was confined to students who had failed the state test in the previous year. The District took over management of MathForward this year, and implementations clearly benefited from the year of experience with the program. However, note that, due to teacher turnovers, all but three of the teachers in the program were new to it this year. Results for RISD's junior high schools are summarized in the chart below.

Percentage of RISD Students who failed to meet 2006 TAKS Minimum Standard who met 2007 TAKS Minimum Standard: MathForward versus Comparison Classes

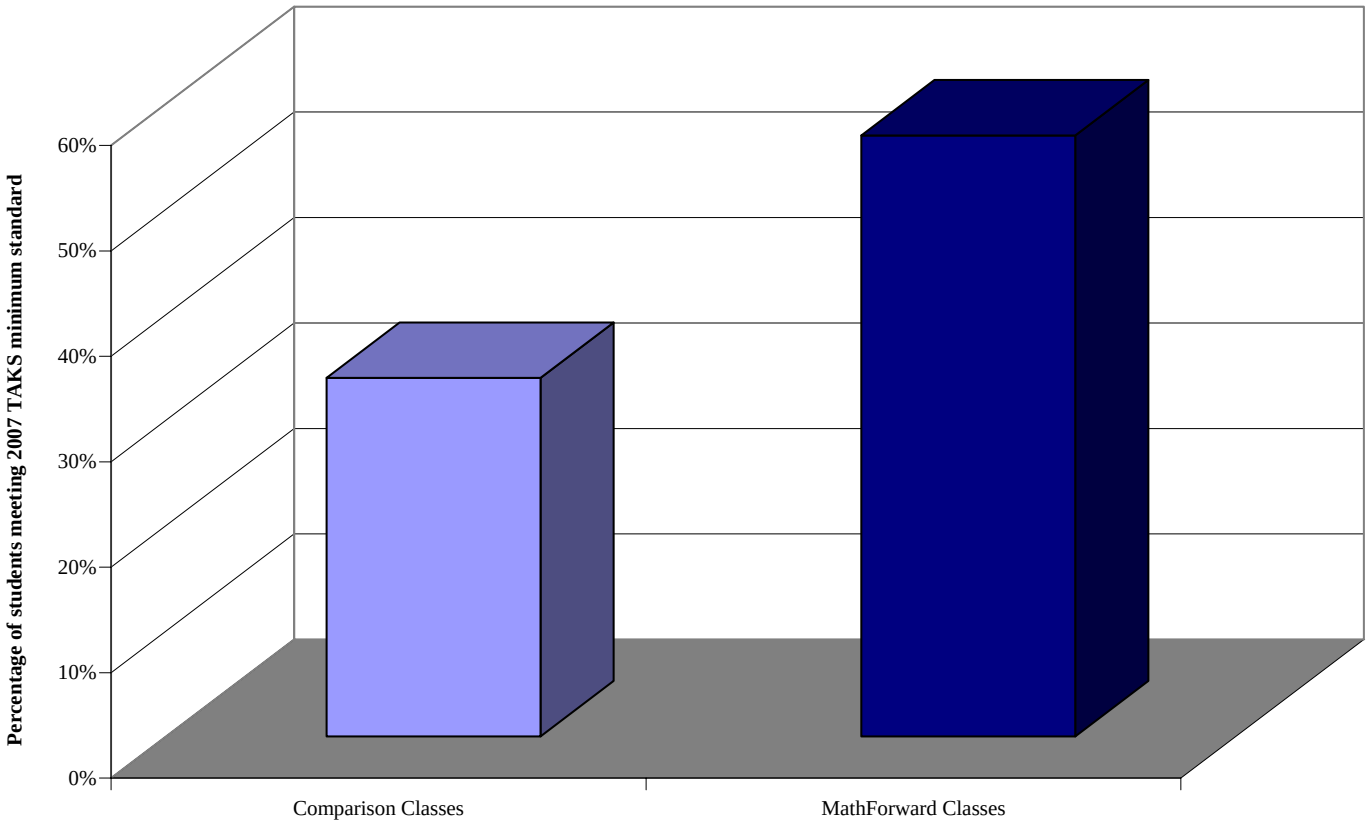


The overall 46% state test pass rate (for students who did not pass the state test last year) represents an improvement when compared to last year's 33% pass rate, as well as a gain when compared to the comparison group. Supplementary analysis which examined the score gains (with normal curve equivalent conversions) by school confirms significant positive differences in all schools but one, and also points to a slight year-to-year

decline in district-wide scores, both in 2006 and in 2007. Thus the positive trend in the middle school MathForward program is even more remarkable because it reversed the district-wide trend in both years.

The 9th grade Algebra high school program, while only a small-scale pilot project, also showed promising gains. These are summarized in the chart below:

Percentage of RISD High School Students who failed to meet TAKS Minimum Standard in 2006 who met 2007 TAKS Minimum Standard: MathForward versus Comparison Classes

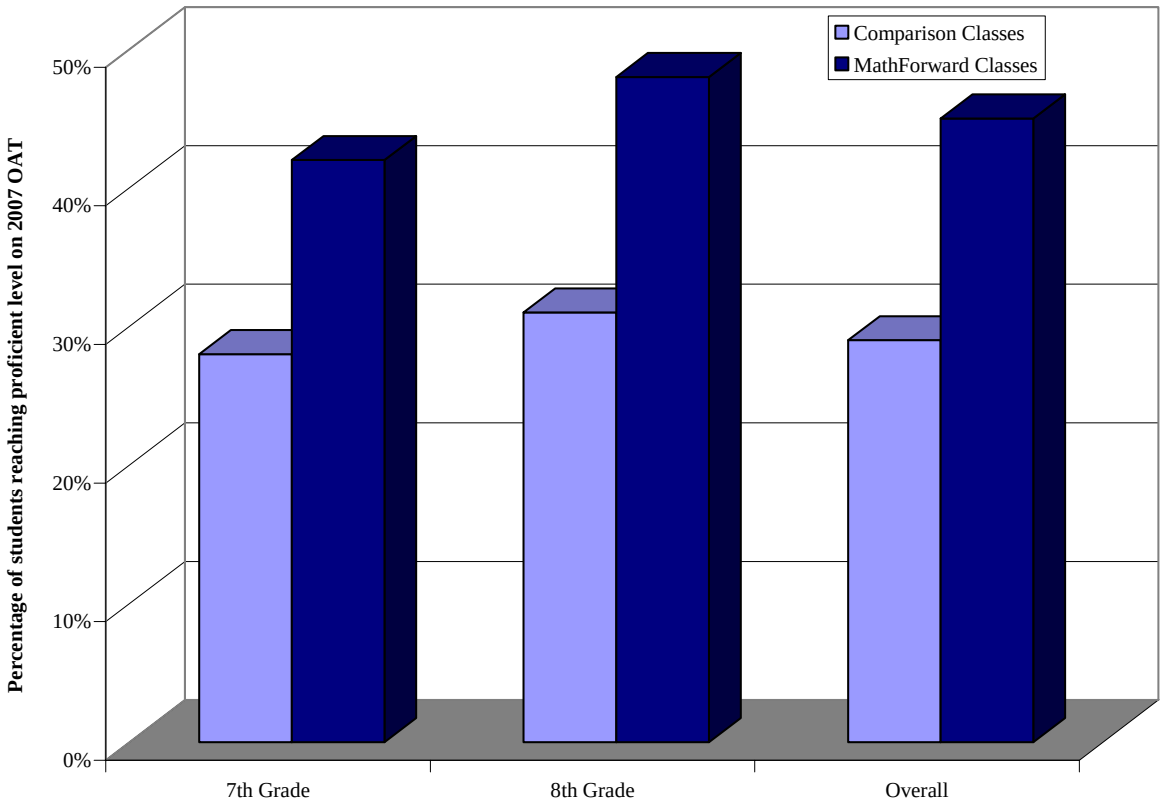


Over the two high schools involved in the pilot, the chart shows that 57% of MathForward students who failed the state test in 2006, attained proficiency in 2007. By contrast, the comparison group had a 34% pass rate. This suggests that MathForward can be scaled to high school math.

Euclid City School District

The Euclid pilot intervention included selected classes in grades 7 and 8 at two middle schools. The program followed the standard guidelines for MathForward, except that teachers did not receive direct instruction in math content knowledge. Proficiency rate comparisons for both schools are summarized in the chart below.

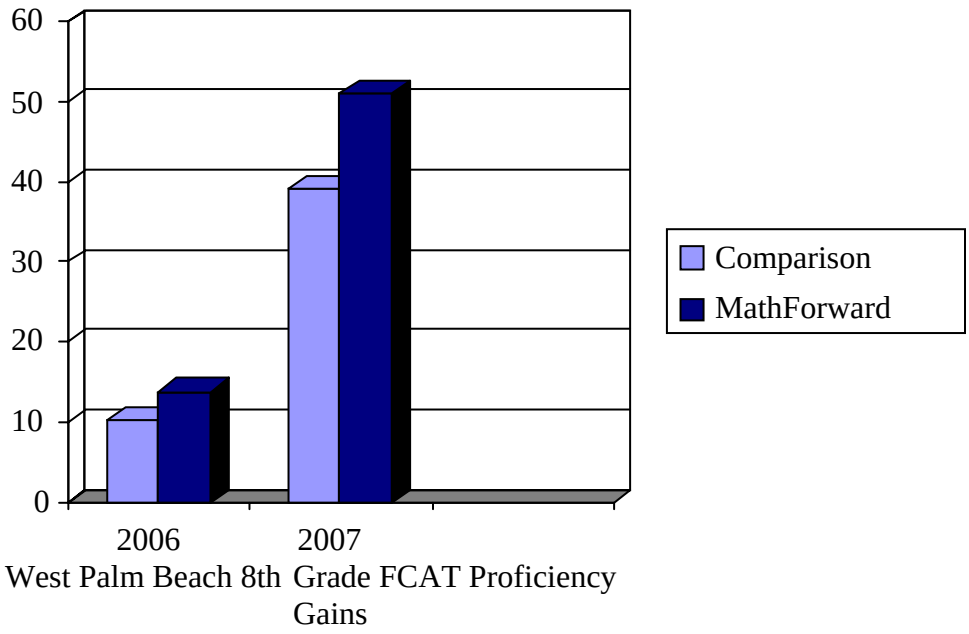
Percentage of Euclid City SD Students who were not Proficient on 2006 OAT who attain Proficiency on OAT 2007: MathForward versus Comparison Classes



This chart shows that the program had a substantial impact on pass rate, in comparison to non-MathForward students in the same schools. Overall, 2007 pass rate of students who were not proficient in 2006 and who were in MathForward was 45%, while the similar comparison group's 2007 pass rate was 29%. Supplemental analysis comparing score gains confirms this effect, and shows its statistical significance. Full details are in the attached report on Euclid.

West Palm Beach School District

In West Palm Beach, MathForward was piloted in the Palm Springs Middle School Grade 8 (pre-Algebra). All classes in the school used a double period (block) for math, so the only difference between MathForward and the control was in the interventions other than increased class time. Note also that in Florida the spring administration of the state test (FCAT) occurs in February, so these results show only the impact of a little more than one semester of MathForward (note also that last year's experience at RISD suggests anecdotally that for first-year teachers, most of the gains may occur in the second semester. However, this effect has not been formally analyzed.) Results are summarized in the graphic below:

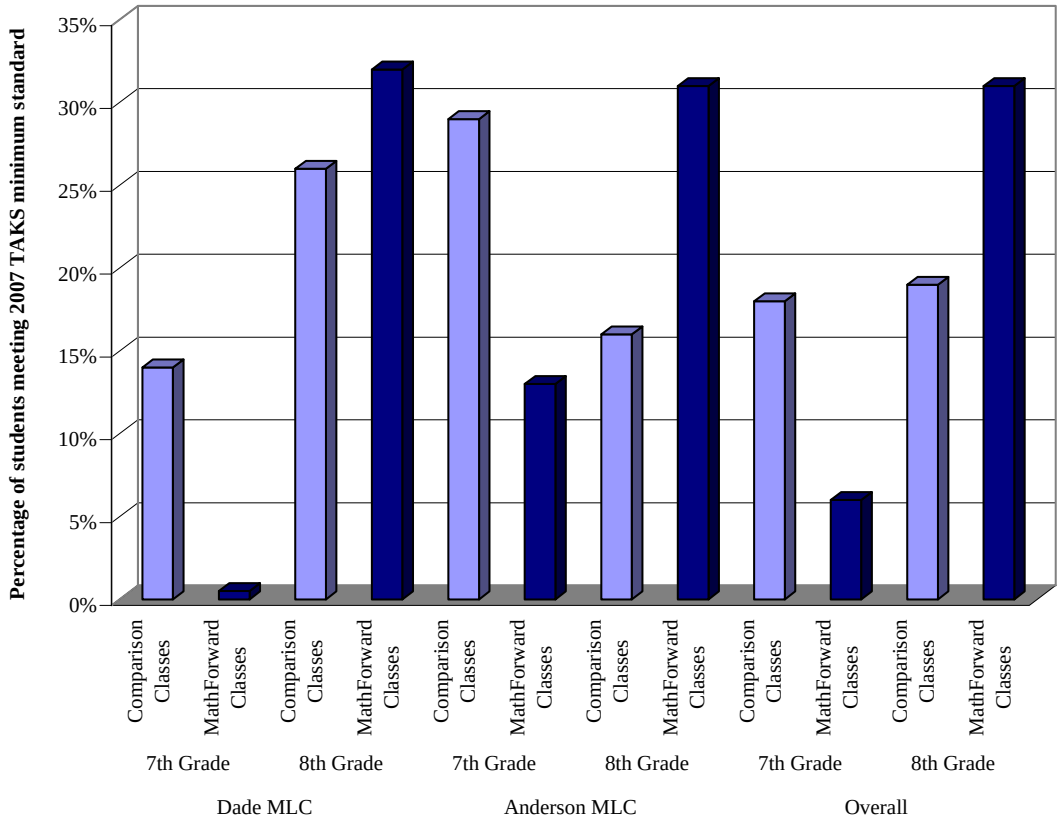


This analysis was performed by the school district itself, and did not follow the control group strategy our researchers used for the other districts. As all pre-algebra students were involved in the intervention at Palm Springs Middle School, for the control group here 469 demographically similar students enrolled in pre-algebra classes in other schools were selected district-wide. Consequently, the control group strategy used in other districts was not used here, and the chart shows non-zero 2006 scores. As shown above, 29% of this comparison group reached proficiency in 2007, while 37% of the MathForward students did so. According to the analysis reported (but not detailed) by the district, the MathForward gain was substantially and significantly larger than that of the comparison group. For all these reasons, the larger gains in proficiency shown by the MathForward students are even more remarkable.

Dallas ISD

The Dallas ISD pilot program was at two middle schools, for grades 7 and 8. Because the implementation was only partially successful, the pattern of negative and positive findings is particularly instructive. Consequently, we will discuss the results for the two schools separately, rather than combining them. The chart below shows the results.

Percentage of DISD Students who failed to meet 2006 TAKS Minimum Standard who met 2007 TAKS Minimum Standard: MathForward versus Comparison Classes



MathForward programs in 8th grade at both schools showed greater gains in pass rate than a comparison group drawn from within the schools, but not in 7th grade. This is easily explained: while both schools suffered from unusually major implementation issues, overall implementation fidelity was much higher at Anderson. Furthermore, Anderson recruited a teacher from the RISD MathForward program to teach in their school.

Thus, even the negative results in the DISD analysis are instructive. The poor results in a school with a poor implementation, contrasted with the much better results in a school with a somewhat stronger implementation and a teacher from the RISD MathForward program, reinforces our belief that the synergies of MathForward are the main contributor to the growth we have now observed across four school districts.

Fidelity of Implementation

While we did not directly observe the teachers inside their classes during the past year, we can take from their responses on the year-end survey of their own views of the intervention how well they might be implementing the intervention. The MathForward program is based on eight primary focal points for change:

- Expand to 100 minute Power-Block class format
- Techonology infusion centered on networked use of TI-Navigator and TI-73 graphing calculators
- Teachers use common aligned assessment strategies
- Implementation of an accelerated curriculum
- Hightened expectations for all students
- Increase Teacher Content Knowledge and Pedagogical Skill
- Increase Administrative and Parental Support of Mathematics Learning
- On-going Professional Development and Coaching

A set of questions that relate to each of these aspects was drawn from the larger teacher survey to form a measure of how fully the teachers were embracing the intervention's goals. Questions responses were scored on a five point likert scale, and responses within each aspect were averaged and then added together.

The teacher responses could then be linked to the average classroom performance for those cases where we can chart outcomes by teacher (primarily in the Richardson ISD). Charts 2 and 3 below show how the fidelity of implementation scores were associated with the percentage of a teacher's students meeting the minimum passing level (chart 2) and the average percentage correct on the TAKS for given teacher (chart 3). In both cases, the implementation scores were significantly positively related to the student performance outcomes.

Chart 2: Percentage of students meeting the minimum passing level by Fidelity Score:

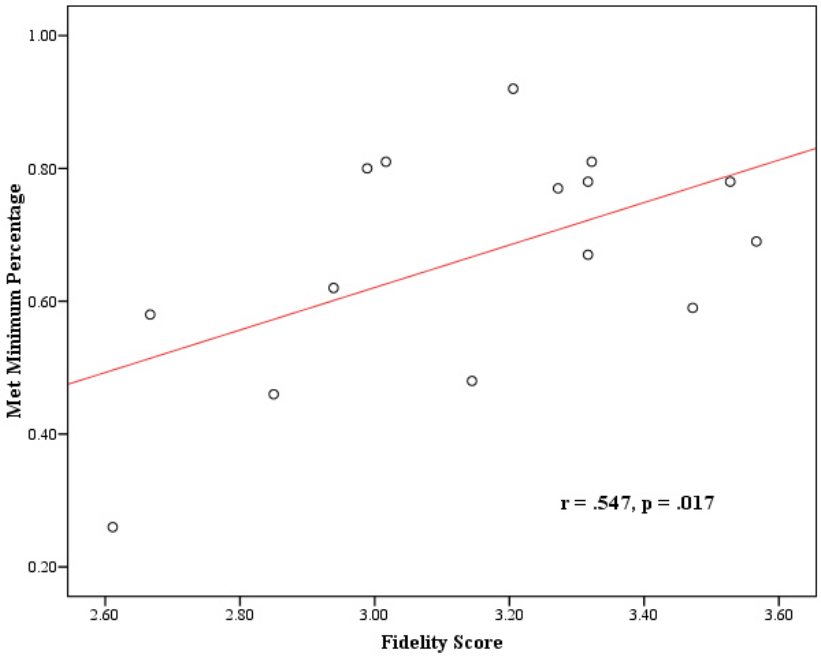
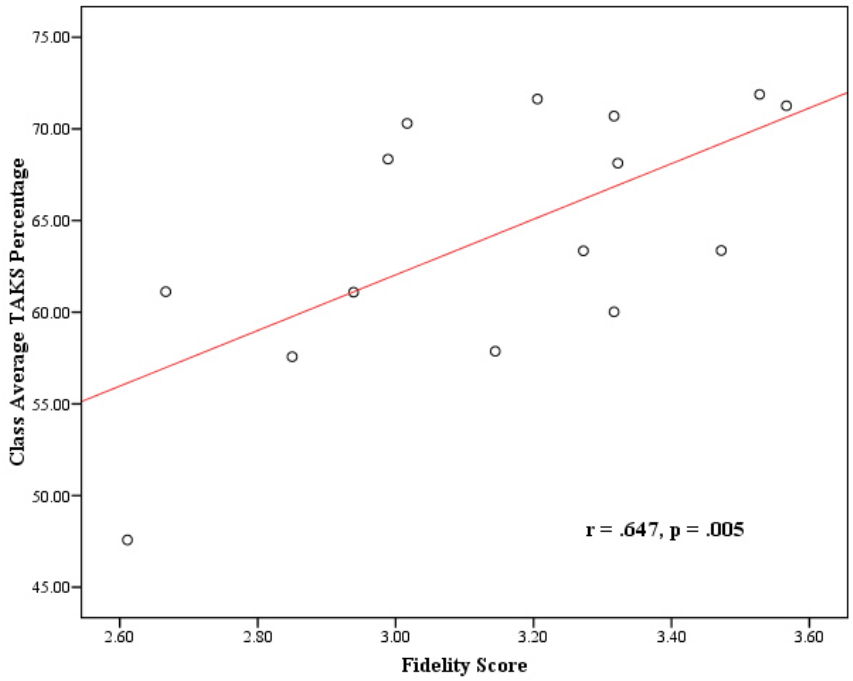


Chart 3: Average Correct TAKS Percentage by Fidelity Score:



Again, while the Fidelity measures are not based on direct observations of the teachers but instead come from their own perceptions and statements regarding the main aspects of the intervention, these scores seem quite useful in terms of how they might predict the students' mathematics performance. In addition, it seems likely that the effectiveness of the intervention follows from how well the teachers are able to enact the key aspects of the MathForward program.