HOUGHTON MIFFLIN HARCOURT

GO Math! EFFICACY STUDY YEAR ONE FINAL REPORT

Submitted by

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APPLIED RESEARCH & EVALUATION, INC.

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Executive Summary

Mathematics achievement in the United States is an ongoing concern. According to the National Center for Education Statistics (2011), 60% of fourth-grade students and 65% of eighth-grade students fall below the domestic proficiency level in math; only 47% of fourth-grade students and 30% of eighth-grade students reach a high level of proficiency according to TIMSS international benchmarks[1].

GO Math! Research Strands

Writing to Learn
Vocabulary
Scaffolding
Metacognition
Graphic Organizers

To better prepare students to thrive in the 21st century, 45 states, the District of Columbia, and 4 U.S. Territories have adopted the Common Core State Standards (CCSS). Houghton Mifflin Harcourt (HMH) developed the first Common Core-aligned mathematics program, *GO Math!*. This program also incorporates five major research strands identified by past evidence-based research to provide personalized and adaptive 21st-century instruction to ensure success.

GO Math! Efficacy Study Sites

- 7 States (Arizona, Idaho, Illinois, Michigan, Ohio, Pennsylvania, Utah)
- 79 teachers, 9 schools
- 1,363 students in Grades 1, 2, 3

Cobblestone Applied Research & Evaluation, Inc. conducted a two-year efficacy study of *GO Math!* during the 2012-2013 and 2013-14 school years. Teachers and their students were randomly assigned to either the treatment condition (using the *GO Math!*) or the control condition (using the mathematics program already in place at their school).

Implementation measures were collected to assess the extent to which teachers and students implemented their respective mathematics programs in their classrooms; **outcome measures** assessed the impact of mathematics curriculum on student achievement.

	Outcome Measures
Iowa Test of Basic Skills, Form E (ITBS)	Published norm-referenced instrument that aligned to the CCSS. Included two general mathematics assessment sections that addressed the areas of number sense and operations, geometry, measurement, and number sentences (first and second grade) and the areas of number sense and operations, algebraic patterns and connections, data analysis, probability, statistics, geometry, and measurement (third grade).
State Standardized Tests	Specific to each state. Schools provided scaled scores for mathematics for each participating student in third grade and second grade (when available).
	Implementation Measures
Online Teacher Logs	Completed by all participating teachers monthly to report the content covered and specific program components used in their classrooms.
Classroom Observations	Researchers observed treatment teachers and their students at all nine schools as well as control teachers and their students at seven schools.
Teacher Interviews /Focus Groups	Completed at the end of the year, teachers discussed implementation and satisfaction with *GO Math!*

[1] Provasnik, S., Kastberg, D., Ferraro, D., Lemanski, N., Roey, S., and Jenkins, F. (2012). Highlights From TIMSS 2011: Mathematics and Science Achievement of U.S. Fourth- and Eighth-Grade Students in an International Context (NCES 2013-009 Revised). National Center for Education Statistics, Institute of Education Sciences, U.S. Department of Education. Washington, DC.

Research Question 1: Are teachers using *GO Math!* implementing the curriculum according to the prescribed implementation guidelines?

***Answer: Fidelity levels varied among teachers in the study.* While a majority (62%) implemented the program with high fidelity according to the implementation guidelines and fidelity measures established for this study, the remaining 38% fell short of high-fidelity implementation, primarily involving pacing challenges exacerbated by additional school/district-mandated requirements.**

Implementation was measured via online logs, classroom observations, surveys, and focus groups. Treatment teachers covered a majority of the *GO Math!* program lessons and program components during the first year of the efficacy study. *GO Math!* teachers reported most frequently using H.O.T. Problems and the Engage portion of the lessons with their students. Additionally, nearly every teacher reported using Practice problems *Often* or *Always* and the Animated Math Model Videos *Sometimes*. During classroom observations, the research team most often observed teachers using the consumable student books and ThinkCentral to display the eStudent Edition. Teachers also frequently used the Math Boards. The use of online program components were not implemented as consistently as print versions and largely depended on technology available at teachers' schools.

The breadth of program implementation was calculated for each treatment teacher in two ways– overall program coverage and coverage of lessons only. Overall program coverage included every planning component, lesson, mid-chapter checkpoint, chapter review/test, and chapter test for each chapter. Lesson-only coverage only included each lesson for each chapter. Adherence to implementation guidelines was considered acceptable during the first year of implementation such that on average, teachers across grades implemented approximately 70% of all available lessons and 60% of the total program. We categorized lesson and total program coverage into three levels: low = 50% or fewer lessons/ total program covered; medium = 51 – 70% of lessons/total program covered; and high = 71% or more of lessons/total program covered. Most teachers were considered to have either a high level lesson implementation (n = 26) or a medium level of lesson implementation (n = 11). On the other hand, there were teachers who exhibited a low level of lesson coverage (n =5), and most of these teachers taught third grade.

Average *GO Math!* Lesson Coverage	**Average *GO Math!* Program Coverage**
First grade: 74% of *GO Math!* lessons	***First grade:*** 63% of total *GO Math!* program
Second grade: 79% of *GO Math!* lessons	***Second grade:*** 64% of total *GO Math!* program
Third grade: 67% of *GO Math!* lessons	***Third grade***: 55% of total *GO Math!* program

Research Question 2: How does student math achievement differ between treatment and control/comparison students?

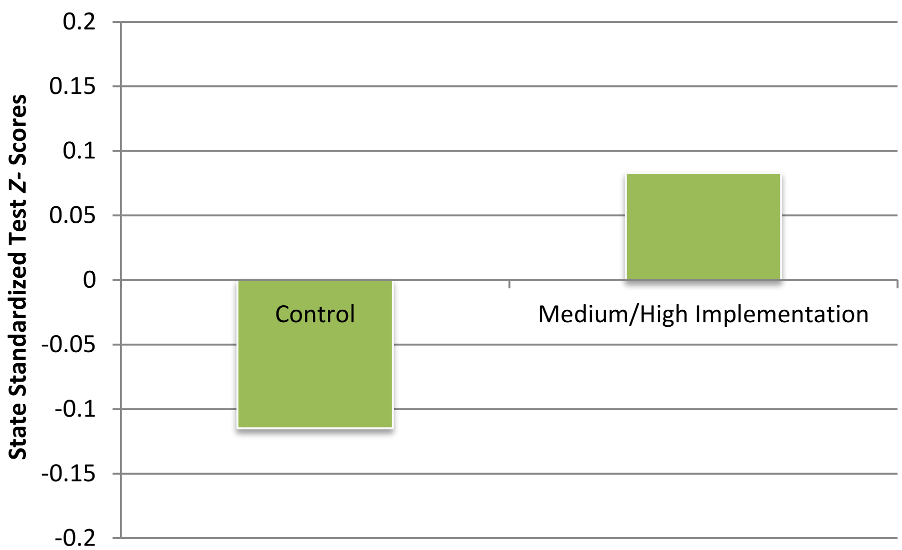
Answer: Student performance was similar overall, but higher for Go Math! students vs. control in cases of moderate-to-high implementation fidelity. The HLM statistical model was used to analyze student data because students were nested within different classrooms, and common student/ teacher characteristics and experiences were expected to influence students' mathematical outcomes. The results are reported after controlling for all student and teacher characteristics. Scaled scores from the Iowa Test of Basic Skills Form E (ITBS) and z-scores from state standardized tests were used to compare groups.

Overall, results from the HLM analysis suggest that students that used the *GO Math!* program performed equally compared to the control group students after controlling for student and teacher characteristics on the ITBS (p = .78; effect size was g = .014) and state standardized tests (p=.12, effect size g = .06). **However when the *Go Math!* sample only included students of teachers who implemented the program with Medium or High fidelity, students who used the *Go Math!* program outperformed control students on state standardized tests, p =.034; effect size was g =.236.**

Research Question 2: How does student math achievement differ between treatment and control/comparison students (continued)?

To further explore these findings, **Figure *i*** illustrates the average standardized test z-score for control students and students of teachers who demonstrated medium/high implementation. As can be seen in **Figure *i*,** after controlling for student and teacher characteristics, students of teachers who implemented the program with medium/high fidelity scored higher on state standardized test scores than control students. **These results suggests that *GO Math!* may positively affect students' math performance, especially when teachers implement the program as intended.**

Figure *i*: State Standardized Test *Z*-scores of Control Students and Students of Teachers who Implemented the *Go Math!* Program with Medium/High Fidelity (n=439)



Note: State standardized test scores are standardized (*Z*-scores) so that a value of "0" represents the overall student average.

Research Question 3: How do students with different characteristics (e.g., English language learners, gender, grade level) perform on mathematics outcome measures when compared to each other?

Answer: Demographic characteristics were associated with performance. Student and teacher characteristics influenced students' performance on both the ITBS at posttest and the state standardized test scores (*z*-scores). The following covariates were significantly associated with students' ITBS scaled scores and state standardized test *z*-scores: ITBS pretest score; Grade level; English language learner; Free or reduced lunch; Ethnicity; Special Education; Math attitudes; Classroom management; Student engagement.

Research Question 4: How do students using *GO Math!* compare from pretest to posttest on mathematics outcome measures?

Answer: Students using the GO Math! program showed a significant increase from pretest to posttest on the ITBS outcome measure $F(1,728) = 63.6$, $p < .001$. The difference between pretest and posttest was 21 scaled score points. This difference is equal to a gain of 1.2 (one year and two months) on the grade equivalence scale. Each grade level also had significant gains from pretest to posttest when analyzed individually.

***GO Math!* Students Pretest and Posttest Achievement Scores**

	Pretest Mean	Posttest Mean	Difference	*F*	*df*
Grade 1	131.54	151.29	19.75	34.00***	1, 222
Grade 2	150.58	171.75	21.17	16.16***	1, 237
Grade 3	168.44	190.83	22.39	15.90***	1, 253
Overall	**150.96**	**172.12**	**21.16**	**63.59*** **	**1, 728**

*** $p < .001$

Product Satisfaction

- Treatment teachers consistently rated *GO Math!* higher on all aspects (e.g., student edition textbook, alignment to CCSS, teaching on-grade-level students) compared to control teachers' ratings of the same program elements of their control program ($F(1, 45) = 38.50$, $p<.001$).
- Overall, treatment teachers were satisfied with *GO Math!* In particular, teachers liked the separate **teacher edition books** for each chapter, and that the **student worktexts** were consumable.
- Teachers found the pedagogical element of **H.O.T. Problems** to work best in their classrooms.
- Most teachers reported that *GO Math!* pedagogy and curriculum were excellent for on-grade-level students; however, the program did not entirely meet the needs of below-grade level or more advanced students.
- The majority of teachers (26 of 28) indicated via surveys that they were Satisfied or Very Satisfied with adherence to CCSS in *GO Math!*
- Teachers found it difficult to follow implementation timelines due to an ambitious program pacing guide combined with additional requirements at their school or district level.

> *"I love [GO Math!] – best in my 17 years of teaching."*
>
> *-- GO Math!* teacher

- Teachers also reported that some students' parents had trouble understanding the curriculum pedagogy and were not always able to help their children with homework.
- Students indicated via surveys that they were overall very happy with the program and they most liked the **Animated Math Model videos**.

Year One Study Conclusions

While results indicate that students using *GO Math!* performed comparably to students using control programs, those in classes with relatively medium or high implementation were associated with more positive student outcomes on state standardized tests, illuminating the potential for *GO Math!* to have a positive impact on student scores when the program is used as intended. Teachers using *GO Math!* rated the program significantly better than comparison programs. The Year One study results highlight the current changes in the rollout of CCSS, as many study teachers (treatment and control) implemented CCSS in their classrooms for the first time during the study. Additional changes in Year Two will require treatment teachers to document coverage of CCSS directly. Most study teachers from Year One will remain in the study during Year Two, and research questions will focus on longer-term effects of using the program for both teacher implementation and student outcomes.

Section One: Efficacy Study Background, Study Purpose, and Program Description

Mathematics achievement in the United States is an ongoing concern. According to the National Center for Education Statistics (2011), 60% of fourth-grade students and 65% of eighth-grade students fall below the domestic proficiency level in math. Among those struggling most are students who qualify for free or reduced price school lunches (proxy measure for low socioeconomic status), those who were identified as English language learners, and students with disabilities. Though some improvement has been reported over the past two decades, the U.S. is significantly behind the leading industrialized countries such as Singapore, Korea, and Japan. As of 2011, only 47% of fourth-grade students and 30% of eighth-grade students reach a high level of proficiency according to The International Math and Science Study (TIMSS) international benchmarks (Provasnik, Kastberg, Ferraro, Lemanski, Roey, & Jenkins, 2012).

Research shows that math achievement is the strongest predictor of college success (Sciarra & Seirup, 2008). In addition, the importance of mathematical ability is particularly evident in the skills that employers rate as essential for employees. According to a report on the knowledge and skills necessary for the 21st century (Casner-Lotto & Barrington, 2006), more than half of major employers (54%) rate new hires with high school diplomas as deficient in mathematics, and 70% rate these employees as deficient in critical thinking and problem solving abilities. In fact, due to these deficiencies in basic and applied skills, nearly one third of major employers anticipate hiring more new employees with two- and four-year college degrees and reducing the number of high school graduates they accept.

Given the importance of mathematics education, educators and policy makers have focused their efforts on improving mathematics curriculum, instruction, and achievement (National Mathematics Advisory Panel, 2008). Research suggests that mathematics competency depends on students' ability to acquire fundamental types of knowledge: conceptual understanding and procedural fluency (Rittle-Johnson, Siegler, & Alibali, 2001). Specifically, it was found that these types of knowledge develop in an iterative manner; that is, increasing one type of knowledge led to growth in the other, which then triggers further gains in the first. In addition to curriculum content, teaching approach has been found to affect students' academic outcomes. Specifically, research has found that instruction should combine both student-centered and teacher-centered approaches to mathematics to improve students' understanding of math (National Mathematics Advisory Panel, 2008).

To better prepare students to thrive in daily life and compete both domestically and in the global market, 45 states, the District of Columbia, and 4 U.S. territories have adopted the Common Core State Standards (CCSS) (Common Core State Standards Initiative, 2013). These new standards emphasize procedural and conceptual knowledge, preparing K-12 students for progressively more complex mathematical reasoning (National Governors Association Center for Best Practices, Council of Chief State School Officers, 2013).

Houghton Mifflin Harcourt (HMH) utilized past evidence-based research to identify and establish five major research strands that were incorporated into the *GO Math!* program: *Writing to Learn*, *Vocabulary*, *Scaffolding*, *Metacognition*, and *Graphic Organizers* (see below for descriptions of how each of the strands were incorporated into the program). The five major research strands served as the foundation for the development of the HMH *GO Math! Student Edition*. A detailed summary of findings and research that informed this project can be retrieved online at the HMH website[2].

The first strand, *Writing to Learn*, was developed on the basis of past research involving writing to elaborate on executive processes of problem-solving and writing about problem-solving in general. Research has shown that writing about mathematical problem-solving can enhance problem-solving performance and overall conceptual understanding (Putnam, 2003; Williams, 2003); provide an additional source of communication (Baxter, Woodward, & Olsen, 2005); allow for reflection of learning (Burns, 2004); aid in learning mathematics (Russek, 1998); and reduce math anxiety (Furner & Duffy, 2002; Russek, 1998; Taylor & MacDonald, 2007).

The second strand, *Vocabulary*, was supported by evidence looking at vocabulary to communicate mathematically (Martinez & Martinez, 2001; Rubenstein & Thompson, 2002, & Thompson & Rubenstein, 2000); increase mathematics achievement (Earp, 1970; Marzano,

[2]http://www.hmhco.com/shop/educationcurriculum/math/elementary-mathematics/go-math/resources

2004; Stahl & Fairbanks, 1986); and connect concepts and terminology (Renne, 2004; Thompson & Rubenstein, 2000; Usiskin, 1996).

Scaffolding, the third identified research strand, was based on past research of scaffolding to deepen conceptual understanding in mathematics (Baker, Schirner, & Hoffman, 2006; Barton & Heidema, 2002; Williams, 2008); meet the needs of individual students (Barton & Heidema, 2002; Kirpatrick et al., 2001); and build student confidence and independence (Angileri, 2006; Hyde, 2006; Williams, 2008).

The fourth strand, *Metacognition*, was identified as a major strand by previous research on metacognition as a means to build mathematical problem-solving (Reys, Suydam, Lindquist, & Smith, 1998; Roberts & Tayeh, 2006); improve mathematic performance (Lucangeli, Corndoli, and Tellarini, 1998; NCTM, 2000; Pogrow, 1999); and improve student attitude towards mathematics (Campione, Brown, & Connell,1998; Maqsud, 1998; Muin, Sumarmo, & Sabandar, 2006).

The final strand, *Graphic Organizers*, was chosen because of extensive research on using graphic organizers to sort information (Braselton & Decker, 1994; Monroe & Pendergrass, 1997; Reys, Suydam, Lindquist, & Smith, 1998); support various student learning styles (Hyerle, 1996; Shores & Chester, 2009); and connect concepts and ideas (Barton & Heidema, 2002; NCTM, 1990; Shores & Chester, 2009).

Overall, *GO Math!* blends student-centered and teacher-directed approaches to a mathematics education aligned with the CCSS. The curriculum aims to enhance achievement in mathematics by improving the student's understanding, achievement levels, and test scores. *GO Math!* is designed to support both students and teachers while they advance throughout the year with abstract and concrete material. The program is supplemented with technology to promote a hands-on, comprehensive, and personalized experience.

Efficacy Study Background

Previous research has been conducted on the *GO Math!* program to determine student performance for those using the program in comparison to other, similar mathematics programs. HMH contracted with the Educational Research Institute of America (ERIA) to conduct experimental and quasi-experimental studies to identify if *GO Math!* enhanced achievement in mathematics by improving the student's understanding, achievement levels, and test scores. These studies were designed to investigate the effectiveness of concept development and vocabulary development components, strategic intervention and intensive intervention materials, and the overall instructional effectiveness of the program. The following is a summary of findings from three separate studies, as referenced by HMH:

- Researchers conducted a pretest/posttest experimental study to test the effectiveness of enhancing content understanding and content-specific vocabulary in all third grade students regardless of special services need, English proficiency, socio-economic status, or minority identification. Results showed a statistically significant difference for all *GO Math!* students compared to students using the standard curriculum across all variables individually and grouped.
- A quasi-experimental study with a control group pretest/posttest design assessed the effectiveness of the strategic intervention and intensive intervention materials. Results indicate that the posttest scores for the first and fourth grade experimental groups were significantly higher than the posttest scores of the students in the control groups.
- Another quasi-experimental study with a control group pretest/posttest design investigated whether the intensive intervention kit was applicable to the Response to Intervention (RTI) framework to identify students with learning disabilities. Results indicate that posttest scores for the second and fifth grade experimental groups were significantly higher than the posttest scores of the students in the control groups, regardless of low or high pretest scores.

In addition to external efficacy studies, HMH conducted a series of *GO Math!* studies focused solely on third, fourth, and fifth grade students in various schools and districts from Kentucky, Massachusetts, and Alabama. The period of testing was from 2010-2011 with baseline testing in 2010.

- <u>Kentucky:</u> In the Whitley School District (WSD) and the Kimper Public School District (KPSD) students had increased levels of identified as proficient or distinguished by 3% in the WSD and 9% in KPSD as measured by the Kentucky Core Content Test.
- <u>Massachusetts:</u> In Arthur T. Cumming Elementary school, the Massachusetts Comprehensive Assessment (MCAS) was used to identify whether students were identified as proficient or distinguished in mathematics. Results showed that students had increased levels of being considered proficient or distinguished by 6%.

- Alabama: In Speake Public School the Alabama's Reading and Mathematics Test (AMRT) was used to identify whether students were meeting or exceeding the state identified mathematics standards. Across all three grades, the percentage of students being identified as either meeting or exceeding state standards increased over 7%.

GO Math! Efficacy Study Purpose

Cobblestone Applied Research and Evaluation, Inc. (herein referred to as *Cobblestone*) conducted the current study to investigate the effects of the *GO Math!* curriculum on lower elementary grade (Grades 1, 2 and 3) students' mathematics achievement using a two-level cluster Randomized Controlled Trial (RCT). This report includes results for Year One of the two year study. This efficacy study was conducted at nine school sites across seven states (i.e., Arizona, Idaho, Illinois, Michigan, Ohio, Pennsylvania, and Utah) during the 2012-2013 school year. Most of these sites[3] will continue to participate in the study during Year Two.

During the study, teachers' implementation of the *GO Math!* curriculum and student outcomes were explored. These data provide insight into how the *GO Math!* curriculum may affect students' achievement in mathematics during grades 1-3. The current study focused on systematically tracking curriculum implementation, measuring students' achievement in mathematics, and product satisfaction of the *GO Math!* program. The main purpose for conducting the efficacy study was to answer the following research questions:

- **Research Question 1:** Are teachers using *GO Math!* implementing the curriculum according to the prescribed implementation guidelines?
- **Research Question 2:** How does student math achievement differ between those students using control curriculum with traditional textbooks and students using the consumable worktexts in the *GO Math!* program?
- **Research Question 3:** How do students with different characteristics (e.g., English language learners, gender, grade level) perform on mathematics outcome measures when compared to each other?
- **Research Question 4:** How do students using *GO Math!* compare from pretest to posttest on mathematics outcome measures?

[3] Two school sites from the same district purchased the *GO Math!* curriculum for all teachers in all grades at the conclusion of the Year One of the study. The decision to purchase the program district-wide was made after internal testing data revealed that students in *GO Math!* classrooms outperformed the non-*GO Math!* students on progress monitoring assessments. Consequently, the control group at these two school sites was effectively removed from the study at the end of Year One. For Year Two of the efficacy study, we will include only those Year One treatment teachers at these schools to determine longer-term success of the program.

- **Research Question 5:** How satisfied are students and teachers with various program components, specifically the consumable student worktexts?

In addition to the five key research questions, two additional questions will be addressed at the conclusion of the two-year study. These additional research questions are the following:

- **Research Question 6:** How does using *GO Math!* for multiple years impact student mathematics achievement?
- **Research Question 7:** Do teachers improve in teaching *GO Math!* content over time as reflected in student scores on mathematics outcome measures?

Program Description

GO Math! is the first research-based K-6 curriculum written to align with CCSS. *GO Math!* program components include: Teacher Edition and Planning Guide Collections, write-in Student Edition books, access to digital resources, and various other ancillary materials. There are five major research strands that inform the program. The five strands are:

1) **Writing to Learn:** Research shows writing can help students process new information, connect this new information to prior knowledge/experience, and make sense of complicated ideas. *GO Math!* provides students with multiple opportunities to put ideas on paper and reflect on processes used in problem solving which can help students work through complex ideas and ultimately contribute to academic success. Specifically, *GO Math!* asks students to explain approaches to solving problems, reflect on information use, and draw pictures or diagrams to support problem-solving.
2) **Vocabulary**: Development of both students' and teachers' math vocabulary is addressed through the design of the *GO Math!* curriculum. Research demonstrates that knowledge of mathematics vocabulary directly affects mathematics achievement. Students are taught vocabulary to communicate mathematically as well as connect terminology to concepts. Students may use the consumable workbooks to connect vocabulary to concepts as well as write notes regarding new words in places that make sense to them. The program requires students to explain meanings of words and how they are used and practice vocabulary that is related to the mathematical concepts.
3) **Scaffolding:** Through scaffolding, students receive support as they learn. This support gradually decreases until students can complete tasks independently. Scaffolding

includes, but is not limited to, retrieving prior knowledge, questioning, modeling, or using cues or tools. Scaffolding has been shown to deepen mathematical understanding and allows individual student needs to be met (Walker, 2008; Williams, 2008). Scaffolds are built into *GO Math!* through providing students opportunities to: build meaningful learning experiences; review and reflect on previous concepts before continuing; solve problems in a graduated way; and model or show what they can do.

4) **Metacognition:** Metacognition, also defined as thinking about thinking or knowing "what we know" and "what we don't know" and how one uses that information (Dirkes, 1985; National Research Council, 2001), is integrated into the *GO Math!* program in multiple ways. Studies demonstrate that use of metacognitive strategies (e.g., connecting new information to that which was previously learned, planning, monitoring, and evaluating thinking processes, and selecting thinking strategies purposefully) increase learning. The *GO Math!* curriculum integrates metacognition by asking students to plan how to solve problems; monitoring success by periodic assessment and trying multiple ways of solving problems; and reflecting in a visual or written format.
5) **Graphic Organizers:** Graphic organizers, also known as visual representations, come in many forms and have been shown to be effective in helping students organize and remember content area information. They can also teach students how to represent problems in an illustrative format and require students to slow down and think through each problem. Graphic organizers in *GO Math!* are used so students can engage in powerful thinking, reflect on problems visually, show relationships among information, and extend understanding of important concepts.

We hypothesized that students using *GO Math!* would have improved understanding of math, achievement in math class, and higher test scores. We expected students to experience these gains because the curriculum would lead to improved information processing and ability to discuss math along with increased confidence and independence, use of metacognitive strategies, and effective use of graphic organizers. Testing this required that assessments be administered that measured students' math comprehension as well as examining students' state testing data. Furthermore, the success of *GO Math!* depends on the extent to which the curriculum was implemented as intended.

Section One Summary

The first year of a two-year efficacy study of the *GO Math!* program was conducted during the 2012-2013 school year to evaluate the effects of *GO Math!* curriculum on elementary students' mathematics achievement. The study will be continued at the school sites for the 2013-14 school year. Because two participating study sites purchased the *GO Math!* curriculum for all students in their district, only treatment teachers from Year One will continue in the program during Year Two; all other participating sites will continue during the second year of the study. The *GO Math!* program includes numerous components designed to increase students' mathematics comprehension including Writing to Learn; Vocabulary; Scaffolding; Metacognition; and Graphic Organizers. The study was designed to assess implementation of the curriculum in classrooms, answer research questions related to student achievement, and to assess product satisfaction of the participating teachers and students.

Section Two: Study Design, Setting, and Sample

Study Design

The *GO Math!* efficacy study was designed as a two-year Randomized Controlled Trial (RCT) in which teachers (and their corresponding classes) were randomly assigned to either the treatment group, using the *GO Math!* program, or a control group (using the existing mathematics curriculum at their schools). Specifically, we randomly assigned teachers at each school, blocked by grade level, in approximately equal numbers of treatment and control. However, where there were three teachers per grade level we randomly assigned two to the treatment group and one to the control group which resulted in a greater number of treatment teachers participating in the study. Teachers and their students used their respective mathematics programs for the duration of the 2012-13 school year. To the extent that it is possible, teachers who utilized the *GO Math!* curriculum during the 2012-13 school year will continue to utilize *GO Math!* with their students during the 2013-14 school year. Additionally, as much as possible, students who were in a first or second grade treatment classroom during this first year of the study will be placed with a second or third grade treatment classroom during the second year of the study as well. A new group of first grade students will be included in the year two study. A pre/posttest experimental design (specifically an RCT) was selected, as this design is well-regarded as the strongest in terms of internal validity (appropriately assigning cause to a particular treatment) while having the highest probability of ruling out alternative explanations of cause (Shadish, Cook, & Campbell, 2002).

Site Selection

Cobblestone actively recruited sites to participate in the study during spring and summer of 2012. Initially, *HMH* provided references of interested schools and districts to *Cobblestone* researchers. In addition, *Cobblestone* researchers identified potential sites throughout the United States by selecting specific criteria from districts listed in the National Center for Education Statistics[4,5]. More than 6,000 school districts and individual school

[4] http://nces.ed.gov/ccd/schoolsearch
[5] http://nces.ed.gov/ccd/districtsearch/

principals were contacted through phone and email. Recruitment was focused on schools with at least 300 enrolled students and a minimum of two teachers per grade level at each school site. Most schools solicited for participation did not respond to the recruitment emails sent to school principals and a majority of districts that had the most diverse group of students declined to participate in the study. Most schools that decided against participating did so specifically because they did not approve of teachers being randomly assigned to the study groups or because they could not commit to the two full years of the study duration.

Of the schools (and/or districts) that met the inclusion criteria, securing participation occurred through initial contact with district superintendents, district curriculum directors, or school principals. Schools were required to complete applications to participate in the study. All participating teachers, site liaisons, district personnel, and *Cobblestone* researchers signed a Memorandum of Understanding to formally secure each school's participation. At most participating schools, a passive parent consent form was distributed as part of the study procedures to allow parents to opt their student out of the study. One school district required the participating school to distribute active parent consent forms to secure students' participation. Students were also provided with an assent form for the same purpose. Through *Cobblestone's* recruiting efforts, the final sample included nine schools across seven states.

Site Demographic Characteristics

All participating sites were located in rural or suburban areas, serving approximately 300 – 1,000 students in grades PreK - 9. The student body of all of the schools (Sites 1 – 9) primarily consisted of students of European descent (Caucasian) but Site 3 was the most ethnically diverse school site (Caucasian = 38%, Hispanic/Latino = 19%, and African-American = 27%). In participating schools, between 25% and 99% of students were eligible to receive free or reduced lunch. Furthermore, participating schools were located in communities with median annual household incomes ranging from $29,000 – $78,000, and varying percentages of residents 25 and older with a college degree (8% – 33%). Sites 6 and 7, from Illinois, are from the same district. **Table 1** provides school-level information about each Site; **Table 2** provides specific demographic information for our participating sample.

Table 1. School Level Demographic Characteristics for Participating Sites

State		AZ	OH		PA	MI	IL		ID	UT
School Site		Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9
Location*		Rural	Suburban	Suburban	Suburban	Suburban	Suburban	Suburban	Rural	Rural
School Size*		529	334	497	395	521	496	490	402	1,019
Ethnicity*	Caucasian	44%	84%	38%	59%	89%	72%	83%	62%	92%
	Hispanic Latino	43%	2%	19%	0%	6%	18%	12%	36%	4%
	African American	8%	6%	27%	34%	1%	1%	1%	0%	2%
	Asian/Pacific Islander	1%	1%	0%	0%	1%	5%	3%	0%	1%
	Two or More Races	4%	1%	16%	7%	3%	4%	1%	2%	1%
Economic Measure*	Free & Reduced Lunch	43%	53%	99%	59%	34%	27%	24%	62%	25%
Community Measure*	Age 25+ With College Degree	8%	17%	10%	15%	24%	16%	16%	10%	33%
	Median Household Income	$37,385	$41,971	$29,630	$43,566	$38,242	$51,162	$51,162	$30,971	$78,704

* Information obtained from www.nces.ed.gov/ccd/schoolsearch; **US Census 2010 or City-data.com (2009).

Table 2. Demographic Characteristics of Student Participants

State		AZ	OH		PA	MI	IL		ID	UT	Average
School Site		Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	
Gender	Male	49%	47%	59%	51%	53%	61%	53%	53%	54%	**53%**
	Female	51%	53%	41%	49%	47%	39%	47%	47%	46%	**47%**
Ethnicity	Asian	3%	2%	1%	1%	2%	9%	5%	1%	2%	**3%**
	African American	5%	4%	33%	25%	2%	2%	0%	2%	2%	**8%**
	Latino/Hispanic	38%	7%	19%	0%	6%	14%	7%	35%	2%	**16%**
	Caucasian	46%	78%	34%	69%	88%	76%	87%	62%	93%	**70%**
	Nat. Haw/Pac Islander	8%	0%	0%	0%	0%	0%	0%	0%	1%	**2%**
	Other Ethnicity	0%	9%	14%	5%	2%	0%	1%	1%	0%	**3%**
English Language Learner Status	ELL	14%	0%	0%	0%	5%	12%	19%	25%	1%	**9%**
	Not ELL	86%	100%	100%	100%	95%	88%	81%	75%	99%	**91%**
Socio-Economic Status	Not eligible Free/Reduced lunch	32%	41%	20%	53%	63%	74%	82%	29%	100%	**57%**
	Free/ Reduced lunch	68%	59%	80%	47%	37%	26%	18%	71%	0%	**43%**

Student Participants

There were a total of 1,363 students who participated in the study including 754 treatment group students and 609 control group students. Students were defined as participating if they completed both a pretest and posttest ITBS assessment. There were 76 separate clusters of students across 79 teachers (three classrooms had two teachers team-teach for the school year, but were counted as one cluster). **Table 2** summarizes the demographic characteristics of participating students, including gender, English language learner status, socio-economic status, and ethnicity. These demographic characteristics were obtained directly from the schools. There were slightly higher percentages of male students at most sites. Students were primarily of Caucasian descent and were not classified as English language learners.

Teacher Participants

There were a total of 79 teachers who participated in the study, 45 treatment teachers who implemented the *GO Math!* program and 34 control teachers who implemented an alternative mathematics curriculum. Teachers' education levels ranged from attainment of a Bachelor's degree to acquisition of a Doctoral degree. Overall, more than half of participating teachers obtained at a Master's degree. On average, teachers had approximately 12 years of teaching experience. This mean was approximately equal to the number of years teaching mathematics. **Table 3** summarizes the teacher characteristics. A slightly higher percentage of control teachers had Master's degrees compared to treatment teachers; however, treatment teachers had taught for more years, on average.

Table 3. Summary of Teacher Characteristics

	Highest Degree Attained			**Teaching Experience**	
	Bachelor of Arts/ Science	Master of Arts Science	Doctoral	Number of years teaching (average)	Number of years teaching math (average)
Treatment	20 (46%)	23 (52%)	1 (2%)	9.4	8.9
Control	14 (42%)	19 (58%)	--	13.8	13.8
Overall*	34 (44%)	42 (55%)	1 (1%)	11.9	11.6

***** Data were unavailable for two teachers; numbers do not add to total

Section Two Summary

Seventy-nine teachers across nine schools in seven states (Arizona, Ohio, Pennsylvania, Michigan, Illinois, Idaho, and Utah) from a combination of suburban and rural areas taught using either the *GO Math!* program (treatment) or their existing mathematics program (control) in their classrooms during this efficacy study. Data were analyzed for 1,363 participating students. The study sample was primarily Caucasian, non-ELL students. Teachers taught for 12 years, on average, and more than half (55%) possessed a Master's level degree. Treatment and control teachers were fairly comparable; however, control teachers had a higher education level on average, while treatment teachers had more teaching experience on average.

Section Three: Description of Study Procedures and Measures

Teacher Compensation

All teachers received a $250 *HMH* product voucher upon completion of the first year of the study. Teachers will receive another $250 *HMH* product voucher upon completing the second year of the study. In addition, all schools were provided with the *GO Math!* program (i.e., teacher and student textbooks, online resources, ancillary materials). Each participating school received enough materials for the students and teachers in the treatment group prior to the start of the 2012-2013 school year. Consumable student materials for students of treatment teachers were replaced between the first and second years of the study. The balance of materials (equal to the total number of participating teachers and students) will be delivered at the end of the study. Treatment teachers were also provided with program overview training prior to the beginning of the school year and a follow-up training approximately six weeks after the school year began.

Study Activities

Treatment teachers and their students used the *GO Math!* program over the course of the 2012-13 school year and will continue to use the *GO Math!* program during the 2013-14 school year. Though school calendars varied in their start and end dates, the sequence of study activities was similar across sites. A detailed description of teacher training is documented in more detail in **Appendix A**; a summary of study activities and corresponding timelines can be found in **Table 4**.

Table 4. Schedule of Study Activities

						2012								2013			
	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J
Site Recruitment & Study Setup	◆	—	—	—	—	◆											
Study Orientation & Follow Up Training			◆	—	—	—	◆					◆	◆				
Student Pretesting						◆	◆										
Use of *GO Math!* Program						◆	—	—	—	—	—	—	—	—	◆		
Classroom Observations & Interviews							◆	—	◆				◆	—	◆		
Student Post-testing															◆	◆	

Data Collection Measures: Curriculum Implementation

Implementation measures were developed to monitor and assess the activities in participating classrooms throughout the year. Implementation measures included monthly teacher logs, classroom observations, and teacher interviews/focus groups. Teachers also communicated informally with the researchers via email, phone, and open-ended sections of the teacher logs. Treatment teachers were continuously encouraged to provide feedback about the *GO Math!* program throughout the study. All treatment teachers participated in focus groups or interviews in the spring. For teachers who were not observed in the spring, individual interviews or focus groups were conducted via phone.

Teacher Implementation Logs

Each month, teachers were required to submit online logs that tracked activities used in their classroom including the curricular content covered, as well as which components of the curriculum package were used (e.g., the website, the manipulatives kit). Logs also provided a place for feedback regarding any problems or issues with the study, materials, or other relevant communication. Separate logs were created for each grade level in the study and for control and treatment teachers. Treatment teachers reported on their usage of the *GO Math!* program while the control teachers primarily reported on their coverage of the CCSS in addition to their coverage of their control textbooks. CCSS were used to provide a comparison between the *GO Math!* program and the control programs of the content covered given that there were several different control programs used in the study.

The logs were developed using an online survey creation website (www.surveygizmo.com) and were provided to teachers via an email link every month that directed them to the appropriate log. In addition, the online log process allowed researchers to remain in constant communication with participating teachers so that issues such as dates for training, observations, and test administration could be planned effectively.

Classroom Observations

To validate and supplement the information obtained from the teacher implementation logs, *Cobblestone* researchers conducted classroom observations lasting the entire class period for treatment teachers at all study sites. Teachers also provided informal feedback directly before or after observation sessions. Treatment classrooms were visited in fall 2012 and spring 2013. Control classrooms at six study sites were also observed.

An observation protocol was created to guide researchers in data collection and establish consistency of observations across sites. Researchers used this protocol to observe and collect information related to areas such as the structure of the lesson (e.g., the entire class engaged in the same activities at the same time), program materials used in the lesson, potential behavior issues, time management, and the extent to which the *GO Math!* core lesson structures were evident, including an assessment of pedagogical elements.

Teacher Interviews

A teacher interview protocol was developed for all participating treatment teachers. In spring 2013, all teachers were interviewed by phone or in person by a member of the research team using the established protocol. Individual interviews or focus groups lasted approximately 40 minutes. The teacher interview/focus group protocol can be found in **Appendix B**.

Data Collection Measures: Outcomes

Participation in the first year of the study required students to complete one mathematics assessment at pretest (fall 2012) and posttest (spring 2013) as well as a brief product satisfaction student survey for treatment students only, which was completed at posttesting.

The Iowa Test of Basic Skills, Form E (ITBS) and the mathematics portion of each state's standardized test (primarily for third grade students) served as the other two outcome measures. Overall math ITBS scores were used for students at all grade levels. The goal in using the ITBS was to obtain an objective measure of student achievement to compare across schools in multiple states. This instrument and the state standardized test scores were intended to measure the impact on mathematics achievement for the two groups. The following includes a description of outcome measures used in the study.

Student Survey

The posttest student survey was created by *Cobblestone*, and asked students to answer several questions assessing attitudes towards mathematics in general as well as multiple questions assessing their satisfaction with various *GO Math!* program elements (treatment students only). For the satisfaction section, different versions of the student survey were created for each grade so that grade level-specific pictures of program components could be included for students to reference. The response options used for the student survey were based on pictorial representation of the popular comic strip *Garfield*, also used in other educational research studies (McKenna & Kear, 1990).

Iowa Test of Basic Skills, Form E (ITBS)

The ITBS is a norm-referenced assessment that measures student learning in the areas of reading, language, mathematics, science and social studies. For the purposes of this study, students completed only Math Parts I and II of the ITBS. (Students did not complete the Mathematics Computation section.) The ITBS was selected as an objective measure of achievement because of its strong psychometric properties. The assessment is the first to align with the CCSS. It contains three separate mathematics sections: Math Part I, Math Part II, and Computation. The first grade assessment (Level 7) had 43 total questions, the second grade assessment (Level 8) had 44 total questions, and the third grade assessment (Level 9) had 50 total questions.

For the first and second grade assessments, the questions in both Math Part I and Math Part II addressed the areas of number sense and operations, geometry, measurement, and number sentences. For the third grade assessments, the areas of number sense and operations, algebraic patterns and connections, data analysis, probability, statistics, geometry, and measurement were addressed.[6]

[6] http://www.riverpub.com/products/ia/math.html

State Standardized Tests – Mathematics Portions

Participating schools were asked to provide *Cobblestone* with the mathematics scores from their state standardized test for every student who participated in the *GO Math!* study. The exact format of each test varied, but each test included at least 30 multiple choice items and three of the state tests included short answer or open-ended questions as well. Each school provided standardized test data with the exception of the Michigan site. The Michigan Educational Assessment Program (MEAP) is administered in fall each year, whereas all other state tests are administered in spring. Given the timing of the MEAP, these data were not included in the analysis as little attribution could be made with such little time available for instruction in fall 2012. (MEAP scores will be included in analyses conducted for the second year of the study.) For the remaining schools, they were instructed to provide scores for each individual math portion and total math scores. **Table 5** describes each state test in more detail.

Table 5. State Standardized Test Descriptions

State	Standardized Test	Types and Number of Questions	Areas Tested
Ohio	Ohio Achievement Assessments (OAA)	**Grade 3:** 40 total items – 32 multiple choice, 6 short answer, 2 extended response	Number, Number Sense, & Operations Measurement, Geometry & Spatial Sense Patterns, Functions, & Algebra Data Analysis and Probability
Illinois	Illinois Standards Achievement Test (ISAT)	**Grade 3:** 75 total items – 70 multiple choice, 3 short-response, 2 extended-response	Number Sense Measurement Algebra Geometry Data Analysis, Statistics & Probability
Arizona	Arizona's Instrument to Measure Standards (AIMS)	**Grades 2, 3:** 90 total multiple choice items	Number & Operations Data Analysis/Probability/Discrete Patterns/Algebra/Functions Geometry & Measurement Structure & Logic
Pennsylvania	Pennsylvania System of School Assessment (PSSA)	**Grade 3:** 76 total items – 72 multiple choice, 4 open-ended	Numbers & Operations Algebraic Concepts Geometry Data Analysis & Probability
Idaho	Idaho Standards Achievement Tests (ISAT)	**Grade 3**: 50 total items – multiple choice	Number & Operations Concepts and Principles of Measurement Concepts and Language of Algebra & Functions Principles of Geometry Data Analysis, Probability, & Statistics
Utah	Criterion-referenced test	**Grade 3:** 60 total items - multiple choice	Operations & Algebraic Thinking Number & Operations in Base Ten Number & Operations – Fractions Measurement, Data, & Geometry

Section Three Summary

The efficacy study was designed to assess implementation of the curriculum in classrooms, answer research questions related to student achievement, and to assess product satisfaction from teachers and students. **Implementation measures** were collected to assess the extent to which students and teachers implemented their respective mathematics programs in their classrooms. **Outcome measures** included the Iowa Test of Basic Skills and state mathematics standardized test scores, which assessed the impact of mathematics curriculum on student achievement.

	Outcome Measures
Iowa Test of Basic Skills, Form E (ITBS)	Published norm-referenced instrument that aligned to CCSS. Included a general mathematics assessment that addressed the areas of number sense and operations, geometry, measurement, and number sentences (for first and second grade) and the areas of number sense and operations, algebraic patterns and connections, data analysis, probability, statistics, geometry, and measurement (for third grade).
State Standardized Tests	Specific to each state. Schools provided scaled scores for mathematics for each participating student.
	Implementation Measures
Online Teacher Logs	Completed by all participating teachers weekly to report the content covered and specific program components used in their classrooms.
Classroom Observations	Researchers observed treatment teachers and their students at all participating schools as well as control teachers and their students at most participating schools.
Teacher Interviews or Focus Groups	Completed at the end of Year One, most teachers participated in individual interviews or focus groups to discuss the program implementation and their satisfaction with *GO Math!* over the duration of the school year.

Section Four: Assessment of Curriculum Implementation

Implementation is a key factor in a curriculum study because it is possible for implementation of a particular program to vary across sites and teachers. To interpret student outcomes appropriately, it was important to measure implementation within treatment and control classrooms. The complete efficacy study includes tracking of program implementation from the initial training through the final assessment at the end of the 2013-14 school year.

For the first year of the study, we were able to examine the depth and breadth of the content covered as well as the quality of implementation through the classroom observations, formal and informal teacher interviews, and online teacher logs. This section provides an analysis of the fidelity of implementation in *GO Math!* classrooms in Year One thereby answering the first research question. We also describe control classroom implementation, specifically through a comparison of CCSS for both groups.

Research Question 1

Are teachers using *GO Math!* implementing the curriculum according to the prescribed implementation guidelines?

Treatment Curriculum Implementation Guidelines

Teachers were required to adhere to specific implementation guidelines which detailed the necessary integration of particular components of the *GO Math!* program into their mathematics instruction time. Guidelines were developed by the *HMH* product team in cooperation with *Cobblestone* researchers. All treatment teachers were given a copy of the implementation guidelines (**Appendix C**) prior to the start of their school year so that they would be aware of both the required and recommended program components. These guidelines were reviewed with all treatment teachers during study training sessions or included in a detailed email prior to the start of the school year. The purpose of the implementation guidelines was to provide treatment teachers with a quick guide to implementation of *GO Math!* as intended by the publisher.

Based on the established implementation guidelines, we tracked the extent to which treatment teachers followed these guidelines throughout the year. Data on teacher level of adherence was provided by teachers and retrieved from monthly implementation logs for the entire school year. *Cobblestone* sent general log reminder emails to all teachers at the beginning of every month and again in the middle of the month. Follow up reminders via email and phone calls were also provided for missing logs. A total of 67% of teachers completed every log for the year; the balance of teachers completed most of their logs and one control teacher did not complete any logs despite multiple attempts to contact the teacher about logs.

Coverage of *GO Math!* Program

The *GO Math!* program is arranged such that Chapters are divided into CCSS domains. For example, the first five chapters of the Grade 1 books specifically address topics in the *Operations & Algebraic Thinking* Domain. Within each chapter, each lesson contains a four-step process, which starts with *Engage*, *Teach and Talk*, *Practice*, and finally *Summarize*. Though individual lesson structures and the amount of problems in each lesson vary, they all follow this same format. Treatment teachers were asked in their implementation logs to note which chapters and lessons they covered in their mathematics instruction since the previous log.

Teachers who had not completed a log for every month were asked to confirm a final summary of logs reports at the end of the year to ensure the information was correct. Despite some missing data from the logs, our summary provides the best estimate of what was implemented in classrooms throughout the school year.

Breadth of Implementation Rating

Breadth of implementation was calculated for each treatment teacher. This consisted of two separate calculations – overall program coverage and coverage of lessons only. Overall program coverage included every planning component, lesson, mid-chapter checkpoint, chapter review/test, and chapter test for each chapter. Lesson-only coverage only included each lesson for each chapter. Both of these were considered acceptable measures of program coverage. One focused more on the overall usage of the program and the other focused on just possible lessons.

Overall Program Coverage

Percent of overall program coverage was calculated for each participating treatment teacher. This encompassed teachers' completion of all lesson, planning and assessment components based on the total number possible if every component of the program was used during the year. These percentages were then averaged for each of the three grade levels. On average, first grade teachers reported covering 63% of the total *GO Math!* program; second grade teachers reported covering 64% of the total program; and third grade teachers reported covering 55% of the total program. We categorized overall program coverage into three levels: low = 50% or less of program covered; medium = 51 – 70% of program covered; and high = 71% or more of program covered. Overall, most teachers were considered to have either a high level implementation (n = 13) or a medium level of implementation (n = 17). On the other hand, there were teachers who exhibited a low level of lesson coverage (n =12), and most of these teachers taught third grade.

***GO Math!* Lesson Coverage**

Calculations for the total numbers of *GO Math!* lessons completed were also calculated for each treatment teacher. This analysis excluded the additional chapter elements such as chapter tests, mid-chapter checkpoints, games, vocabulary builder, and other added chapter supplements. Teachers' total lesson coverage ranged widely from 29% to 100% of total lesson implementation. Across grades, the teachers covered an average of 73% of the lessons available in the program.

Average *GO Math!* Lesson Coverage for Each Grade Level

First grade
Chapters 1–12,
74% of lessons

Second grade
Chapters 1–11,
79% of lessons

Third grade
Chapters 1–12,
67% of lessons

Many teachers noted in their implementation logs and through focus group interviews that various restrictions (e.g., district timelines, school-level restrictions, student preparedness levels) prohibited them from implementing more of the program, particularly at the beginning of the school year. For example, one teacher commented in their implementation log: *"It is hard for some of the 1st graders to start right in on story problems as some of them are still in the decoding stage of reading …"* Most teachers also felt the program's pacing guide was too fast, especially at the beginning of the school year, for the amount of material they were expected to cover. One teacher said, *"The pacing is difficult. It is hard to get through each and every component every day. Some lessons take more than one day to get through because they are difficult for the students to grasp."* These data are consistent with our experience such that most teachers struggle with pacing of any new program during the first year of implementation; however, we consider this level of implementation fairly substantial for the first year of the study.

Table 6, Table 7, and **Table 8** show the total percentage of the entire program covered including all planning components and the total percentage of lessons covered in each chapter for treatment teachers in first, second and third grades, respectively. First grade teachers had a total of 252 possible planning components/lessons that could have been implemented, second grade teachers had a total of 248 possible planning components/lessons that could have been implemented, and third grade teachers had a total of 253 possible planning components/ lessons that could have been implemented. In general, a majority of program components and *GO Math!* lessons were used in classrooms during the first year of the study.

Table 6. First Grade Treatment Teacher Implementation Log - Program Completion

Teacher	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Total % of Program Completed	64%	64%	85%	60%	62%	44%	65%	78%	75%	71%	62%	57%	23%	67%
% Of Lessons Completed	80%	85%	90%	64%	75%	54%	85%	89%	88%	80%	69%	57%	37%	79%

Table 7. Second Grade Treatment Teacher Implementation Log - Program Completion

Teacher	15	16	17	18	19	20	21	22	23	24	25	26	27	28
Total % of Program Completed	51%	85%	69%	73%	87%	50%	75%	60%	86%	69%	48%	75%	25%	46%
% Of Lessons Completed	88%	87%	76%	81%	88%	76%	90%	79%	91%	99%	56%	91%	41%	68%

Table 8. Third Grade Treatment Teacher Implementation Log - Program Completion

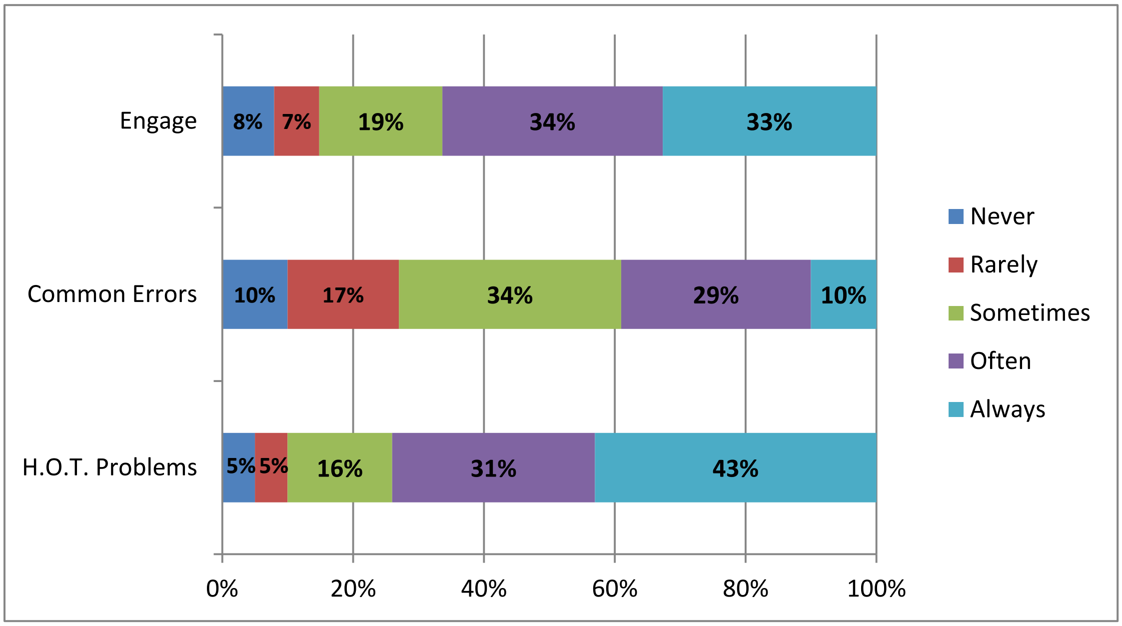
Teacher	29	30	31	32	33	34	35	36	37	38	39	40	41	42
Total % of Program Completed	59%	61%	83%	65%	59%	79%	34%	34%	47%	46%	47%	91%	51%	17%
% of Lessons Completed	89%	74%	88%	86%	68%	90%	48%	32%	69%	55%	69%	100%	54%	29%

Depth of Implementation Rating

GO Math! integrates specific metacognitive approaches into the curriculum that support students' strategy development and encourage students' discovery of what they know and what they do not know. Three of these components distinct to *GO Math!* are the ***Engage*** section at the beginning of each lesson, ***H.O.T. Problems***, and ***Common Errors***, both of which are integrated into different points of each lesson. Specifically, the ***Engage*** portion of each lesson accesses students' prior knowledge, helping them and the teacher determine what they know and what they do not know. ***H.O.T. Problems*** consistently encourage students to utilize higher order thinking and apply strategies to these more difficult problems. ***Common Errors*** are the errors students most often will make in conjunction with the lesson and are identified for teachers in each lesson.

Determining the usage of distinctive program components can be important in understanding how the *GO Math!* program might benefit students in comparison to other, competitor programs. Teachers reported how frequently they used each of these elements on every monthly implementation log. Frequencies for each of these three areas were calculated for each teacher and **Figure 1** shows the frequencies across the entire first, second, and third grade treatment teachers' reported use of these metacognitive *GO Math!* program components. ***H.O.T. Problems*** was the reported to have the highest frequency of use with teachers having their students delve deeper into the lesson's problems "always" or "often". On the other hand, ***Common Errors*** had the highest reported frequency of "never" being used. Overall, teachers reported using ***H.O.T. Problems*** and ***Engage*** more consistently in their lessons compared to the sporadic use of ***Common Errors***.

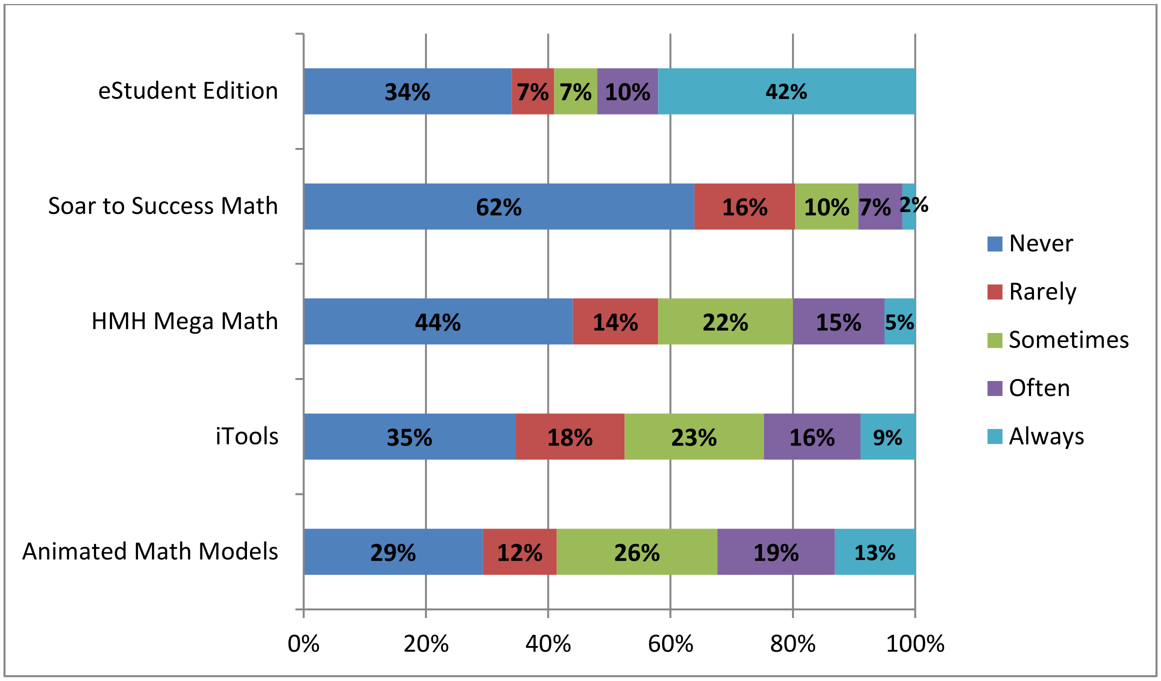
Figure 1. Teacher Ratings of *GO Math!* Curriculum Elements



Online Program Component Usage

In addition to the implementation of the metacognitive *GO Math!* program components, implementation of online elements was recorded in teacher logs. **Figure 2** shows the overall percentage across first, second, and third grade treatment teachers who reported their frequency of use of online components. Overall, the most frequently used program component was the ***eStudent Edition*** with the component being used "Always" or "Often" more than 50% of the time. Conversely, ***Soar to Success Math*** was the most frequently reported program to "Never" be used. Moreover, it should be noted that teachers were unable to access ***Soar to Success Math*** at various points throughout the year. Therefore some consideration should be taken when examining percentages for the use of the ***Soar to Success Math*** component. Excluding the ***eStudent Edition***, most of the online elements were intermittently used throughout the lessons. Teachers reports of online component usage are aligned to data generated from classroom observations.

Figure 2. Teacher Ratings of *GO Math!* Online Curriculum Elements



Comparison Group Programs

Mathematics curricula used in control group classrooms varied at each study site. One district had two participating school sites, which used a consistent mathematics program for both schools and across all grade levels. **Table 9** provides a brief description of the control group programs used, or the "business as usual" condition. In addition to published materials, teachers also used worksheets, games or other exercises to supplement student learning in the classroom. The published materials were all competitor programs for *GO Math!*, and ranged in publication date from 1999 to 2007.

Table 9. Control Group Program Descriptions

Control Program	Program Description
Program 1	Program 1 is a research-based curriculum that focuses on developing children's understanding and skills in ways that produce life-long mathematical power. The curriculum emphasizes four main areas: use of concrete, real-life examples; repeated exposures to mathematical concepts and skills; frequent practice of basic computational skills; and use of multiple methods and problem-solving strategies.
Program 2	Program 2 utilizes examples and models to enhance a deeper conceptual understanding of mathematics. The program incorporates games, projects, lesson warm-up preparation, and cool-down practice to enhance the students' mathematics skills proficiency.
Program 3	Program 3 aims to improve students' understanding of key math concepts through problem-solving instruction, hands-on activities, and math problems that involve reading and writing. The curriculum focuses on problem-solving skills, assessments, and exercises tailored to students of different ability levels.
Program 4	Program 4 is considered a "balanced mathematics" program, focusing on numerical fluency, conceptual understanding, and problem solving.
Program 5	Program 5 emphasizes the five content strands and processes recommended by the National Council of Teachers of Mathematics Standards. At each grade level the program focuses on basic skills development, problem solving, and vocabulary expansion to help students master key math concepts.
Program 6	Program 6 is an inquiry-based program that focuses on computational fluency with whole numbers as a major goal of the elementary grades; emphasizes reasoning about mathematical ideas; enables students to communicate mathematics content to teachers; and engages the range of learners in understanding math.

Control Teacher Coverage of Common Core State Standards

Control teachers were also asked to complete monthly implementation logs. Given the wide range of control curriculum used in participating classrooms, we asked that control teachers report on the extent to which they covered content from the CCSS as one consistent measure across all control classes. Control teachers self-reported which CCSS they covered during mathematics lessons as well as which Units, Lessons, or Chapters they covered in their mathematics program since the previous log. For the purposes of comparison, the research team also determined which CCSS each treatment teacher reported covering from the *GO Math!* program by linking specific *GO Math!* lessons with CCSS. This was done to standardize coverage of CCSS across conditions. It is important to note the differences regarding how the coverage of CCSS was calculated—again, specific standards were self-reported by control teachers whereas specific lessons were reported by treatment teachers, and then the coverage of CCSS was inferred when CCSS were linked to specific *GO Math!* lessons.

Based on this comparison, control teachers reported covering more CCSS than treatment teachers. Again, this is most likely due to the fact that control teachers did not have restrictions on the materials they could use during mathematics instruction while treatment teachers were specifically requested to use *GO Math!* as much as possible and to avoid using supplemental materials. The largest gap between treatment and control teachers with regard to coverage of CCSS was between third grade classrooms.

These results should be interpreted with caution due to the method in which the information was obtained. It is likely that treatment teachers covered CCSS using non-*GO Math!* supplemental materials and, therefore, would have reported different results if they were to have reported CCSS in the same manner as the control teachers. Despite these issues, it was determined that treatment teachers' coverage of the CCSS would be best represented using only what the teachers covered using the *GO Math!* program eliminating any additional coverage that did not come from the program.

Table 10, Table 11, and **Table 12** show the average CCSS coverage of both treatment and control teachers at each grade level (The CCSS for each grade are found in **Appendix D**). The full breakdown of each teacher's coverage of CCSS can be found in **Appendix E**.

Table 10. First Grade Teachers' Common Core State Standards Coverage

	Coverage of *Operations & Algebraic Thinking*	Coverage of *Number & Operations in Base 10*	Coverage of *Measurement & Data*	Coverage of *Geometry*	Total Coverage
Control Average	98%	89%	90%	78%	89%
Treatment Average	93%	79%	64%	74%	78%

Table 11. Second Grade Teachers' Common Core State Standards Coverage

	Coverage of *Operations & Algebraic Thinking*	Coverage of *Number & Operations in Base 10*	Coverage of *Measurement & Data*	Coverage of *Geometry*	Total Coverage
Control Average	92%	88%	89%	89%	89%
Treatment Average	89%	92%	81%	74%	84%

Table 12. Third Grade Teachers' Common Core State Standards Coverage

	Coverage of *Operations & Algebraic Thinking*	Coverage of *Number & Operations in Base 10*	Coverage of *Number & Operations – Fractions*	Coverage of *Measurement & Data*	Coverage of *Geometry*	Total Coverage
Control Average	93%	91%	63%	81%	86%	83%
Treatment Average	98%	86%	58%	62%	61%	73%

Classroom Observations

Researchers conducted observations in all treatment and most control classrooms once during the course of the first year of the study. (All teachers will be observed again during the second year of the study.) The observations took place during fall 2012 and spring 2013. During the observations, researchers documented classroom activities carefully and completed an observation protocol form. The observation protocol allowed the research team to gather information on students in the classroom, instructional variables, teaching materials, teacher variables, and pedagogical elements. Implementation variables such as teacher/ student rapport, classroom management and student engagement were used as implementation factors in the analysis of student data (see **Section Five**) along with program coverage, lesson coverage and depth of implementation to determine the extent to which these implementation factors were linked to student achievement indicators.

Researchers were able to see various elements of the *GO Math!* program used during treatment classroom observations. Although there were a variety of ancillary materials available for use, researchers most often observed students writing in ***Student Workbooks***, listening to a lesson given by the teacher or answering questions at their desks or at the board, or using materials from the manipulatives kit. About half of the teachers observed used the accompanying ***ThinkCentral.com*** resources, and those who did typically used the ***eStudent Edition*** and the ***Animated Math Model videos***. Teachers' ability to integrate online program components was directly related to technology available in their classrooms, and most teachers expressed a willingness to use even more online or electronic components with students, but were limited by their own facilities. Additional teacher feedback regarding the entire *GO Math!* program can be found in **Section Six** of this report.

Section Four Summary

To establish construct validity of our implementation fidelity measures, we assessed teachers in a variety of ways including self-reported online teacher implementation logs, interviews, and classroom observations. The level and quality of implementation varied throughout the study in both conditions, although there did not appear to be an overwhelming advantage for students in either condition in terms of potential quality of the learning environment.

Treatment teachers covered a majority of the *GO Math!* program lessons and program components during the first year of the efficacy study. The use of online components was not implemented as consistently and was largely dependent of the availability of technological support in their schools. In terms of the usage of metacognitive program components, **H.O.T. Problems** were used most often and **Common Errors** were used least often. **Section Six** (Product Satisfaction) will provide additional detail regarding the usage of program components as well as students' and teachers' relative satisfaction with these. Overall, the *GO Math!* program was implemented at an adequate level considering this was the first year teachers used the program, and the first year many have attempted to align their teaching to CCSS.

Section Five: Results Related to Students' Achievement in Mathematics

This section focuses on answering the research questions related to the impact of the *Go Math!* program on students' mathematics achievement. A detailed account of the analysis plan and the results from the analyses conducted to answer each of these questions are described in detail below.

Analysis of Outcome Measures

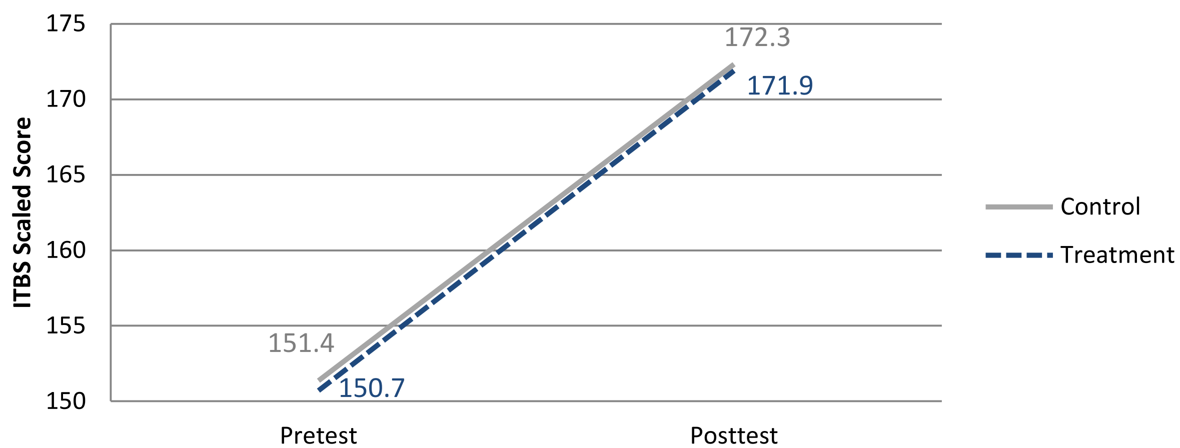
To assess the influence of the *Go Math!* curriculum on students' mathematics achievement, hierarchical linear modeling (HLM) was used. HLM was used because students were nested within different classrooms and it was expected that students who share the same classroom share more common characteristics and experiences with each other than with students in different classrooms. Additionally, teacher characteristics (e.g., experience, education, and classroom management) were expected to influence students' mathematics achievement. HLM addresses the above-mentioned issues by simultaneously examining the effect of student background characteristics (e.g., ethnicity, socioeconomic status, prior achievement), teacher characteristics (e.g., student-teacher rapport, classroom management), and study condition (i.e., treatment or control group) on students' mathematics achievement. For a complete discussion of the rationale and theory underlying HLM models, please see Raudenbush and Bryk (2002).

Appendix F describes the HLM statistical models (i.e., random intercept model in the Mplus, version 6 program) and includes a list of variables and their operational definitions associated with the student and teacher background characteristics that were used in the HLM models. The student-level variables fall into the following categories: (1) baseline measure of mathematics achievement (i.e., pretest scores); (2) key student demographic characteristics (i.e., ethnicity, gender, grade level, English language learner status, special education status and a proxy measure of students' socio-economic status), and (3) student attitudes towards math. The teacher-level variables fall into the following categories: (1) relevant experience (i.e., number of years as a teacher, number of years as a math teacher, and degree), (2) classroom characteristics (i.e., teacher-student rapport, classroom management, and student engagement), and (3) the key variable of interest, the treatment condition.

Research Question 2
How does student achievement differ between those students using control curriculum with traditional textbooks and students using the consumable worktexts in the *GO Math!* program?

Students' performance in mathematics was measured using the Iowa Test of Basic Skills Form E (ITBS) and state standardized test scores in mathematics, when available.[7] For the analyses, the raw scores from the ITBS were converted into scaled scores and the state standardized test scores were converted into *z*-scores and then combined, as the original scores were based on different scales.

Figure 3. Pretest and Posttest ITBS Scores, by Condition (N=1,387)



As can be seen in **Figure 3**, without controlling for student or teacher characteristics, the treatment group and control group performed nearly identically at pretest (*M*=150.7, *M*=151.4, respectively) and at posttest (*M*=171.9, *M*=172.3, respectively).

Table 13 provides details of the ITBS HLM analysis. When interpreting the results of the HLM analysis, it is important to realize that each variable is reported on after controlling for all other student and teacher characteristics in the HLM model. In other words, the results of the variables are reported after considering all other characteristics as equal. To enhance model

[7] The missing data were addressed using a full maximum likelihood estimator with robust standard errors (MLR; Byrne 2012). Full maximum likelihood estimation estimates values for missing data based on the values of non-missing data and the relationship between the missing data and the non-missing data (Schlomer, Bauman & Card, 2010). Full maximum likelihood estimation is considered to be one of the most rigorous and least biased methods of handling missing data (Graham, 2009); whereas additional bias can be introduced into results by using listwise deletion and excluding cases with missing data.

parsimony, non-significant covariates (i.e., gender, teacher's experience, student-teacher rapport, and student engagement) were dropped from the model. The final ITBS HLM model demonstrated good model fit ($X^2(4)=2.9$, $p=.68$; RMSEA=0.00; CFI=1.00; TLI=1.01; Byrne, 2012), meaning that the model was consistent with the data. As shown in **Table 13**, after controlling for various student and teacher characteristics, there was no statistically significant treatment effect of participation in the *Go Math!* program (B=-0.32, SE=1.15, $p=.78$), indicating that treatment and control students performed similarly on the ITBS at post-test.

Table 13. HLM Results for the ITBS Scaled Scores (N= 1,363)

Fixed Effect	Coefficient	Standard Error	Approx. T-Ratio	*p* value
ITBS Pretest	0.77	0.03	28.89	**<0.001**
Grade 2	4.40	1.63	2.70	**0.007**
Grade 3	11.36	1.60	7.11	**< 0.001**
English language learner	-3.63	1.10	-3.31	**0.001**
Free or reduced lunch	-1.67	0.79	-2.12	**0.034**
Hispanic/Latino	-0.88	0.74	-1.20	0.232
African American	-4.71	1.15	-4.11	**<0.001**
Other ethnicity	-1.37	1.28	-1.07	0.284
Special Education	-6.50	1.94	3.35	**0.001**
Math Attitudes	1.82	0.48	3.81	**< 0.001**
Advanced Degree	-2.08	1.22	-1.71	0.087
Rapport	-1.71	0.98	-1.75	0.081
Classroom Management	2.06	0.89	2.32	**0.02**
Condition	-0.32	1.15	-0.28	0.783
Intercept	47.04	5.84	8.06	**< 0.001**

Note: English Language Learner coded 0=non-ELL, 1=ELL; Free or reduced lunch coded 0=not eligible, 1=eligible; Special education coded 0=no special education, 1=special education, advanced degree coded 0=BA or certificate, 1=MA or PhD, Condition coded 0=control, 1=treatment.

Table 14 provides details of the state standardized test *z*-score analysis. Similar to the ITBS analysis, non-significant covariates were dropped from the model (i.e., gender, English language learner status, receipt of special education services, teachers' experience teaching math, teachers' degree, and student engagement). The resulting model demonstrated good model fit ($X^2(2)=0.782$, $p=.68$; RMSEA=0.00; CFI=1.00; TLI=1.02; Byrne, 2012), indicating that the model was consistent with the data. As shown in **Table 14**, after controlling for various student and teacher characteristics, there was no statistically significant treatment effect of participating in the *Go Math!* program (B=.12, SE=0.12, *p*=.34). This means that after controlling for student and teacher characteristics treatment and control students performed similarly on state standardized tests.

Table 14. HLM Results for the State Standardized z-Scores (n = 1,179)

Fixed Effect	Coefficient	Standard Error	Approx. T-Ratio	*p* value
ITBS Pretest	0.04	0.00	18.74	**< 0.001**
Grade 2	0.04	0.13	0.30	0.766
Grade 3	-0.64	0.15	-4.35	**< 0.001**
Free or reduced lunch	-0.14	0.07	-1.88	**0.06**
Hispanic/Latino	-0.08	0.07	-1.25	0.21
African American	-0.33	0.13	-2.54	**0.011**
Other ethnicity	-0.11	0.08	-1.48	0.138
Math Attitudes	0.15	0.04	3.72	**< 0.001**
Classroom Management	0.16	0.07	2.23	**0.026**
Engagement	-0.38	0.12	-3.27	**0.001**
Condition	0.12	0.12	0.95	0.344
Intercept	-5.54	0.49	-11.37	**< 0.001**

Note: Free or reduced lunch coded 0=not eligible, 1=eligible; Condition coded 0=control, 1=treatment.

Quality of Implementation

Quality of program implementation was assessed by examining total program implementation and implementation of lessons. Implementation quality for both indices was then broken down into three categories: high implementation (71% or more of the program covered), medium implementation (between 51-70% of program covered) and low implementation (50% or less of program covered). Data from participants with teachers who demonstrated low adherence to the program model for each implementation index were removed from the sample and HLM analyses comparing the treatment and control conditions were run.

After restricting the sample to students with teachers who implemented the program with medium to high fidelity (see **Table 15** and **Table 16**) there was a significant effect of participation in the *Go Math!* program on students' state *z*-scores (Total Program B=0.23, SE=0.11, *p*<.05; Lessons Only B=0.21, SE=0.02, *p*<.05). This means that after controlling for student and teacher characteristics and quality of implementation, students who used the *Go Math!* program had higher state *z*-scores than students in the control group. Unfortunately, this finding was not replicable with the ITBS posttest outcome variable (Total Program B=0.67, SE=1.07, *p*=.78; Lessons Only B=-0.40, SE=1.16, *p*=.73). Nevertheless, this finding is promising because it suggests that when the *Go Math!* program is implemented with fidelity to the program model students' perform significantly better on state standardized tests.

Table 15. HLM Results for the State Standardized z-Scores, Medium-High Total Program Implementation (N = 976)

Fixed Effect	Coefficient	Standard Error	Approx. T-Ratio	*p* value
ITBS Pretest	0.04	0.00	16.40	**< 0.001**
Grade 2	0.03	0.13	0.23	0.821
Grade 3	-5.48	0.15	-3.72	**< 0.001**
Free or reduced lunch	-0.12	0.08	-1.59	0.112
Hispanic/Latino	-0.09	0.07	-1.41	0.148
African American	-0.29	0.14	-2.07	**0.038**
Other ethnicity	-0.10	0.08	-1.29	0.197
Math Attitudes	0.15	0.05	3.24	**0.001**
Classroom Management	0.15	0.08	2.02	**0.043**
Engagement	-0.44	0.13	-3.47	**0.001**
Condition	0.23	0.11	2.12	**0.034**
Intercept	-5.18	0.51	-10.22	**< 0.001**
Note: Free or reduced lunch coded 0=not eligible, 1=eligible; Condition coded 0=control, 1=treatment.				

Table 16. HLM Results for the State Standardized z-Scores, Medium-High Lessons Only Implementation (N = 1065)

Fixed Effect	Coefficient	Standard Error	Approx. T-Ratio	*p* value
ITBS Pretest	0.04	0.00	17.54	**< 0.001**
Grade 2	0.03	0.12	0.23	0.822
Grade 3	-0.58	0.14	-4.16	**< 0.001**
Free or reduced lunch	-0.15	0.07	-2.03	**0.042**
Hispanic/Latino	-0.08	0.07	-1.26	0.208
African American	-0.29	0.13	-2.30	**0.021**
Other ethnicity	-0.10	0.08	-1.32	0.187
Math Attitudes	0.16	0.04	3.61	**< 0.001**
Classroom Management	0.14	0.07	2.04	**0.047**
Engagement	-0.35	0.12	1.99	**< 0.001**
Condition	0.21	0.02	-3.65	**0.041**
Intercept	-5.23	0.49	-10.78	**< 0.001**
Note: Free or reduced lunch coded 0=not eligible, 1=eligible; Condition coded 0=control, 1=treatment.				

Effect Size Estimates

Table 17 provides the effect size estimates based on the results of the HLM analyses. The process and calculation for determining the effect sizes for both outcome measures was obtained from the Procedures and Standards Handbook (2011) provided by the What Works Clearinghouse. Further information for calculating the effect sizes is located in **Appendix G.**

Table 17. Effect Size Estimates Based on Results from HLM Analyses

Outcome Measure	Sample	Adjusted Mean Posttest Difference	Unadjusted Posttest Standard Deviation		Sample Size		Hedges's *g* Effect Size
			Treatment	Control	Treatment	Control	
ITBS	Full Sample	-0.32	23.72	23.14	753	609	.014
	Med.-High Total Program	0.67	23.11	23.14	551	609	.029
	Med.-High Lessons Only	-0.40	23.56	23.14	640	609	.017
State *z*-Score	Full Sample	0.12	1.01	0.98	756	423	.060
	Med.-High Total Program	0.23	0.97	0.98	553	423	.236
	Med-High Lessons Only	0.21	0.99	0.98	642	423	.213

Research Question 3
How do students with different characteristics (e.g., English language learners, gender, grade level) perform on mathematics outcome measures when compared to each other?

The HLM analyses, as shown in **Table 15** and **Table 16**, indicated that student and teacher characteristics influenced students' performance on both the ITBS at posttest and the state standardized test scores (state *z*-scores). These differences were found with all students in the sample regardless of their study condition. With regard to student characteristics, the following covariates were significantly associated with students' ITBS scaled scores and state *z*-scores:

- **ITBS pretest score:** higher pretest scores predicted higher posttest scores on the ITBS and higher state *z*-scores.
- **Grade level:** being a second or third grade student predicted higher ITBS posttest scores than the reference group (first grade students). In contrast, being a third grade student predicted lower state *z*-scores than the reference group (first grade students).

- **English language learner:** being an English language learner predicted lower ITBS posttest scores than the reference group (non English language learners).
- **Free or reduced lunch:** being a student that qualified for free or reduced lunch predicted lower ITBS posttest and state *z*-scores than the reference group (students not qualified for free or reduced lunch).
- **Ethnicity**
    - **African American:** predicted lower scores on both the ITBS and state *z*-scores than the reference group (Caucasian).
- **Special Education:** being a student that received special education services predicted a lower score on the ITBS posttest than the reference group (students who did not receive special education services).
- **Math attitudes:** more positive math attitudes predicted higher ITBS posttest and state *z*-scores.
- **Classroom management:** higher rated classroom management predicted higher scores on both the ITBS posttest and the state *z*-scores.
- **Student engagement:** higher rated student engagement predicted lower state *z*-scores.

Research Question 4
How do students using *GO Math!* compare from pretest to posttest on mathematics outcome measures?

Research question 4 examines the specific results of only those students using the *Go Math!* program from pretest to posttest for the ITBS. Those students using the *Go Math!* program significantly increased their achievement scores from pretest to posttest on the ITBS. The overall results from the repeated measures analysis of covariance (**Table 18**) indicates that after controlling for student characteristics, students who participated in the *Go Math!* program significantly improved their ITBS scaled score from pre-test to post-test by approximately 21.2 points, $F(1, 728)=63.6$, $p<.001$.

Table 18. Treatment Students Pretest and Posttest ITBS Scaled Scores

	Pretest Mean	Pretest Grade Equivalent	Posttest Mean	Posttest Grade Equivalent	Difference	*F*	*df*
Grade 1	131.54	K.8	151.29	1.8	19.75	34.00***	1, 222
Grade 2	150.58	1.8	171.75	3.0	21.17	16.16***	1, 237
Grade 3	168.44	2.8	190.83	4.1	22.39	15.90***	1, 253
Overall	**150.96**	--	**172.12**	--	**21.16**	**63.59*** **	**1, 728**

*** p < .001

When examined individually, each grade level demonstrated significant improvement, with third graders demonstrating the most improvement, followed by second graders, and first graders. Each grade level demonstrated a grade equivalence gain of at least one full grade. Third graders increased by 1.3 years.

Attrition

An attrition analyses was conducted based on the comparison of students completing the pretests and posttests. A full description of the study attrition and differential attrition (comparing treatment and control groups) can be found in **Appendix H**. Attrition analyses suggested some differences between treatment and control in terms of demographic characteristics that did not appear to affect the results obtained in **Section Five**. The analyses of the pretest ITBS showed no differences between control and treatment for the attrition students, $t(138) = .37$, $p = .72$. This result combined with the results shown in **Appendix H** gives us confidence that the results of attrition are not a threat to the overall results of **Section Five**.

Section Five Summary

An HLM analysis was used to assess the impact of participation in the *Go Math!* program on students' mathematics achievement (i.e., ITBS posttest scores and state standardized test *z*-scores). The results from these analyses suggest that participation in the *Go Math!* program did not lead to significant improvements in mathematics achievement. However, when data from students who were in classrooms with low fidelity of implementation were dropped, a significant difference in state standardized test *z*-scores between control and *Go Math!* participants was found (this result was not replicated with ITBS posttest scores). These findings are promising as they suggest that when the *Go Math!* program is implemented with fidelity it has the potential to impact students' state standardized test performance.

The HLM analyses also assessed the influence of student and teacher background characteristics on ITBS posttest and state *z*-scores. Results from these analyses suggest that students' prior achievement, math attitudes, and key student demographic characteristics (i.e., English language learner status, socioeconomic status, receipt of special education services, ethnicity and grade level) influence students' mathematics achievement. In contrast, teacher background variables such as degree and level of experience tended to be non-significant once student background variables and variables assessing teachers' classroom management and level of student engagement were in the model.

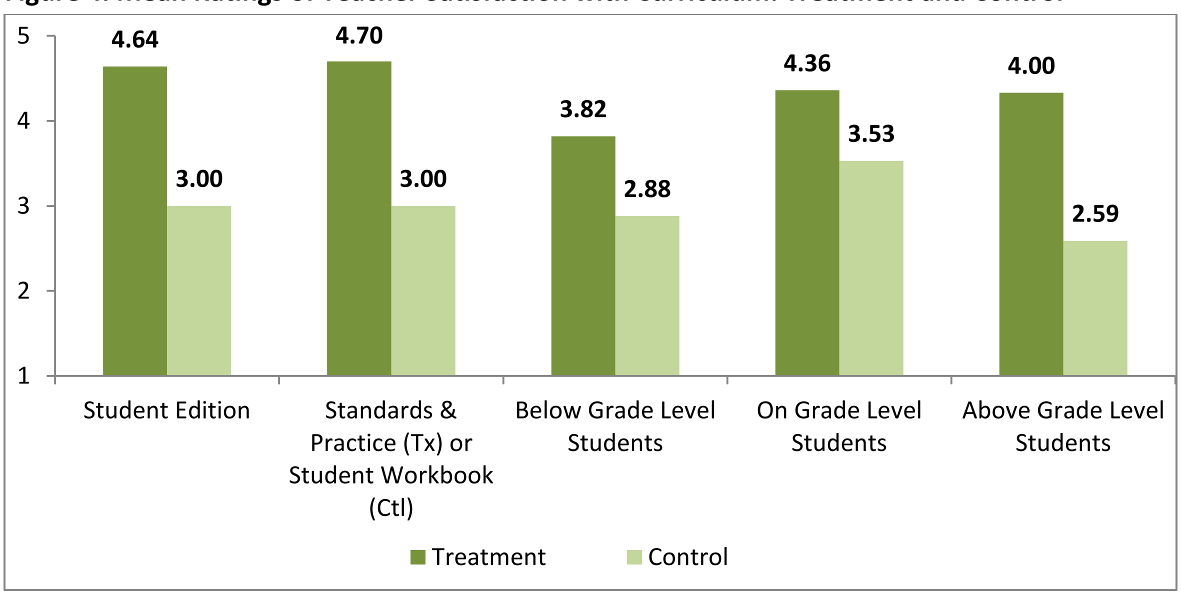
When examining the trajectories of *Go Math!* program participants' mathematics development, students demonstrated significant increases in ITBS from pretest to posttest. On average students demonstrated a gain of approximately 21.2 scaled score points, which is roughly equal to a gain of one year and two months on the grade level equivalence scale. When examined individually, each grade level demonstrated significant improvement with third graders demonstrating the most improvement, followed by second graders, and first graders.

Section Six: Product Satisfaction

Product satisfaction of the *GO Math!* program was assessed using feedback from three separate sources. First, teachers completed **satisfaction surveys** relating to program components (materials), lesson components (structure of lesson plans), and program elements (activities). Second, **teacher comments** from teacher logs and focus groups lent insights to overall satisfaction as well as how each component or element impacted teaching and learning. Third, students completed **student surveys** regarding their feelings toward various *GO Math!* components and activities.

Twenty-eight of the 42 treatment teachers (67%) completed the teacher satisfaction survey. Overall, the majority of these 28 teachers responded favorably to most program components (the ***Math Boards*** and the ***Grab and Go Differentiated Centers Kits*** were not used by enough of the teachers surveyed to gain favorable majorities). Twenty teachers from the 33 classrooms (61%) in the control condition (not using the *GO Math!* curriculum) also responded to a survey asking for levels of satisfaction with various resources and outcomes related to their programs. Overall, *GO Math!* outperformed alternative programs in every area measured, with average control condition levels of satisfaction barely exceeding neutral levels at best (see **Figure 4**).

Figure 4. Mean Ratings of Teacher Satisfaction with Curriculum: Treatment and Control



Scale: 1 = *Very Dissatisfied* to 5 = *Very Satisfied*

Univariate Analysis of Covariance (ANCOVAs) was used to assess whether or not teachers who used the *Go Math!* program were more satisfied than control teachers. Results from the ANCOVAs can be found in **Table 19.** After controlling for the number of years that teachers taught math[8], teachers who used *Go Math!* were significantly more satisfied across all satisfaction indices compared to teachers in the control group.

Table 19. Results of ANCOVAs and Estimated Marginal Means of Satisfaction

Satisfaction Index	Average Satisfaction		*F*	*df*
	Treatment	Control		
Overall (n=48)	4.33	2.70	38.50***	1, 45
Lesson Preparation (n=45)	4.48	3.57	19.76***	1, 42
Teacher Edition (n=42)	4.61	3.24	35.81***	1, 39
Teacher Resource Book (n=41)	4.49	3.13	32.46***	1, 38
Assessment Guide (n=41)	4.21	3.25	14.20**	1, 38
Common Core Alignment (n=45)	4.54	2.65	46.31***	1, 42
Teaching Below Grade Students (n=45)	3.80	2.92	6.51*	1, 42
Teaching On Grade students (n=45)	4.39	3.48	12.86**	1, 42
Teaching Above Grade Students (n=44)	4.35	2.57	46.11***	1, 41
Student Edition (n=40)	4.64	3.00	31.87***	1, 37
Student Workbook (n=41)	4.69	3.02	43.26***	1, 38

Note: *$p<.05$, **$p<.01$, ***$p<.001$

Overall *GO Math!* Teacher Satisfaction

"I enjoyed the program and look forward to another year of using it!"

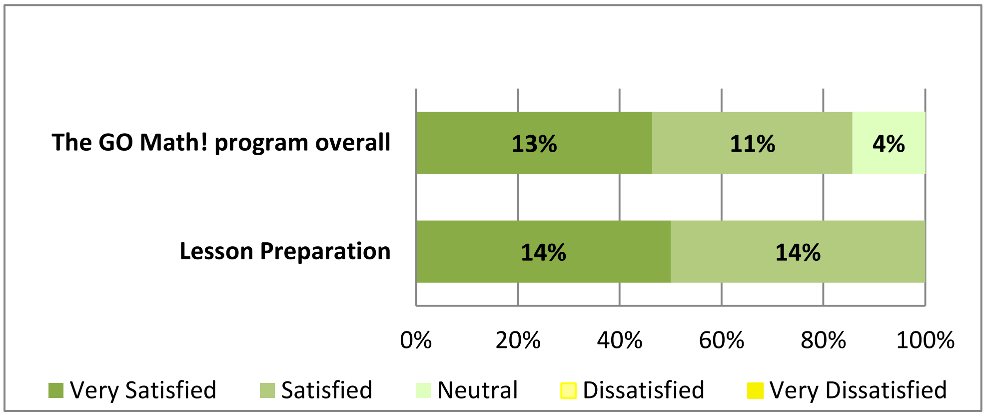
"I love [it]—best in my 17 years of teaching."

Teachers rated their satisfaction with the overall program on a 1 – 5 scale, with 1 = *Very Dissatisfied* and 5 = *Very Satisfied*. A full 85% of treatment teachers surveyed reported being either *Satisfied* (39%, n = 11) or *Very Satisfied*

[8] It was necessary to control for number of years teaching math, as treatment teachers taught significantly more years of math compared to control teachers.

(46%, n = 13) with the **program overall**; 14% (n = 4) reported a *Neutral* response. All of the teachers were *Satisfied* (50%) or *Very Satisfied* (50%) with using ***GO Math!*** for **lesson preparation** (see **Figure 5**).

Figure 5. Overall Teacher Satisfaction

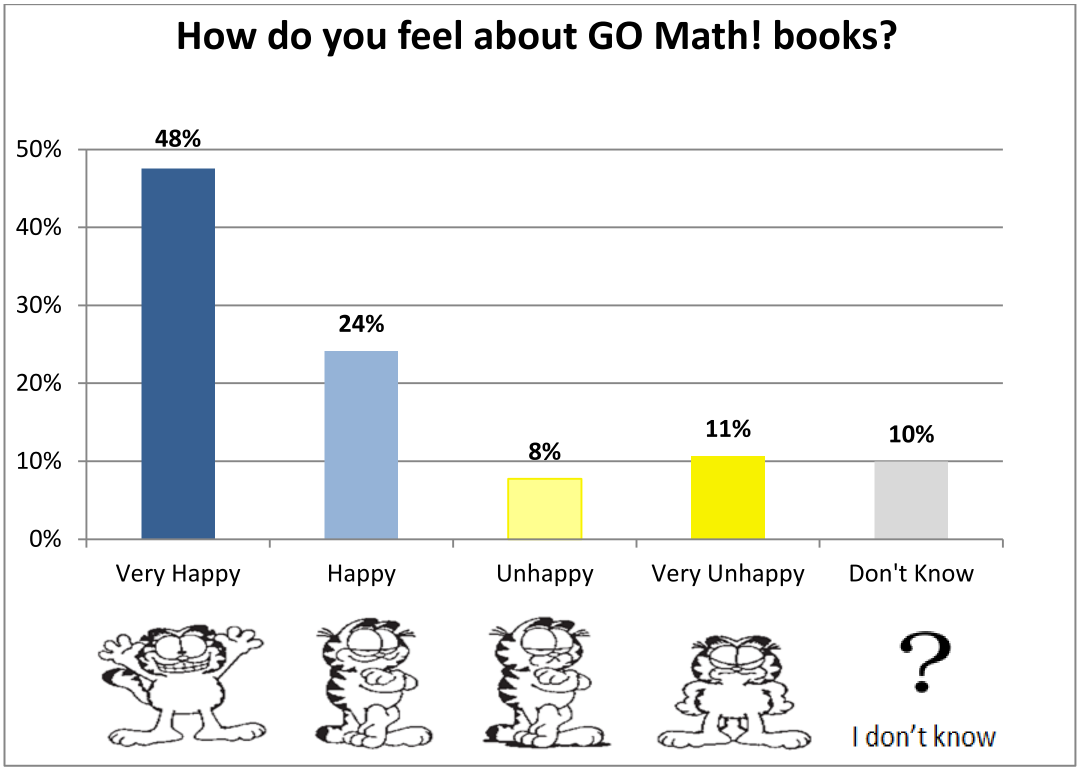


The more enthusiastic responses tended to come from second and third grade teachers. As one stated, *"I am finding that I like **GO Math!** more and more as I use it. To be honest, I was not looking forward to using it … But I can honestly say that I'm convinced and hooked and I don't want to go back to any other math. … My hat is off to you!"*

Teachers appreciated that the program was "*tech-savvy*" and felt that students benefitted from the design. Teachers and students were excited by the **mental challenges** presented by the curriculum. Many teachers commented on the **improvement** they observed in their students, including their students' ability to better grasp concepts and memorize facts. Of the 28 teachers surveyed, a vast majority were either *Satisfied* (42.9%, n = 12) or *Very Satisfied* (39.3%, n = 11) with **students' response** to the curriculum; 14.3% (n = 4) were *Neutral*; and only 1 (3.6%) was *Dissatisfied*.

Student surveys also directly asked students in treatment classrooms to rate the *GO Math!* books. Response options were on a four point scale ranging from 4 = *Very Happy* to 1 = *Very Unhappy*, with a picture of the Garfield character indicating the emotive response (an *I Don't Know* option was also present). Responses across grades (n = 854) indicated that students were very happy with the books (see **Figure 6**).

Figure 6. Student Survey Ratings of *GO Math!* Books



Core Program Components

Teachers expressed positive ratings on the teacher surveys and via log comments for the core program components. Specifically regarding the ***student textbooks*** and ***workbooks***, teachers appreciated that students had a *"tool right at their fingertips"* and further remarked that not having to pass out separate worksheets was very helpful.

> *"My children love the book. They like getting their pencil and coming back to the carpet with*

Regarding the ***Manipulatives Kit*** and the ***Grab and Go Differentiated Centers Kit***, teachers appreciated that the manipulatives were individually packed, which made it easy to distribute. They also liked that they were *"foamy"* rather than hard plastic, *"so the noise level and the clinking has been reduced greatly."* The ***Grab & Go Differentiated Centers Kit*** received positive feedback as well: *"The games are nice as well. I like to use the games in my Math Centers, so the kids are working cooperatively on skills that we're teaching."*

Though nearly 40% of teachers indicated they did not use the ***Math Boards***, of those who did, they reported they and their students enjoyed the ***Math Boards***, but found it difficult to manage having them with the textbooks on students' desks at the same time.

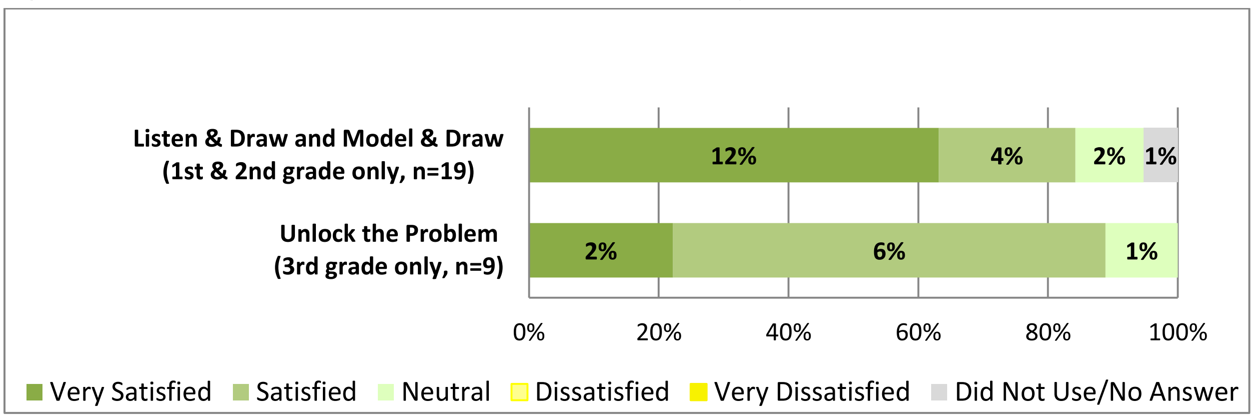
Teachers provided mixed feedback relating to the ***Teacher Edition Textbook*** and the ***Teacher Planning Guide***. For example, while some teachers indicated that having the separate books was convenient, especially to take home for planning, other teachers noted that the pages started coming out of the books easily and they had to be stapled back in.

Student Learning Activities

First- and second-grade teachers reported identical high levels of satisfaction with the ***Teach & Talk: Listen & Draw*** and ***Model & Draw*** lesson components. Third-grade teachers reported generally high levels of satisfaction with the ***Teach & Talk: Unlock the Problem*** lesson component (see **Figure 7**). One teacher stated, *"My kids also get really excited about getting their math book out, seeing what the Listen and Draw will be for the day."*

"I always read the 'In Depth' problems and try to teach to that. We read the word problems together as many of my students are not able to read that much text yet. I do insist that the children draw a model with each problem as is recommended by GO Math! I was pleased that the children are saying, 'Make a model,' when asked how to solve a problem."

Figure 7. Teacher Satisfaction with Teach & Talk Lesson Components



Teachers shared their enthusiasm for the ***Math Journals*** and the ***Spiral Review***, though one teacher did express a desire for the ***Spiral Review*** to be more in-depth and comprehensive.

As one teacher stated, "*I love the **Math Journals** because they have to think when they're doing it and that reinforces a lot of what you're covering and then making them think about it.*" Teachers also reported students enjoying the ***Math Journal***, the ***H.O.T. Problems***, and *explaining their answers*. Some sample statements from teachers include, *"They show pride in themselves when they can solve the **H.O.T. Problem** without help."* And, *"The kids really enjoy the H.O.T. questions. They love to be challenged. Like, 'Oh this is so easy!' but many times they don't have it right, because they're missing the fine line, and then once they figure it out, they get so excited."*

Digital Path / ThinkCentral.com

Per teacher feedback, students highly enjoyed these *Digital Path/Engage* resources, though many were unable to utilize them due to lack of access to the necessary technology.

"They like the technology—especially Curious George. When they get to come up to the board and mark the answer, they really like that."

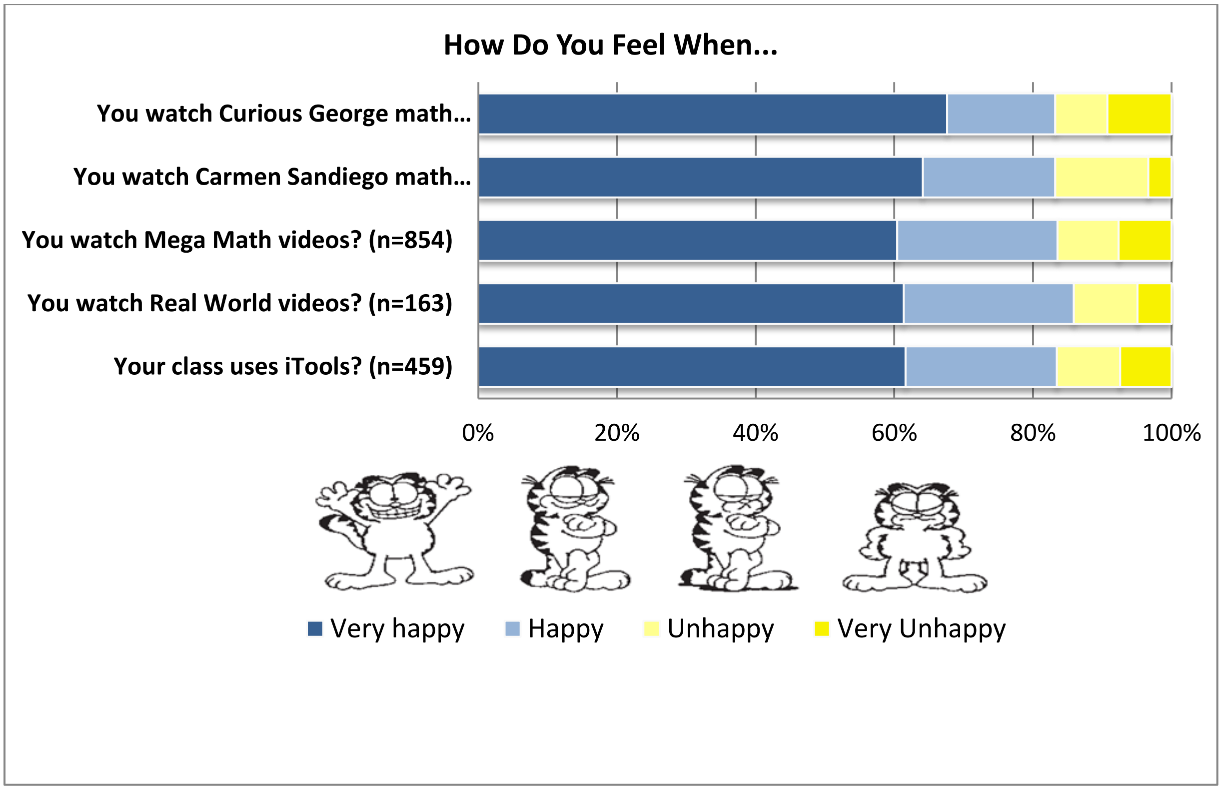
*"I wish there had been more of the **Real World** videos. They really enjoyed that. They got into it, it made sense to them."*

Overall, teachers reported high levels of satisfaction with ***Thinkcentral.com*** and the ***Engage lesson components*** according to the teacher survey. Some of the most celebrated aspects of the program included the various elements found through ***ThinkCentral.com***. Many teachers used the ***e-planner*** extensively, one stating, *"My favorite utility is the **GO Math! e-planner**. I use it every day to help guide my lesson. I find it to be an invaluable part of my teaching. Good job on that! … I use pretty much all of the e-edition materials in the **e-planner** and the kids love it."*

When technology allowed, teachers greatly enjoyed the ability to display the ***Student Edition*** to the entire class. *"I project the **student book** onto the whiteboard a lot. It's nice to have the pages available electronically. You can show the kids exactly what they're supposed to be doing in the same format they're doing it in."* Being able to click on the icons in page corners to get to various components such as ***Mega Math*** was especially useful. One teacher commented, *"I like the **Mega Math** and I like that everything can be projected, the workbook pages, everything."*

Treatment classroom students were also asked about various ***ThinkCentral*** elements, including ***Animated Math Model videos*** and ***iTools***. Students reported high levels of happiness with these elements, as shown in **Figure 8**.

Figure 8. Student Survey Responses to *ThinkCentral* Components



Chapter Elements & Assessing Student Performance

Some of the elements and activities teachers in the focus groups reported liking most included the ***Homework*** (including the review of previous lessons and the fact that they don't have to make copies), ***Parent Letters***, and the ***Mid-Chapter Checkpoints*** for guiding instruction. They liked the stories introducing each unit for addressing *"the literacy component."*

"I love all the practice the students get with the program!"

"I like how each day a new skill is added to the previous day."

"I really like the online resources. We have a projector in the room and we do those together."

There were several units and tools that teachers reported as especially useful including the ***student clocks*** and "*how they broke the lessons into smaller sections*." The ***fraction bars*** were also found to be very helpful. One teacher reported that the *"**data, measurement, and geometry units** seem much easier and fun for the children. Next year I plan to use them earlier in the year so that the children are more developmentally ready for the difficult addition and subtraction units."* Most teachers liked that the lesson plans included different strategies so that children can choose the one that works best for them, though a few felt that this was confusing for students, moving too quickly through alternative strategies before children had the opportunity to master any of them.

Overall, teachers valued the assessment tools included with the program. One teacher mentioned using ***Soar to Success Math*** extensively in the beginning of the school year to help students with skills that they did not pass on the initial assessments. Another teacher liked the ***Check for Understanding*** questions (though on the survey a few teachers did report *Dissatisfied* responses to the ***Quick Check*** problems). The ***Constructed Response*** problems and the ***Chapter Review/Test*** were seen as particularly valuable: *"I like how there's two tests per section so when we review I use one of those tests. It really helps first graders because they're new at test taking. The parents like it because it serves as a nice little study guide."*

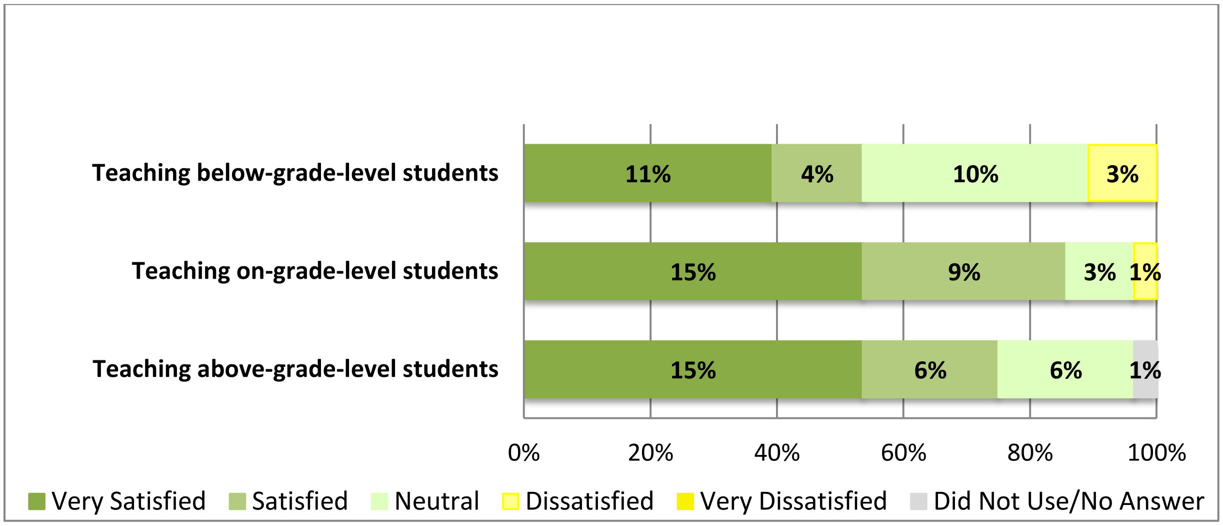
There were some concerns expressed by teachers involving the timing and format of the **Chapter Tests**. Teachers would like to provide students with more opportunities to demonstrate their learning and monitor progress: "*I feel that there is not enough of a selection of assessments for student grades… As a result, I have added quizzes on math facts to have a few more math grades for my students."* Some found the format of the tests confusing: "*The taking apart chapters were very frustrating. The practice came in one format but the test in another, so the students were confused at how to do this*."

Intervention & Enrichment

Several teachers commented on how useful they found the ***Reteach Workbooks***. One teacher suggested that there be more practice problems on each page: *"I'd rather have the page mostly practice because I can do the teaching part."* The survey showed 19 (67.9%)

teachers were *Satisfied* or *Very Satisfied* with the ***Reteach Workbooks***, while 1 (3.6%) was *Dissatisfied*. Teachers felt that the curriculum was **best suited for students performing at grade level** but served other students less well, particularly those performing below grade level (see **Figure 9**).

Figure 9. Teacher Satisfaction Relating to Teaching Different Levels of Students



Common Core State Standards

Twenty-six of 28 teachers surveyed were either *Satisfied* or *Very Satisfied* with the *GO Math!* program's alignment to CCSS. During the focus group, one teacher commented, *"Now that I've gone almost all the way through the book, I can see the reasons why it's put together in the order it is in. Lessons clearly build upon prior lessons. Lesson objectives are very clear and relate to CCSS which makes my job easier when it comes to lesson planning."* Another noted, *"I really enjoy the test prep questions/workbook pages to prepare them for the [Pennsylvania System of School Assessment] PSSA."* For schools that are not yet using the CCSS assessments, teachers must "double up" on the curriculum to teach their students what appears on the state tests.

One area of dissatisfaction for those using *GO Math!* was based on the standards changes due to CCSS as opposed to the *GO Math!* program specifically. Teachers expressed frustration about standards for money being moved from third grade to second grade, which meant that third graders completing the first year of the program will not have a chance to learn this material. One teacher said, "*"I know when we did the curriculum map for 3rd grade, there's a Common Core standard about money, and there's nothing about money in the book. That's a big problem."* Another teacher responded to that comment saying, "*"Next year if it hasn't been taught yet, that's going to put a lot of pressure on that money chapter, if we're expected to introduce it, teach it, master it, all in 2nd grade. There isn't enough practice about money in GO Math!"*

Concerns Regarding Special Standards & District Requirements

Some teachers recommended including language objectives in the lesson plans due to changing requirements in certain schools. For example, in one district teachers would have liked to see more art-related activities integrated into the curriculum. There was some disconnect between the *GO Math!* curriculum and existing assessment instruments. For some teachers, this posed a problem in that it was too late to teach to the state standards if they hadn't planned ahead: *"I'm looking at this test and it's got tally marks in there and tables and money. … My kids have not been exposed to these things and I feel like maybe I should have changed the lessons around a little bit."*

Areas for Improvement

A Need for Real-time Technical Support

Many teachers had trouble accessing on-line tools such as ***Soar to Success***, ***Mega Math***, and the ***Carmen Sandiego*** videos. There were also common problems with ***iTools***:

> *"We now have iPads and Apple TV's in the classroom. I am unable to access the iTools student edition and teacher edition from the iPad. It would be very helpful to have the technology updated so that these are available to iPad users."*

> *"I like the **ThinkCentral** website that students can access outside of school for more practice on difficult skills, but many of our students do not have access to a computer at home. They will only be able to access the activities in the school computer lab for a very limited amount of time."*

In many cases there are technical issues that without the ability to solve quickly lesson plans are interrupted and use of program components is impeded.

Access to Technology and Supplies

To overcome a lack of access to technology, on-line tools should have print alternatives available wherever possible:

> *"I like that there are so many things online, but I wish we had some of those in print. I did a lot of printing. I had two binders full of stuff that was online, like the* ***PARCC prep*** *and there was an* ***ELL book****, and if I'm going to have to use the paper to print them, I'd like to have them just already printed for me."*

Teachers without Smart Boards were unable to use ***ThinkCentral*** in the classroom and subsequently did not explore it as a resource outside of the classroom. Also, teachers did not always have the ability to find or make the materials required for games and asked if these could be included with the Manipulatives. Several lessons and activities (e.g., measurement) required objects that were lacking in some classrooms. This is doubly true for homework, where students were unable to complete workbook assignments for lack of access to special objects and supplies:

> *"Our regular classrooms are not all equipped with the items you request them to measure in the GO Math! book.* ***I feel it might be more beneficial if there were things on the page that the children could measure.*** *… The students who missed class those days had a difficult time measuring at home. They ended up measuring the tiny picture in the book and all of their answers are the same number."*

Content, Pacing, and the Need to Supplement

Teachers experienced difficulty in that students were not yet familiar with the tools, vocabulary, and much of the foundational content necessary to follow the lesson plan: *"…the program starts off assuming students know more than they do."* One teacher suggested that introductory lessons should be included to better familiarize students with the structure of the curriculum and explain recurring concepts such as how to solve word problems. Many were concerned that the pacing of the program was unrealistic, with not enough practice included. This combined with content overloading created problems for students: *"I find it's just too much at once sometimes."* Students had difficulty staying on target with many of the skills presented, though this tended to improve over the course of the year. Some teachers ended the year without having finished all of the chapters. Others dedicated twice the normal time allotted for math study in their classrooms in order to cover most of the lessons.

> *"It is impossible for me to do a lesson a day. It is taking about 3 days per lesson. This allows me to do* ***interventions*** *and then build in the* ***problem-solving*** *and* ***H.O.T. questions****, which are very important to me."*

Many teachers commented on gaps in knowledge between what their students learned in previous years (through other curricula) and what they were expected to know in order to progress through the lessons. As a result, teachers found that they needed to supplement *GO Math!* lessons with outside material in order for students to understand concepts, practice, and learn.

Some of the feedback involved teachers wishing they had more time to fully utilize the tools and resources available. Others commented on the difficulty they experienced trying to identify the appropriate resource book with the right intervention or activity. Teachers using the *GO Math!* program found it very difficult to coordinate the timing of lesson topics with teachers using other curricula—this was further problematic for families with multiple children in the same grade assigned to separate study conditions.

Several teachers expressed concern that there was not enough practice to get students to a level of memorizing basic addition and subtraction solutions. One suggested including flashcards for "Quick Facts". Another teacher included more built-in practice for his students and suggested it be added to the *GO Math!* curriculum: *"That is something I did with my first graders, on the whiteboard, and we did it really quickly. We called it 'Lightning Round Addition or Subtraction,' and it just took 5 or 10 minutes."*

The content areas garnering the most criticism involved chapters on **telling time** and **counting money**, where teachers felt there was not enough time and practice dedicated to each topic. Specifically for the second grade, one teacher commented, *"I felt maybe there was* *a little more need for **telling time**. I felt like a whole chapter could have been devoted to that. I have a chapter that is both time and money and I think they could have been split up."*

Additional Time for Review and Practice

Some children do not possess the level of reading and writing skills required to follow the lessons and do the work, which can be an impediment to learning and performance: *"Sometimes there is too much print for many of my students who are just emergent readers. … Also some of my students do not know numbers 0-10 and how to write them correctly. Some review of these skills would be helpful as we begin the year."* This is especially true for first grade, but extends to second and third grade when it comes to exams: *"There was a lot of reading on the test and that was a problem for some students."*

> *"Many of them cannot read yet so the 'On Your Own' section is not really on their own, which makes it hard to work with the intervention groups."*

The following comments illustrate some of the specific struggles teachers and students have experienced:

- *"… They just need so much remediation and review and practice, and they're still having trouble understanding "fewer" – which group has fewer, which group has more, and we've been doing that all year and they just still struggle."*
- *"More review on the facts. Doesn't matter what grade you're in. Because they still count with their nose and their toes. The spiral review is there, but one problem isn't going to do it. There needs to be more."*

ELL and Special Needs

None of the teachers in the focus groups mentioned using the ***ELL Activity Guide***, though some commented on how much they valued the ***Reteach Book*** and other ***RTI*** assessments and components in responding to ELL student needs: *"It gives suggestions. I like that and I like how it says if they did this wrong well then maybe it's this."*

> *"… There is a low group that is completely left out … for the really gifted kids, this is painfully boring. There are extension problems, but they're not nearly enough. It's awesome for middle-of-the-roaders."*

One particular issue that some teachers felt was not well-addressed by the program involves ELL students with overall literacy issues: *"I had a book in Spanish, but my students can't read Spanish either."* One teacher suggested simplified lessons incorporating more pictures and a clearer focus on vocabulary-building. These students were unable to articulate the critical thinking or complete the written explanations required in the ***Student Edition*** and ***Standards & Practice Book***

For students with special needs, teachers felt that the ***RTI interventions*** were well-designed but did not contain enough practice: *"Kids in Special Ed need repeated practice over and over again."*

Parental Support

Though the degree of difficulty for parents varied with each school site, it was mentioned by at least one teacher at every school. Many parents struggled with understanding concepts and helping their children with homework:

- *"Several parents mentioned at conferences that they were at a loss for helping their students in Math because they weren't taught to do Math in the same way."*
- *"I've had some parents asking for the textbook to be sent home because they complain that they don't know how to show their child how to do it."*
- *"Concepts are difficult. Parents are stating this is difficult for them. We are a Title I school."*

Table 20 outlines specific recommendations for improvement for various parts of the program.

Table 20. Teacher Suggestions for Program Improvement

Resource	Comment
Student Books	Divide Student Edition textbook and Standards Practice book into two volumes each
	Improve binding on Standards Practice book
	Include more workspace in Standards Practice book for student practice
	Include more blank lines for all open-ended problems
	Include sample problems and clearer instructions on School-Home Letters
Online Tools	Simplify student log in process
	Provide parents with online timed practice sessions
	Provide flashcards/other tools for those without internet access
Teacher Edition (TE) Book &	Improve binding on TE books
	Include clearer instructions in TE for finding various resources

Other Resources	Incorporate Assessment Guide into TE
	Include all Answer Keys in TE
	Include Individual Record Form in TE
	Incorporate Blackline Masters into TE
	List specific activities in the Chapter at a Glance section of TE
	Include an easy reference list of manipulatives
	Provide general instructions for skills utilized throughout the curriculum (e.g., how to approach word problems)
	Build in more time for students to work in math centers before On Your Own
	Include more quizzes (similar to mid-chapter checkpoint) throughout units

Section Six Summary

Overall, treatment teachers expressed satisfaction with *GO Math!* via surveys, comments from logs, and comments from focus groups. They were pleased with the overall program and specifically the ***Student Edition consumable worktexts*** and ***Standards and Practice books*** as well as the setup of the teacher edition books. Teachers indicated they found the math journals and spiral review helpful, and when able to utilize ***ThinkCentral*** in their classrooms, they indicated that it was helpful during instructional time. Teachers also appreciated the program being aligned to the CCSS and indicated that the program was effective for students performing at grade level, but less engaging for students performing above grade level and occasionally too difficult for students below grade level.

Students indicated via surveys that they liked the ***Student Edition consumable worktexts*** as well and that the ***Animated Math Model videos*** were also enjoyable. Teachers also mentioned the ***H.O.T. Problems*** as one of the elements of the program for which students showed the most enthusiasm. Teachers indicated that some specific areas for improvement included adjusting the pacing guide (which many found too ambitious), building in more practice for reading and writing skills, and adding more material for below-grade-level and above-grade-level students.

Section Seven: Discussion

This final section of the report will summarize and interpret the first year findings of the *GO Math!* efficacy study and describe changes for the second year.

Explanation of Year One Findings

An analysis of student outcome data indicates that students using *GO Math!* performed comparably to students using control programs. However, for those using only *GO Math!*, when considering actual program implementation as a factor, those with relatively medium or high levels of *GO Math!* implementation were associated with more positive student outcomes on state standardized tests. This finding indicates that if *GO Math!* is implemented to a sufficient level in the classroom, that it has the potential to impact more positive test scores for students. Most teachers implemented at least 50% of the total program (including all preparation elements, mid-chapter checkpoints, and tests) and more than half of teachers implemented over 70% of available lessons. This level of implementation was considered adequate given that this was the first year using the new program in their classrooms. Many teachers, however, noted that due to district or standardized test preparation requirements, it was at times difficult to implement the program as intended. While the relationship between implementation and outcomes is only speculative after the first year of the study, the second year of the study will examine if students with greater exposure to *GO Math!* perform better, or those teachers using *GO Math!* in their classrooms are able to cover more of the program and consequently reflect more positive student scores after two years. In addition to possible moderation effects of program implementation, we offer additional explanations for the mixed results obtained after Year One.

Most teachers and their students using *GO Math!* indicated that they liked the program and that it worked well in their classrooms. Multiple program strengths were highlighted by teachers through implementation logs and focus group interviews. Specifically, teachers liked the physical setup of the program and having individual chapter books for the *Teacher Edition* as well as having consumable student workbooks. Teachers appreciated not having to carry around one large teacher edition textbook or make copies for students for each lesson. Additionally, teachers appreciated two specific elements of the pedagogy of the program: the spiral review in each chapter and allowing students to use multiple strategies for solving problems. Finally, teachers valued the program's alignment to the CCSS. Students also liked the program, particularly the H.O.T. Problems and the Animated Math Model videos. The Animated Math Model videos proved a fun way to engage students with the material. The H.O.T. Problems were challenging, but still achievable. Control teachers, many of whom were not working with a set curriculum but rather had to piece their math instruction materials together themselves, consistently rated their program lower than treatment teachers. Despite this positive feedback about the *GO Math!* program, the first year of implementing any new program can be difficult for teachers. Training and follow-up training provided guidance for incorporating the new program, but efficient usage takes time for even the most skilled professionals. It is expected that as teachers continue to use the program during Year Two, familiarity with the structure and content will lead to more thorough implementation.

For many teachers, the 2012-13 school year was the first year they attempted to implement use of CCSS in their classrooms. For some teachers, using *GO Math!* served as their initial introduction to the contents of CCSS, while others had more experience. Regardless of previous training, trying to implement CCSS proved difficult for all teachers in both study conditions. For those not yet implementing CCSS at the state level, it was difficult to cover everything for *GO Math!* as well as additional topics that would be tested on the district or state tests. Furthermore, nearly every teacher did not follow the chapters in exact order due to conflicting district timelines which did not correspond to the setup of the *GO Math!* program. Additionally, treatment teachers expressed this difficulty in implementing a new math program and the CCSS simultaneously. Some schools indicated having one curriculum that was aligned to the CCSS and one curriculum (control) that was not proved difficult as well. It is expected that as teacher become more familiar with CCSS and new CCSS-aligned assessments are commonplace, these issues will dissipate.

Finally, the training provided to participating GO Math! teachers consisted of webinars with GO Math! trainers at the beginning of the 2012-13 school year, as well as a follow-up session later in fall. Although instruction via webinar was considered more beneficial than no training, it appears that many teachers had a difficult time adequately transferring program knowledge and tips for usage via the webinar training, whereas an in-person initial training would have been ideal. The webinar format did seem to work well for follow-up training. Additionally, the initial training sessions did not provide teachers with much of an opportunity to witness how a *GO Math!* lesson is ideally taught in the classroom and no opportunity to practice what they learned. Therefore, additional training in GO Math! is recommended to occur via in-person sessions as well as include model lessons to demonstrate proper implementation to maximize program usage and adherence to implementation guidelines.

Year Two Study Changes

One major change that has occurred in the study involves two school sites, located in the same district. From their own internal progress monitoring data collected during Year One, teachers and administrators at these school sites observed that students in *GO Math!* classrooms had better outcomes in comparison to control classrooms. In addition, teachers and parents of control classroom students were concerned that control programs were not linked to CCSS and consequently students would be at a disadvantage later without exposure to *GO Math!* and the inherent link to CCSS. While our own study data have not supported these same assertions regarding these advantages for *GO Math!* students in these schools, district and school administration decided to purchase the entire program for all grade levels at these schools at the end of Year One. Consequently, all teachers at the schools will be using *GO Math!* during the second year of the study which effectively removes the control groups from both of these school sites. Those teachers who were originally designated as treatment teachers will continue to complete implementation logs and student data will still be collected for students of these teachers, providing additional information regarding two-year usage of the *GO Math!* program and its effect on student achievement.

A second change to the study in Year Two involves reporting of coverage of CCSS by treatment teachers. During Year One, specific lessons *in GO Math!* were linked to specific CCSS as indicated by published HMH materials, thus inferring coverage of CCSS when specific lessons were reviewed. However, control teachers reported coverage of CCSS directly on teacher logs. We understand that often teachers either supplement with materials to ensure coverage of CCSS or tend to underreport coverage due to simple memory errors or inaccurate estimation.

Therefore, in Year Two we will supplement treatment teacher logs with direct reporting of CCSS to ensure that data collected for both conditions are comparable for reporting, ultimately allowing for a better comparison between treatment and control teachers' coverage of the CCSS.

Throughout the second year of the study, we will continue to monitor implementation to determine if program usage increases or changes as teachers become more accustomed to the program. We expect that teachers will begin adding additional elements, and consequently increasing their implementation, as they (and students) get more comfortable using the program. Every teacher, control and treatment, will be observed teaching a *GO Math!* lesson in the classroom and an observation protocol will be completed for each teacher. Additionally, the new first grade students, both control and treatment, will complete the ITBS as a pretest measure in the fall. All students, control and treatment in grades one, two, and three, will complete the ITBS as a posttest measure in the spring and appropriate analyses of test results will be conducted.

Additional analyses in Year Two will focus on answering research questions related to how well teachers use the program in their classrooms in one versus two years of program implementation. In addition, we will examine if exposure to GO Math! for two consecutive years is advantageous for students. Due to personnel changes at many of the participating school sites, there were fifteen new teachers at study sites for the 2013-14 school year. Most of these teachers were in treatment classrooms, which means that though the second study year will be the first year they are teaching *GO Math!*, for those teaching second and third grades, their students will theoretically have already had a year of *GO Math!* instruction. We will conduct analyses that take this into consideration upon completion of the second year of the study. We made every effort to remind schools to keep students in corresponding condition classrooms as they progressed from first to second grade or second to third grade, and will document any condition changes as the study progresses. We hypothesize that students who receive two years of *GO Math!* instruction from a teacher who also used the program for the two years of the study will demonstrate higher scores on outcome measures than students who did not.

Section Seven Summary

While results indicate that students using GO Math! performed comparably to students using control programs, those in classes with relatively medium or high implementation were associated with more positive student outcomes on state standardized tests illuminating the potential for GO Math! to have a positive impact on student scores when the program is used as intended. The study results also highlight the current changes in the rollout of CCSS, as many study teachers (treatment and control) implemented CCSS in their classrooms for the first time during the study. Additional changes in Year Two include having treatment teachers document coverage of CCSS directly. Most study teachers from Year One will remain in the study during Year Two, and research questions will focus on longer-term effects of using the program for both teacher implementation and student outcomes.

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Appendix A. Treatment Teacher Training Description

Teacher training was comprised of two separate sections: a research study orientation and product training. All participating sites participated in training at their own school sites prior to the start of study participation. Training sessions occurred between May and August, 2012, with most schools' training occurring in August.

Research Study Orientation: A representative from the *Cobblestone* research team provided the study overview training to all participating treatment and control teachers and study liaisons. The research study orientation included a review of study activities, including timelines and procedures for pre/post testing and shipping of testing materials. The orientation also included collecting specific teacher information such as contact information, demographic information and signed teacher consent forms. Most study orientation sessions were held prior to the product training sessions so all teachers could be present, and then control teachers were excused while treatment teachers attended the product overview sessions.

Product training: An HMH trainer conducted the product overview training for approximately 5 hours during the first session. Trainers used a PowerPoint presentation to review the program pedagogy, program components and also demonstrate online features of the program. All trainers were familiar with product components. A follow up training was held with all study sites in which trainers held a WebEx conference with each individual school approximately four weeks after the school year began to reinforce usage of program components and to identify any problems that teachers were having using the new program. During follow up sessions trainers also reviewed additional online components. Trainers also provided their individual contact information for teachers to follow up with them directly if they had any questions about the program or specific components.

Appendix B. Treatment Teacher Interview Protocol

1) Please describe the elements of the *GO Math!* program that best contribute to your students' learning.
    a. Is the program meeting the needs of your students in the areas of problem solving, computation, math concepts, etc.?
2) Do you find that *GO Math!* addresses every Common Core mathematical practice as well as you would like?
3) Please let us know your opinion of the physical setup of the program (i.e., the separate books for each chapter, the consumable student books).
    a. What specific elements do you find most helpful? Least helpful?
4) Please comment on the accompanying ThinkCentral component.
    a. If you use ThinkCentral, what do you like most?
    b. What do you like least?
    c. If you do not use ThinkCentral, why do you not use it?
5) In your opinion, is *GO Math!* able to meet the needs of all students in your class, regardless of gender, ethnicity, ELL status, etc.?
6) In general, please describe your view of the pacing and flow of the lessons.
7) In your opinion, what did your students think about the *GO Math!* program?

Appendix C. Treatment Teacher Implementation Guidelines for *GO Math!*

The following guidelines cover implementation for each Chapter and Lesson of the *GO Math!* program. Chapters consist of multiple lessons that address one or more domains of the Common Core State Standards. All lessons contain an Essential Question and follow a four-step process of *Engage*, *Teach and Talk*, *Practice*, and *Summarize*. Please adhere to these guidelines during the *GO Math!* efficacy study and follow the pacing plan outlined in the Planning Guide. Each component listed below is considered a **required** element when implementing the *GO Math!* program.

Required

Before you start a new Chapter…

- Review the Chapter Essential Question & Chapter At A Glance
- Review Teaching for Depth
- Review Prerequisite Skills
- Developing Math Language
- Introduce the Chapter
    - Including Show What You Know Diagnostic Assessment

Lesson Implementation – make sure to use program materials where noted (e.g. Math Boards)

- Problem of the Day
- **Engage**
- **Teach and Talk**
- **Practice**
- **Summarize**
- Quick Check differentiation problems
- HOT (Higher Order Thinking) problems
- Common Errors

Each component listed below is considered an **optional** element when implementing the *GO Math!* program.

Lesson Components

- Fluency Builder problems
    - Differentiated Instruction activities, including Grab-and-Go! Independent activities

Digital Resources

ThinkCentral

- Animated Math Models
- iTools
- HMH Mega Math
- Soar to Success Math
- eStudent Edition

Other

- *GO Math!* National Classroom Connection Site: http://www.hmhelearning.com/math/gomath12/na/index/php

Appendix D. Common Core Mathematics State Standards for First, Second and Third Grades

Common Core Mathematics State Standards for First Grade

Operations and Algebraic Thinking

1.OA.A.1
Use addition and subtraction within 20 to solve word problems

1.OA.A.2
Solve word problems that call for addition of three whole numbers whose sum is less than or equal to 20

1.OA.B.3
Apply properties of operations as strategies to add and subtract.

1.OA.B.4
Understand subtraction as an unknown-addend problem.

1.OA.C.5
Relate counting to addition and subtraction.

1.OA.C.6
Add and subtract within 20, demonstrating fluency for addition and subtraction within 10.

1.OA.D.7
Understand the meaning of the equal sign, and determine if equations involving addition and subtraction are true or false.

1.OA.D.8
Determine the unknown whole number in an addition or subtraction equation relating three whole numbers.

Number and Operations in Base Ten

1.NBT.A.1
Count to 120, starting at any number less than 120.

1.NBT.B.2
Understand that the two digits of a two-digit number represent amounts of tens and ones.

1.NBT.B.3
Compare two two-digit numbers based on meanings of the tens and ones digits, recording the results of comparisons with the symbols >, =, and <.

1.NBT.C.4
Add within 100, including adding a two-digit number and a one-digit number, and adding a two-digit number and a multiple of 10, using concrete models or drawings and strategies based on place value, properties of operations, and/or the relationship between addition and subtraction.

1.NBT.C.5
Given a two-digit number, mentally find 10 more or 10 less than the number, without having to count; explain the reasoning used.

1.NBT.C.6
Subtract multiples of 10 in the range 10-90 from multiples of 10 in the range 10-90 (positive or zero differences.)

Measurement & Data

1.MD.A.1
Order three objects by length; compare the lengths of two objects indirectly by using a third object.

1.MD.A.2
Express the length of an object as a whole number of length units, by laying multiple copies of a shorter object (the length unit) end to end.

1.MD.B.3
Tell and write time in hours and half-hours using analog and digital clocks.

1.MD.C.4
Organize, represent, and interpret data with up to three categories; ask and answer questions about the total number of data points, how many in each category, and how many more or less are in one category than in another.

Geometry

1.GA.1
Distinguish between defining attributes (e.g., triangles are closed and three-sided) versus non-defining attributes (e.g., color, orientation, overall size).
1.GA.2
Compose two-dimensional shapes (rectangles, squares, trapezoids, triangles, half-circles, and quarter-circles) or three-dimensional shapes (cubes, right rectangular prisms, right circular cones, and right circular cylinders) to create a composite shape, and compose new shapes from the composite shape.
1.GA.3
Partition circles and rectangles into two and four equal shares, describe the shares using the words halves, fourths, and quarters, and use the phrases half of, fourth of, and quarter of.

Common Core State Standards for Second Grade

Operations and Algebraic Thinking

2.OA.A.1
Use addition and subtraction within 100 to solve one- and two-step word problems involving situations of adding to, taking from, putting together, taking apart, and comparing, with unknowns in all positions, e.g., by using drawings and equations with a symbol for the unknown number to represent the problem.
2.OA.B.2
Fluently add and subtract within 20 using mental strategies. By end of Grade 2, know from memory all sums of two one-digit numbers.
2.OA.C.3
Determine whether a group of objects (up to 20) has an odd or even number of members, e.g., by pairing objects or counting them by 2s; write an equation to express an even number as a sum of two equal addends.
2.OA.C.4
Use addition to find the total number of objects arranged in rectangular arrays with up to 5 rows and up to 5 columns; write an equation to express the total as a sum of equal addends.

Number and Operations in Base Ten

2.NBT.A.1
1a. 100 can be thought of as a bundle of ten tens — called a "hundred."
1b. The numbers 100, 200, 300, 400, 500, 600, 700, 800, 900 refer to one, two, three, four, five, six, seven, eight, or nine hundreds (and 0 tens and 0 ones).
2.NBT.A.2
Count within 1000; skip-count by 5s, 10s, and 100s.
2.NBT.A.3
Read and write numbers to 1000 using base-ten numerals, number names, and expanded form.
2.NBT.A.4
Compare two three-digit numbers based on meanings of the hundreds, tens, and ones digits, using >, =, and < symbols to record the results of comparisons.
2.NBT.B.5
Fluently add and subtract within 100 using strategies based on place value, properties of operations, and/or the relationship between addition and subtraction.
2.NBT.B.6
Add up to four two-digit numbers using strategies based on place value and properties of operations.

2.NBT.B.7
Add and subtract within 1000, using concrete models or drawings and strategies based on place value, properties of operations, and/or the relationship between addition and subtraction; relate the strategy to a written method. Understand that in adding or subtracting three-digit numbers, one adds or subtracts hundreds and hundreds, tens and tens, ones and ones; and sometimes it is necessary to compose or decompose tens or hundreds.
2.NBT.B.8
Mentally add 10 or 100 to a given number 100–900, and mentally subtract 10 or 100 from a given number 100–900.
2.NBT.B.9
Explain why addition and subtraction strategies work, using place value and the properties of operations. Explanations may be supported by drawings or objects.

Measurement and Data

2.MD.A.1
Measure the length of an object by selecting and using appropriate tools such as rulers, yardsticks, meter sticks, and measuring tapes.
2.MD.A.2
Measure the length of an object twice, using length units of different lengths for the two measurements; describe how the two measurements relate to the size of the unit chosen.
2.MD.A.3
Estimate lengths using units of inches, feet, centimeters, and meters.
2.MD.A.4.
Measure to determine how much longer one object is than another, expressing the length difference in terms of a standard length unit.
2.MD.B.5.
Use addition and subtraction within 100 to solve word problems involving lengths that are given in the same units, e.g., by using drawings (such as drawings of rulers) and equations with a symbol for the unknown number to represent the problem.
2.MD.B.6.
Represent whole numbers as lengths from 0 on a number line diagram with equally spaced points corresponding to the numbers 0, 1, 2, ..., and represent whole-number sums and differences within 100 on a number line diagram.
2.MD.C.7.
Tell and write time from analog and digital clocks to the nearest five minutes, using a.m. and p.m.
2.MD.C.8.
Solve word problems involving dollar bills, quarters, dimes, nickels, and pennies, using $ and ¢ symbols appropriately. Example: If you have 2 dimes and 3 pennies, how many cents do you have?
2.MD.D.9.
Generate measurement data by measuring lengths of several objects to the nearest whole unit, or by making repeated measurements of the same object. Show the measurements by making a line plot, where the horizontal scale is marked off in whole-number units.
2.MD.D.10.
Draw a picture graph and a bar graph (with single-unit scale) to represent a data set with up to four categories. Solve simple put-together, take-apart, and compare problems[1] using information presented in a bar graph.

Geometry

2.G.A.1.
Recognize and draw shapes having specified attributes, such as a given number of angles or a given number of equal faces. Identify triangles, quadrilaterals, pentagons, hexagons, and cubes.
2.G.A.2.
Partition a rectangle into rows and columns of same-size squares and count to find the total number of them.
2.G.A.3.
Partition circles and rectangles into two, three, or four equal shares, describe the shares using the words halves, thirds, half of, a third of, etc., and describe the whole as two halves, three thirds, four fourths. Recognize that equal shares of identical wholes need not have the same shape.

Common Core Mathematics State Standards for Third Grade

Operations and Algebraic Thinking

3.OA.1
Interpret products of whole numbers
3.OA.2
Interpret whole-number quotients of whole numbers
3.OA.3
Use multiplication and division within 100 to solve word problems in situations involving equal groups, arrays, and measurement quantities
3.OA.4
Determine the unknown whole number in a multiplication or division equation relating three whole numbers.
3.OA.5
Apply properties of operations as strategies to multiply and divide
3.OA.6
Understand division as an unknown-factor problem.
3.OA.7
Fluently multiply and divide within 100, using strategies such as the relationship between multiplication and division
3.OA.8
Solve two-step word problems using the four operations. Represent these problems using equations with a letter standing for the unknown quantity. Assess the reasonableness of answers using mental computation and estimation strategies including rounding.
3.OA.9
Identify arithmetic patterns (including patterns in the addition table or multiplication table), and explain them using properties of operations.

Number and Operations in Base Ten

3.NBT.1
Use place value understanding to round whole numbers to the nearest 10 or 100.
3.NBT.2
Fluently add and subtract within 1000 using strategies and algorithms based on place value, properties of operations, and/or the relationship between addition and subtraction.
3.NBT.3
Multiply one- digit whole numbers by multiples of 10 in the range 10-90 (e.g. 9 x 80, 5 x 60) using strategies based on place value and properties of operations.

Number and Operations – Fractions

3.NF.1
Understand a fraction 1/b as the quantity formed by 1 part when a whole is portioned into b equal parts; understand a fraction a/b as the quantity formed by a parts of size 1/b.
3.NF.2
Understand a fraction as a number on the number line; represent fractions on a number line diagram.
3.NF.3
Explain equivalence of fractions in special cases, and compare fractions by reasoning about their size.

Measurement and Data

3.MD.1
Tell and write time to the nearest minute and measure time intervals in minutes. Solve word problems involving addition and subtraction of time intervals in minutes, e.g. by representing the problem on a number line diagram.
3.MD.2
Measure and estimate liquid volumes and masses of objects using standard units of grams (g), kilograms (kg), and liters (l). Add, subtract, multiply, or divide to solve one-step word problems involving masses or volumes that are given in the same units, e.g., by using drawings (such as a beaker with a measurement scale) to represent the problem.
3.MD.3
Draw a scaled picture graph and a scaled bar graph to represent a data set with several categories. Solve one- and two-step "how many more" and "how many less" problems using information presented in a scaled bar graphs.
3.MD.4
Generate measurement data by measuring lengths using rulers marked with halves and fourths of an inch. Show the data by making a line plot, where the horizontal scale is marked off in appropriate units— whole numbers, halves, or quarters.
3.MD.5
Recognize area as an attribute of plane figures and understand concepts of area measurement.
3.MD.6
Measure areas by counting unit squares (square cm, square m, square in., square ft., and improvised units).
3.MD.7
Relate area to the operations of multiplication and addition.
3.MD.8
Solve real world and mathematical problems involving perimeters of polygons, including finding the perimeter given the side lengths, finding an unknown side length, and exhibiting rectangles with the same perimeter and different areas or with the same area and different perimeters.

Geometry

3.G.1
Understand that shapes in different categories (e.g., rhombuses, rectangles, and others) may share attributes (e.g., having four sides) and that the shared attributes can define a larger category (e.g., quadrilaterals). Recognize rhombuses, rectangles, and squares as examples of quadrilaterals, and draw examples of quadrilaterals that do not belong to any of these subcategories.

3.G.2
Partition shapes into parts with equal areas. Express the area of each part as a unit fraction of the whole.

Appendix E. Teachers' Common Core State Standards Coverage

Each Common Core domain (e.g., Operations & Algebraic Thinking) contained a specific number of standards. For example, in third grade, there are nine separate standards under the Operations & Algebraic Thinking domain. For each teacher, the percentage of standards covered in each domain was calculated. The tables below show the percentages for each domain for both the control group and the treatment group.

Table a. First Grade Teachers Common Core Coverage

Teacher	Operations & Algebraic Thinking	Number & Operations in Base 10	Measurement & Data	Geometry	Total
CONTROL TEACHERS					
1	100%	100%	100%	100%	**100%**
2	88%	83%	100%	100%	**93%**
3	100%	100%	100%	100%	**100%**
4	100%	83%	75%	100%	**90%**
5	100%	67%	100%	100%	**92%**
6	100%	100%	100%	100%	**100%**
7	100%	83%	50%	33%	**67%**
8	100%	83%	50%	100%	**83%**
9	100%	83%	100%	0%	**71%**
10	100%	100%	100%	100%	**100%**
11	100%	100%	100%	100%	**100%**
12	100%	83%	100%	0%	**71%**
Control Average	**98%**	**88%**	**89%**	**77%**	**89%**
TREATMENT TEACHERS					
1	100%	0%	0%	0%	**25%**
2	100%	100%	75%	100%	**94%**
3	100%	83%	0%	100%	**71%**
4	88%	100%	100%	67%	**89%**
5	100%	33%	100%	100%	**83%**
6	100%	75%	50%	100%	**81%**
7	100%	83%	75%	100%	**90%**
8	63%	100%	75%	67%	**76%**
9	100%	100%	75%	67%	**85%**
10	100%	100%	100%	67%	**92%**
11	75%	100%	25%	67%	**67%**
12	88%	100%	25%	0%	**53%**
13	88%	83%	100%	100%	**93%**
14	100%	50%	100%	100%	**88%**
Treatment Average	**93%**	**79%**	**64%**	**74%**	**78%**

Table b. Second Grade Teachers Common Core Coverage

Teacher	Operations & Algebraic Thinking	Number & Operations in Base 10	Measurement & Data	Geometry	Total
CONTROL TEACHERS					
1	100%	89%	70%	100%	**90%**
2	100%	100%	100%	100%	**100%**
3	100%	100%	80%	33%	**78%**
4	100%	90%	100%	100%	**98%**
5	50%	56%	80%	67%	**63%**
6	100%	100%	80%	100%	**95%**
7	100%	67%	100%	100%	**92%**
8	75%	89%	90%	100%	**88%**
9	100%	100%	100%	100%	**100%**
Control Average	**92%**	**88%**	**89%**	**89%**	**89%**
TREATMENT TEACHERS					
1	100%	89%	90%	100%	**95%**
2	75%	100%	90%	100%	**91%**
3	100%	100%	90%	100%	**98%**
4	100%	100%	90%	0%	**73%**
5	100%	100%	90%	100%	**98%**
6	100%	100%	90%	100%	**98%**
7	100%	100%	20%	67%	**72%**
8	75%	100%	90%	0%	**66%**
9	100%	100%	70%	100%	**93%**
10	100%	100%	90%	100%	**98%**
11	75%	20%	60%	67%	**55%**
12	100%	100%	90%	100%	**98%**
13	25%	78%	90%	100%	**73%**
14	100%	100%	90%	0%	**73%**
Treatment Average	**89%**	**92%**	**81%**	**74%**	**84%**

Table c. Third Grade Teachers Common Core Coverage

Teacher	Operations & Algebraic Thinking	Number & Operations in Base 10	Number & Operations – Fractions	Measurement & Data	Geometry	Total
1	89%	67%	0%	50%	100%	**61%**
2	100%	100%	100%	100%	100%	**100%**
3	89%	100%	67%	88%	50%	**79%**
4	100%	100%	100%	100%	100%	**100%**
5	100%	100%	100%	88%	100%	**98%**
6	100%	67%	100%	88%	100%	**91%**
7	100%	100%	0%	100%	100%	**80%**
8	100%	100%	100%	88%	100%	**98%**
9	89%	67%	33%	75%	100%	**73%**
10	89%	100%	100%	100%	100%	**98%**
11	67%	100%	0%	13%	0%	**36%**
Control Average	**93%**	**91%**	**64%**	**81%**	**86%**	**83%**
1	100%	100%	100%	100%	100%	**100%**
2	100%	100%	100%	100%	100%	**100%**
3	100%	67%	0%	8%	50%	**45%**
4	100%	67%	57%	25%	0%	**50%**
5	100%	100%	57%	100%	100%	**91%**
6	100%	100%	14%	17%	50%	**56%**
7	100%	100%	100%	33%	0%	**67%**
8	100%	100%	100%	75%	50%	**85%**
9	78%	67%	57%	92%	0%	**59%**
10	100%	67%	14%	17%	0%	**40%**
11	100%	100%	100%	100%	100%	**100%**
Treatment Average	**100%**	**67%**	**100%**	**92%**	**100%**	**92%**

Appendix F. Random-intercept Models with Covariates

To estimate the program effect, we ran a random-intercept model with covariates using Mplus, version 6. Our model was a two-level linear models with students nested within classrooms (Rabe-Hesketh & Skrondal, 2008). A general linear random-intercept model with covariates can be represented as follows:

$$\begin{aligned} y_{ij} &= \beta_1 + \beta_2 x_{2ij} + \ldots + \beta_p x_{pij} + \zeta_j + \varepsilon \\ &= (\beta_1 + \zeta_j) + \beta_2 x_{2ij} + \ldots + \beta_p x_{pij} + \varepsilon \end{aligned}$$

In the above model, y_{ij} refers to the outcome of student *i* in cluster (or class) *j*; *x*'s refer to various students, teacher/class variables (i.e., covariates). The random intercept term (i.e., ζ_j) signals the linear model is of multilevel (two-level in our study) rather than simple OLS (ordinary least square) regression.

The following is a list of variables and their operational definitions associated with student background characteristics that were used in the HLM models.

Outcome variables:

1. ITBS scaled scores posttest
2. *Z*-score of state standardized test

Student background characteristics variables:

1. Proxies for prior academic achievement
   - Prior ITBS scaled scores pretest
2. Race indicators
   - African American (1)
   - Hispanic or Latino (1)
   - Other ethnicity (1)
   - White (reference group)
3. English language learner
   - English language learner (1)
   - Non-English language learner (reference group)
4. Grade level indicators
   - Grade 2 (1)
   - Grade 3 (1)
   - Grade 1 (reference group)
5. Social economic status proxy measure
   a. Free reduced lunch (1)
   b. No free reduced lunch (reference group)
6. Special Education
   a. Special education (1)
   b. Not enrolled in special education (reference group)
7. Math attitudes
   a. Composite score

Teacher/classroom characteristics variables:

1. Condition
   - Treatment (1)
   - Control (reference group)
2. Teacher education
   - Advanced degree (i.e., MA or PhD; 1)
   - No advanced degree (i.e., BA or certificate; reference group)
3. Student engagement
   - Composite score (1=very low, 5=very high)
4. Classroom management
   - Composite score (1=very low, 5=very high)

Appendix G. Effect Size Calculations

Hedges's g estimated from HLM analyses is defined as the adjusted group mean difference divided by the unadjusted pooled within-group SD. The formula for this calculation is:

$$g = \frac{\gamma}{\sqrt{\frac{(n_1 - 1)S_1^2 + (n_2 - 1)S_2^2}{(n_1 + n_2 - 2)}}}$$

In the above formula, γ equals the HLM coefficient for the intervention's effect (see coefficient for "Condition" in **Table 13, Table 14, Table 15, and Table 16** in Section 5); n_1 is the treatment sample size for the HLM analysis and n_2 is the control sample size for the HLM analysis (see **Table 17**); S_1 and S_2 are the student-level unadjusted posttest SD for the treatment and control groups, respectively (see **Table 17**). The calculation was performed both by hand-written calculations and using an effect size calculator provided online from Emory University[9].

9 http://www.psychsystems.net/manuals/StatsCalculators/Effect_Size_Calculator%2017.xls

Appendix H. Attrition and Differential Attrition Analyses

Sample attrition is defined as those students who completed the ITBS pretest, yet did not complete the ITBS posttest. There were 1,527 participating students that completed the pretest. Of the original 1,527 students, 1,387 also completed the posttest. A total 1,363 students were included in the final sample. This final inclusion of 1,363 students was based on missing demographic information for select students who were subsequently removed from the analyses.

The difference between the original sample of students that took any or all of the pretests and the final number of students is 140. Teachers reported on their monthly online logs that 49 students moved out of the schools' boundaries; however, we suspect that most of the students that did not complete a posttest did move although we did not have a way to confirm this assumption. The other likely possibility for a small number of students would be an absence during the posttesting period.

An overall summary of the attrition data is provided in **Table a**. This table shows that there were statistical differences when comparing the number of students in the treatment and control groups and in the participating and attrition groups, $X^2(1, N = 1{,}527) = 6.48$, $p < .05$. Overall, the treatment had significantly more students drop from the study than the control group (11% vs. 7%, respectively) after completing the pretest. After accounting for attrition, there were 766 participating treatment students (89% of treatment students with a pretest) and 621 participating control students (93% of control students with a pretest) who had completed the ITBS pretest and posttest. Because there were more treatment students from the treatment group that dropped out of the study, we analyzed the pretest ITBS score for only the students who dropped out. We found that the pretest scores of the student that dropped out from both the treatment and control groups were equivalent, $t(138) = .37$, $p = .72$. This provides us confidence that while more treatment students dropped from the study, this did not impact the overall analysis comparing students who completed both the pretest ITBS and posttest ITBS.

Table a. Total Students with a Pretest Assessment: Students with Pretest and Posttest vs. Students Missing Posttest Only

Assessment	Condition	Students with Complete Pretest and Posttest	Students Missing Posttest Only (Attrition)	*p* of chi square
ITBS	Treatment	766 (89%)	93 (11%)	0.011
	Control	621 (93%)	47 (7%)	

Differential Attrition

Almost any experimental study has participant attrition, particularly in applied research settings (i.e., schools) where students may leave before the year is over due to circumstances outside of the control of the school, teacher, or researchers. What is important to determine, however, is whether there was differential attrition such that students in one group (treatment or control) were more likely to exit the study in comparison to the other group before completing posttest measures; two sets of analyses were conducted to test this. The first set of analyses used demographic characteristics to examine the extent to which students that completed both a pretest and posttest differ from students that completed only a pretest. The second set of analyses sought to determine if of the students who dropped out of the study, the treatment and control students differ in their achievement scores on the ITBS. The second set of analyses was discussed in Section Five under the Attrition section.

Based on our sample attrition analysis, there were 140 students who took the ITBS pretest assessment but did not take a posttest. **Table b** explores the demographic characteristics of these students to see whether there was any systematic differential attrition between the groups.

Table b shows that the students in the attrition group generally corresponded to the same group of students that completed the study. The only area where groups were unequal was for socio-economic status where students in the treatment group were more likely to be eligible for free or reduced lunch; however, the difference was not a result of attrition as be seen in the table.

Table b. Students with Complete Pretest and Posttest vs. Complete Pretest Only

Demographic Characteristics		Pretest and Posttest Complete *n* = 1,387		Complete Pretest Only *n* = 140		*p* of Chi Square
		Treatment *n* = 766	Control *n* = 621	Treatment *n* = 93	Control *n* = 47	
Gender	Male	50%	40%	6%	3%	0.84
	Female	51%	41%	5%	3%	
Ethnicity	Caucasian	51%	43%	4%	2%	0.64
	Hispanic/Latino	51%	43%	4%	2%	
	Multi-ethnic / Other	50%	45%	4%	1%	
	African-American	62%	32%	5%	1%	
Primary Language	English	52%	41%	5%	2%	0.43
	English Language Learner	49%	46%	2%	3%	
Social Economic Status	Non-Eligible for Free/Reduced Lunch	49%	46%	3%	2%	0.03
	Free/Reduced Lunch Eligible	56%	38%	4%	2%	
Grade	Grade 1	50%	41%	6%	3%	0.95
	Grade 2	50%	40%	7%	3%	
	Grade 3	51%	41%	5%	3%	