Academy of MATH®

EFFICACY STUDY
(Randomized Control Study)

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ACADEMY OF MATH® EFFICACY STUDY SUMMARY

The *Academy of MATH®* is a standards-based online intervention that can be used with a wide variety of students struggling in mathematics for instruction, assessment, and progress monitoring. The *Academy of MATH* is research-based and follows fundamental learning principles including: allowing multiple opportunities to learn, using a mastery-based learning approach, and providing consistent motivation. The program helps struggling students develop conceptual, procedural, and strategic competence in 10 skill areas essential to mathematics proficiency. To that end students are first administered an automated placement test which provides a snapshot of their mathematical ability relative to their grade level, identifies performance goals, and creates an Individualized Training Plan. While students train on the different skill areas the Responsive Intervention Engine monitors progress and adjusts content to accelerate or remediate as required.

DESIGN AND METHODS

The purpose of the current study was to evaluate the efficacy of the *Academy of MATH* program in helping Tier II and Tier III students that are at risk of academic failure in mathematics to attain critical mathematics skills. The study was a randomized control trial of the *Academy of MATH*. Therefore, the final results are based on a sample of 51 students identified as being at risk for academic failure in mathematics who were randomly assigned to receive intervention using the *Academy of MATH* as a pull-out intervention. The students who participated in the current study all attended Westwood Elementary School located in Manchester, Tennessee. The study was conducted by Edina Torlaković, Senior Reaseach Scientist at EPS Literacy and Intervention.

The researcher reviewed students' performance on two assessments administered in the fall of 2010/2011 school year to identify students in grades 2 through 4 that were at risk for academic failure in mathematics: the STAR Mathematics (STAR) assessment was used for grades 2 and Discovery Education Assessment Mathematics Progress Zone (DEAMPZ) was used for grades 3 and 4. Students included in the study were assessed before and after intervention with the Diagnostic Online Mathematics Assessment (DOMA) Basic Math Skills and the *Academy of MATH* Placement Test embedded in the program. These two measures were used as the primary indices of improvement in mathematical ability for the current study. To ensure that conclusions made based on the results of the current study are valid, the standards of the U.S. Department of Education's "What Works Clearinghouse" were adhered to in the design and implementation of the current study.

In the fall of 2010/2011 all students in grades 2 through 4 were tested with either STAR or DEAMPZ. Students that were in the bottom 30th percentile on STAR or performed at Basic or Bellow Basic proficiency level on DEAMPZ were identified as Tier II and Tier II students at risk for academic failure in mathematics. The students identified in the previous step were randomly assigned to either the treatment or control group. The final sample consisted of 51 students in grades 2 through 4, with 26 (51%) and 25 (49%) students assigned to the treatment or control group, respectively.

For the treatment group, teachers followed the requested guidelines for fidelity in the *Academy of MATH*. Students were "pulled-out" of the classroom to use the program 3 to 5 times a week, for 30 minutes each session, over a period of 7 months (November to May). This resulted in an average of 60 minutes per week per student using the program. Teachers were also not allowed to use any other math intervention product with the treatment group.

Across grades 2-4, teachers exposed the control students to a "business as usual" classroom instruction which included a variety of math activities.

RESULTS

Did students in the treatment group demonstrate significant learning gains in mathematics?

The results of the current study indicate that non-proficient students who train in the *Academy of MATH* show significant improvement in their mathematical abilities.

Students in the treatment group who were trained in the *Academy of MATH* exhibited significant gains from the start to the end of the study. Students in the treatment group achieved statistically significant (all $p < .01$) gains on all three subscales of DOMA: Numbers and Operations, Measurement, and Fractions. The gains ranged from over a full grade level to approximately half a grade level from the start to end of the study. They also gained over a full grade level on the *Academy of MATH* Placement Test (1.35). These gains were statistically significant ($p < .01$).

How does the mathematical performance of treatment students compare to the students in the control group?

Students in both the treatment and control group achieved gains in mathematical ability over the course of the current study. Overall, the gains achieved by students who trained in the *Academy of MATH* were greater than those achieved by students in the control group.

Students who trained in the *Academy of MATH* achieved gains across the three subscales that comprise the DOMA. They made significantly greater gains ($p < .05$) in Numbers/Operations and Measurement than students in the control group. Although both treatment and control students made substantial gains in Fractions ability the difference between the groups was not statistically significant ($p > .10$).

Students in the treatment group achieved gains of over a full grade level (1.35) based on the *Academy of MATH* Placement Test. In contrast, students in the control group only achieved gains of just over half a grade level (0.68). Analyses revealed that the greater gains achieved by students in the treatment condition were significantly greater than those achieved by students in the control group ($p < .05$).

How do *Academy of MATH* tests correlate with other standardized tests of mathematical ability?

The *Academy of MATH* Placement Test was strongly correlated to the three subscales of the norm-referenced DOMA assessment. Students scores on the *Academy of MATH* Placement pre-test were correlated with their DOMA Number/Operations ($r = .70$, $p < .01$), Fractions ($r = .34$, $p = .01$), and Measurement ($r = .60$, $p < .01$) scores. Furthermore, students scores on the *Academy of MATH* post-test were strongly correlated with their DOMA Number/Operations ($r = .70$, $p < .01$), Fractions ($r = .54$, $p < .01$), and Measurement ($r = .71$, $p < .01$) scores. These results suggest that the *Academy of MATH* Placement Test reliably measures students' mathematical abilities in several areas.

CONCLUSION

The results of the current study show that the *Academy of MATH*, when implemented with fidelity, is effective in providing a comprehensive intervention for Tier II and Tier III students that are at risk of academic failure in mathematics. Overall, students who trained in the *Academy of MATH* over a period of five months achieved significantly greater gains in mathematical ability than those students who received "business as usual" classroom instruction.

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1. INTRODUCTION

The goal of this study was to evaluate the efficacy of the *Academy of MATH* program with struggling students in mathematics at the elementary school level (grades 2 through 4). Such students are typical of Response to Intervention Tier II and Tier III students. The study was conducted during the 2010/2011 school year at Westwood Elementary School in Manchester, Tennessee. This report presents the evaluation design and methods, a description of the *Academy of MATH* program, an assessment of program implementation, student performance results, and a discussion of findings.

2. RESEARCH DESIGN

The purpose of this study was to evaluate the effectiveness of the *Academy of MATH* program in helping Tier II and Tier III students attain critical mathematics skills. The evaluation study employed a Randomized Controlled Trial (RCT) design with the random assignment of students to treatment and control groups. Students within each grade level were randomly selected to participate in a pull-out intervention employing either the *Academy of MATH* program or the materials teachers typically used with non-proficient students.

The study addressed the following over-arching evaluation questions:

1. Do students in the treatment group demonstrate significant learning gains in mathematics during the study period?
2. How does the mathematics performance of students in the treatment groups compare to that of students in the control group?

2.1 METHODOLOGICAL APPROACH

Westwood Elementary School is a rural elementary school in Manchester, Tennessee. Within the school's regular assessment, all students in grades 2–4 were pre-tested with either the STAR Math Assessment (grade 2 students only) or the Discovery Education Assessment Mathematics Progress Zone (DEAMPZ) (grades 3 through 4). These scores were used by the researcher in order to identify low-achieving Tier II and Tier III students. Students that were within 30th percentile on STAR or those that performed at Basic or Bellow Basic proficiency level on DEAMPZ were selected to participate in the study. They were randomly assigned to either the treatment or control group.

2.2 MEETING RESEARCH & EVALUATION STANDARDS

The current study met the quality standards for research set out by the U.S. Department of Education "What Works Clearinghouse" (WWC; 2006). The study also adhered to the Program Evaluation Standards described by the Joint Committee on Standards for Educational Evaluation (1994). This ensured that the study had construct, internal, and external validity. Furthermore, conclusions were based on sound statistical analyses and principles. The WWC Study Review Standards contain nine overarching standards that were considered in the design, implementation, and analyses of the current study. The following section briefly describes the steps that were taken to ensure the nine standards were met.

WWC STANDARDS

1. **Randomization**: At the classroom level all students were randomly assigned to either the control or treatment group.

2. **Baseline Equivalence**: Prior to the start of the study students in the treatment and control groups performed similarly on student outcome measures.

3. **Overall Attrition**: A site with a mobility rate of less than 20% was selected. This contributed to a low attrition rate of approximately 15% due to students dropping out of the study or a lack of complete data.

4. **Differential Attrition**: The attrition rates were essentially the same for the treatment (13%) and control (17%) groups. A chi-square analysis confirmed that the attrition rate did not significantly differ based on whether they were assigned to the treatment or control group.

5. **Intervention Contamination**: After careful consideration, it was determined that the current study was free of any events or other threats to validity. Thus, conclusions concerning the effects of the *Academy of MATH* program can be made confidently.

6. **Mismatch between Unit of Assignment and Unit of Analysis**: Recall that randomization occurred at the student level. Multi-level analyses were conducted to account for student, class, and school influences on students' outcomes.

7. **Variation in People and Outcomes**: Students included in the study had a variety of backgrounds. To account for this, demographic information and multiple measurements were used to assess all students' performance.

8. **Analysis of Interventions' Effects on Different Subgroups Outcomes**: In analyses of the outcome variables subgroups of students (gender, ethnicity, free/reduced lunch, and English language proficiency) were considered in the analyses.

9. **Statistical Reporting**: All primary results and statistical analyses concerning the current study are reported.

3. METHOD

The study evaluated the efficacy of the *Academy of MATH* program in helping students gain critical mathematical skills that were struggling with mathematics. The program was implemented as a pull-out intervention with groups of 2-6 students. This section describes different study components, including measures, procedures, settings and participants.

3.1 MEASURES

A combination of qualitative and quantitative methods was included in the study design in order to allow for a full understanding of the impact of *Academy of MATH* on students' mathematical abilities. The DOMA and *Academy of MATH* Placement Test were used to assess students' gains in mathematical ability. In contrast, the STAR Math and DEAPZ were used to identify students for the current study.

Diagnostic Online Mathematics Assessment: Basic Skills (DOMA)

The DOMA is an online assessment of students' basic mathematics skills. The program is designed to be administered to students from Kindergarten to grade 5. The program presents students with a variety of multiple choice questions and adapts the difficulty of these questions to students' skill level. The test evaluates students' mathematical ability in three areas: Numbers and Operations, Measurement, and Fractions. At the conclusion the DOMA a student is assigned a Grade Level Equivalent (GLE) score for each domain.

The DOMA has a large database of questions and thus can be administered several times a year. However, the publisher recommends that the test only be administered once every ten to twelve weeks.

Academy of MATH Placement Test

The *Academy of MATH* Placement Test is an assessment of students' mathematics ability. It is a multiple-choice test that determines students' mathematics ability in ten skill areas: number sense, addition, subtraction, multiplication, division, fraction operations, expressions/equations, measurement, geometry, and data/statistics/probability. The Placement Test is used to determine a student's grade-level to personalize their training in the *Academy of MATH* and track changes in their mathematical skills.

Discovery Education Assessment Mathematics Progress Zone (DEAMPZ)

The DEAMPZ is a multiple-choice assessment tied to state standards which assesses students' mathematical ability. Specifically, students are assessed in five areas: mathematical process, numerical operations, algebra, geometry/measurement, and data analysis.

STAR Math Assessment

The STAR Math Assessment is a norm-referenced online assessment of students' mathematical abilities. The test is designed for students in grades 1 through 12 and takes approximately 15 minutes to complete. Students are presented with multiple choice questions in eight areas: numeration concepts, computation processes, estimation, geometry measurement, data analysis/statistics, word problems, and algebra. Students receive an overall percentile rank score which was used in the current study to identify grade two students who were performing poorly.

3.2 PROCEDURES

This section describes procedures followed for various study aspects including site selection, data collection, training, implementation, test administration, and scoring.

Site Selection

Specific site selection criteria were set up in order to guarantee a student population and settings that are typical of *Academy of MATH* users. These are:

1. Implementation of *Academy of MATH*
2. Application of the RTI approach
3. Teachers' completion of implementation training

4. Schools' commitment to implement intervention with fidelity: student training in *Academy of MATH* 3–5 times a week for daily sessions of 30 minutes
5. Ethnic and economic diversity,
6. Teacher comfort with random assignment of students to groups, and
7. No other primary math intervention or research studies occurring.

Data Collection Timeframe

Table 1 represents the timeframe of training and data collection activities. The study orientation was done within the first month of school. Following the orientation, the student scores on STAR and DEAMPZ were reviewed and students participating in the study were selected. After random assignment of students into study groups was completed, the product training occurred. Product training was led by a certified *Academy of MATH* trainer who is also a curriculum specialist. After the training, implementation of *Academy of MATH* began.

Initial teacher training for the *Academy of MATH* started in November of 2010 and regular support calls began three weeks after this initial training on the *Academy of MATH*. These support calls included discussions with teachers and teaching assistants, modeling of intervention strategies, and additional training for staff. The trainer provided guidance throughout the implementation and visited the schools again in February.

Table 1: Timeline of Data Collection Activities

Task and Activity	August	September	October	November	December	January	February	March	April	May
Study orientation			√							
Administration of student measures				√	√					√
Assignment of students into study groups				√						
Teacher training begins				√						
Student training begins					√					
Follow up training and interviews					√	√	√	√	√	√
End of Study										√

Test Administration and Scoring

Teachers were presented with an overview of tests, including instruction for administration, make-up testing, accommodating students with Individualized Education Program plans, and assessment return.

- DOMA is administered online and scouring is automated.
- *Academy of MATH* Placement Test is administered online and scoring is automated.

Implementation Fidelity

In order to ensure that the *Academy of MATH* program was implemented with fidelity, various implementation-monitoring procedures were used. These included regular checks of the *Academy of MATH* database created with the products automated online data collection, implementation guidelines, teacher training, and regular follow-up calls.

Academy of MATH Database and Automated Online Data Collection

The *Academy of MATH* is an online intervention tool. The implementation fidelity is characterized by the extent to which students use the program. An automatic *Academy of MATH* database stores various aspects of implementation. These are time in program, time in focused training, number of skills mastered, percentage of program completed, etc. All these fidelity measures are saved every time a student logs in and their total is updated with every task completed by a student.

Implementation Guidelines

The *Academy of MATH* program is highly structured, and the Instructors Resource Guide provides a clear plan for program implementation. Accordingly, teachers followed the guidelines, having the students use the program three to five times a week for 30 minutes each session. Teachers were also not allowed to use any other intervention material with the treatment groups.

Training and Site Visits

EPS curriculum specialists designed implementation model for the *Academy of MATH*. This model is used by the Professional Development team and it is based on thousands of implementations with Tier II, Tier III, English Language Learners, and Special Education students. It integrates comprehensive professional development and ongoing support to meet the needs of diverse populations and close the achievement gap for struggling students.

A certified *Academy of MATH* and RTI implementation specialist was chosen to provide the site with training and support consistent with typical *Academy of MATH* services to schools.

Phase 1—Plan: School leaders determined the capacity for program fidelity while study implementation goals were established. At the end of this phase, teachers and administrators completed the Implementation Planning Guide.

Phase 2—Deploy: Professional development specialists equipped teachers with product knowledge and tools to implement the interventions effectively. Students received hands-on guidance, and teachers learned to monitor and manage student training. At the end of this phase,teachers:

- Understood the theory and benefits of the programs
- Assessed student's mathematics proficiency
- Monitored and managed student learning effectively

Trainers from Professional Development started the program with students to model best practices and ensure that teachers were engaged with the implementation. At the end of this phase, teachers:

- articulated the benefits of the programs to students
- created excitement for student learning in the programs
- started student training and interpret Placement Test results

Phase 3—Coach: Ongoing classroom coaching and implementation support helped teachers analyze data and apply appropriate intervention strategies for each student. This ensured ongoing program fidelity with on-site classroom coaching and supplemental materials. During these classroom visits, teachers were coached on:

- Monitoring student progress
- Analyzing and assessing data
- Intervention strategies
- Classroom strategies

Mid-Year Review: This ensured ongoing program fidelity with a mid-year review of interim report cards. With these reports, facilitators became aware of:

- Program usage and fidelity
- Student time-on-task and levels mastered
- Suggested ways to improve implementation

Phase 4—Evaluate: The Accelerated Learning Model team met with administrators to review year-end results and plan for the next school year.

A Comprehensive Year-end Report helped teachers and administrators understand year-end results and use data to make Year 2 Planning decisions. At the end of this implementation period, participants received recommendations for Year 2 implementation, a Planning Guide for Year 2, and a comprehensive year-end district level report. This report helped teachers and administrators gain insight into:

- Comparative views of participating schools relative to key fidelity metrics
- Student gains on program assessments
- Correlation between time-on-task and gains

The implementation specialist also had the opportunity to monitor the teachers fidelity of implementation through regular site visits that involved classroom/lab observations. This provided a qualitative measure of implementation fidelity.

It was explicitly stated in written and verbal form that under no circumstances should mathematics teachers use any components of *Academy of MATH* with the control group. The teachers indicated that they understood the importance of preventing contamination between treatment and control groups.

3.3 SETTINGS

The sample for the study represents elementary school students from Westwood Elementary School in Manchester, TN. A total of 60 students (30 treatment and 30 control) and 3 teachers/teaching assistants participated in the study. See Table 2 for School Characteristics.

Table 2: Westwood Elementary School Characteristics

Geographic Location and City Description	Rural, Small
Total student enrolment	593 (based on August 2010 data)
Percent qualified as low income (free/reduced lunch)	69.3%
Ethnic breakdown	
Asian	1.2%
African American	4.2%
Hispanic	15.9%
American Indian/Alaskan Native	—
Multiracial	—
White	78.8%
Past performance on state wide assessments	**Below State Average**

Note. Percentages may not add to 100 due to rounding

3.4 PARTICIPANTS

The final student sample for the study included 51 students in grades 2–4. The student sample consisted of 26 and 25 students assigned to the treatment and control groups, respectively. Table 3 shows the distribution of students in the treatment and control groups by grade.

In addition to the principal, the school identified a school-level coordinator. The school level coordinator was the primary contact for study-related issues. Responsibilities included ensuring that materials were distributed, assessments and program were being implemented correctly, and site visits were scheduled, among other responsibilities.

Table 3: Distribution of Students by Grade and Group Assignment

Grade	Treatment	Control
2	6	7
3	10	11
4	10	7
Total	**26**	**25**

Teacher Participants and Facilitators

A sample of teachers/teaching assistants contributed to the study by participating in an observation and informal interviews. Study participants, also called facilitators, consisted of 3 teachers and teaching assistants.

Of the 3 study facilitators, 1 holds a High school diploma, 1 holds a Bachelors degree, and 1 holds an Associate degree. The facilitators have been teaching for a range of 1 to 20 years. They have been working at their current school for a range of 1 to 2 years.

Student Participants

The final sample for the study included 51 students in grades 2–4. The student sample size consisted of 26 (51%) treatment and 25 (49%) control students. This section presents a description of the students demographics and chi-square analyses to determine group equivalence.

Demographics

Table 4 presents demographic information for students in the treatment and control conditions.

Table 4: Student Demographics by Group

Characteristics	Treatment Students (n=26) Percent	N	Control Students (n=25) Percent	N	Total Students (n=51) Percent	N	Chi-Square Results Value	Sig.
Grade Level								
Second	46	6	54	7	25	13		
Third	48	10	52	11	41	21		
Fourth	59	10	41	7	33	17	x^2=0.64	0.73
Gender								
Female	59	16	41	11	53	27		
Male	42	10	58	14	47	24	x^2=1.57	0.21
Ethnicity								
African American	67	4	33	2	12	6		
Hispanic	44	4	56	5	18	9		
White	50	18	50	18	71	36	x^2=0.76	0.68
Free Reduced Lunch								
FRL	52	23	48	21	86	44		
non-FRL	43	3	57	4	14	7	x^2=0.21	0.64
Limited English Proficiency (LEP)								
LEP	44	4	56	5	18	9		
non-LEP	52	22	48	20	82	42	x^2=0.19	0.67
Special Education								
IEP	55	6	46	5	22	11		
non-IEP	50	20	50	20	78	40	x^2=0.07	0.79

Note. Percentages may not add to 100 due to rounding

Group Equivalence

The comparability between the characteristics of students in treatment and control groups is critical in ensuring the validity of the study's findings. The equivalence of students in treatment and control groups was determined by examining differences in student demographic characteristics and attrition.

Student Characteristics

Table 4 presents all demographic data collected for students in the treatment and control conditions. Chi-square analyses revealed that the control and treatment group were equivalent on all demographic variables (i.e., grade, gender, ethnicity, free/reduced lunch status, English proficiency, and immigration status) that data were collected on.

Student Outcomes

Although student improvement was demonstrated through the use of gain scores throughout this study the treatment and control group should be equivalent on all outcome measures at the outset of the study. Table 5 displays treatment and control students pre-test scores on all outcomes for the current study. Overall, students in both groups were equivalent on all outcomes at pre-test. Comparison of DOMA subscale pre-test scores and *Academy of MATH* Placement pre-test scores across treatment and control students revealed no significant pre-test differences between the treatment and control groups (all $p > .29$).

Table 5: Pre-Test Academic Performance Measures by Group

Measure	Treatment			Control			t	df	p-value
	n	Mean	SD	n	Mean	SD			
DOMA Numbers and Operations	26	2.93	0.82	25	2.80	1.03	0.49	49	0.63
DOMA Measurement	26	2.53	0.88	25	2.47	1.01	0.23	49	0.82
DOMA Fractions	26	1.46	1.55	25	1.01	1.45	1.08	49	0.29
Academy of MATH Placement Test	26	2.55	1.16	25	2.48	.96	0.25	49	0.81

Attrition

An analysis was conducted to examine the overall sample attrition (the number of participants that did not complete the study for any reason). As indicated earlier, the initial study sample comprised of 30 *Academy of MATH* participants and 30 control participants, for a total sample of 60 participants. Nine students were omitted from the final sample due to missing data. The final sample for analysis was comprised of 26 participants in the *Academy of MATH* and 25 control participants for a total of 51 final study participants. The overall attrition rate was 13% for the treatment sample and 17% for the control. Chi-square analyses revealed no significant differences in overall attrition rates by condition, $\chi^2(1) = 0.01$, p > .05.

4. PROGRAM DESCRIPTION

The *Academy of MATH* is a standards-based, online intervention tool that can be used with increasing levels of intensity by a wide range of struggling students in mathematics for instruction, assessment and progress monitoring. The *Academy of MATH* is based on extensive research into computer based instruction and the learning process. The program follows fundamental learning principles such as providing multiple opportunities for students to learn and apply mathematics and incorporating mastery-based learning and behavioural motivation.

The program follows a systematic approach to help struggling students develop mathematical proficiency. For each skill area and level, students develop conceptual understanding in Terms, procedural fluency in Operations, and strategic competence in Word Problems. The program includes over 14,000 questions, correlated to NCTM standards and Common Core State Standards, which help students make connections to other areas of math and to real-world situations.

The *Academy of MATH* supports individual instruction and personalized learning. Automated placement tests provide a snapshot of each students math knowledge relative to grade level. Using test data the program identifies performance goals and creates an Individualized Training Plan, allowing each student to work on skill gaps at his or her own pace. Skill mastery design and positive feedback keep students moving forward. While training, the Responsive Intervention Engine monitors progress and adjusts content to accelerate or remediate as required. Mastery learning, immediate positive and corrective feedback, and customizable "guides" are just some of the features that help students build confidence.

5. PROGRAM IMPLEMENTATION

As described in Section 3.2, teachers received implementation guidelines before the beginning of the study that asked them to use the program for a minimum of 30 minutes three to five times a week.

The implementation fidelity is characterized by the extent to which students used the program. One of the features of the *Academy of MATH* is the automatic online recording of these fidelity measures within the database. This allowed the examination of quantitative indices of the extent that the *Academy of MATH* was used by students. In addition, an EPS curriculum specialist had the opportunity to monitor the teachers fidelity of implementation through site visits that involved classroom observations and prepared regular reports. This provided a qualitative measure of implementation fidelity.

This section presents implementation findings. As displayed in Table 6 students in the treatment group were trained in the *Academy of MATH* on average 60 minutes per week.

Table 6: *Academy of MATH* Fidelity Measures by Group

Group	N	Time in Program (hr)	Focused Training (hr)	Time/Week (min)	Program Completed (%)	Skills mastered
Treatment	26	18.00	14.27	59.35	74	47
Control	25	0.45	0	0	0	0

Note: 25 control group students were pre-tested and post-tested in Academy of MATH placement test and for that reason time in program for this group is 0.45 hours on average. However, focused training time is 0 hr, meaning that these students did not spend any time training in the program.

6. STUDENT PERFORMANCE RESULTS

The efficacy of the *Academy of MATH* was evaluated in two steps using a variety (i.e., descriptive, inferential, multi-level) analyses. First, it was established that, based on a variety of measures, that students in the treatment group achieved significant gains over the course of the intervention. Second, using gain scores it was determined whether students in the treatment group experienced significantly greater gains than students in the control group.

6.1 *ACADEMY OF MATH* 'S IMPACT ON LEARNING

This section presents the learning gains of students who participated in the *Academy of MATH* program in the 2010/2011 school year. Results are presented for student performance on the DOMA subscales and the *Academy of MATH* Placement Test.

Question 1: Do students in the treatment group demonstrate significant learning gains in mathematics during the study period?

Recall that a randomized control examination of the efficacy of the *Academy of MATH* was conducted at Westwood Elementary School for students in grades 2 through 4. Study facilitators in this school followed explicit implementation guidelines to ensure program fidelity. To address whether students who participated in the *Academy of MATH* program demonstrated significant learning gains in mathematical achievement from the

beginning of the study to the end of the study, gains on various subscales of the DOMA were calculated. Specifically, descriptive analyses were conducted on the Grade Level Equivalent (GLE) scores on the Numbers and Operations, Measurement, and Fractions subscales. Gains on the *Academy of MATH* Placement Test were also analyzed.

### Descriptive Analysis

DOMA Gains for Treatment Students

Descriptive and inferential analyses were conducted on treatment students gains on the DOMA subscales to evaluate the efficacy of the *Academy of MATH*. As shown in Table 7, students participating in the *Academy of MATH* program improved in numbers and operations on average by .77 grade levels, 0.41 grade levels on measurement, and 1.05 grade levels on fractions (see Figure 1 for pre-test/post-test GLE scores). All the gains on the DOMA were statistically significant (all p < .01).

Table 7: Mean DOMA Subscale Gains for Treatment Students

Outcome Measure	Gains (Mean)	Standard Error	t-value	df	p-value
GLE Numbers and Operations	0.77	0.08	9.25	25	0.00*
GLE Measurement	0.41	0.12	3.02	25	0.00*
GLE Fractions	1.05	0.33	3.45	25	0.00*

* Significant at the 0.01 level

Figure 1: Student's DOMA Pre-Test and Post-Test GLE Scores
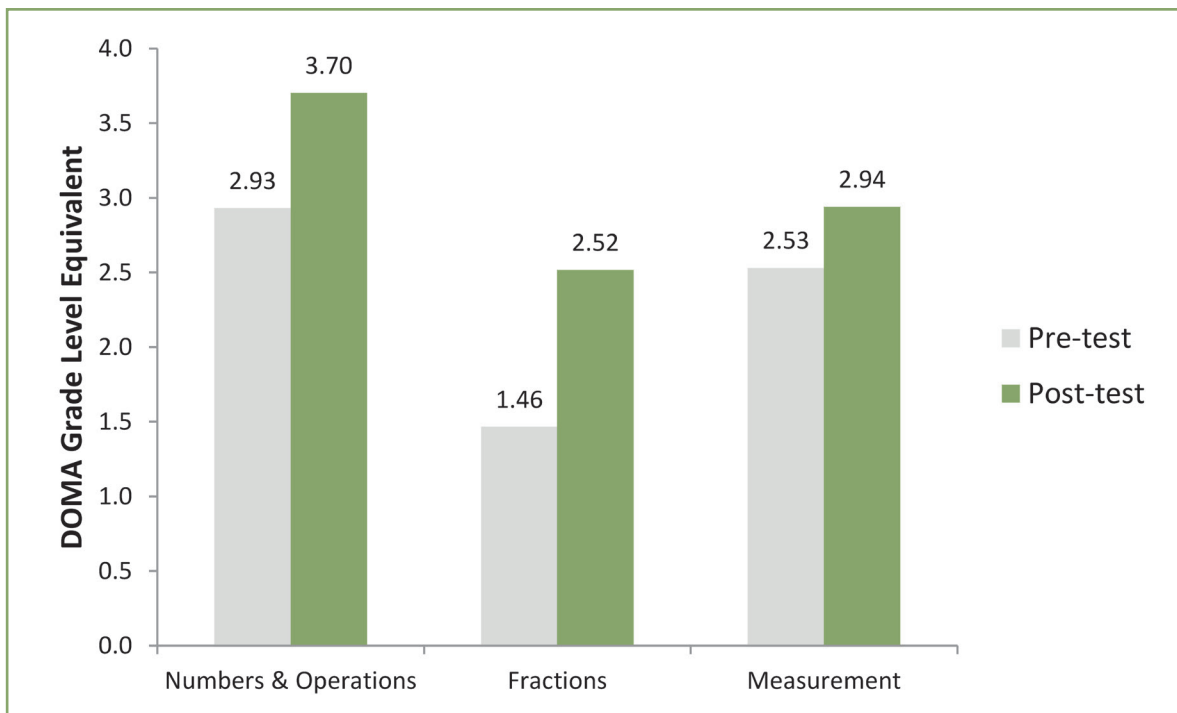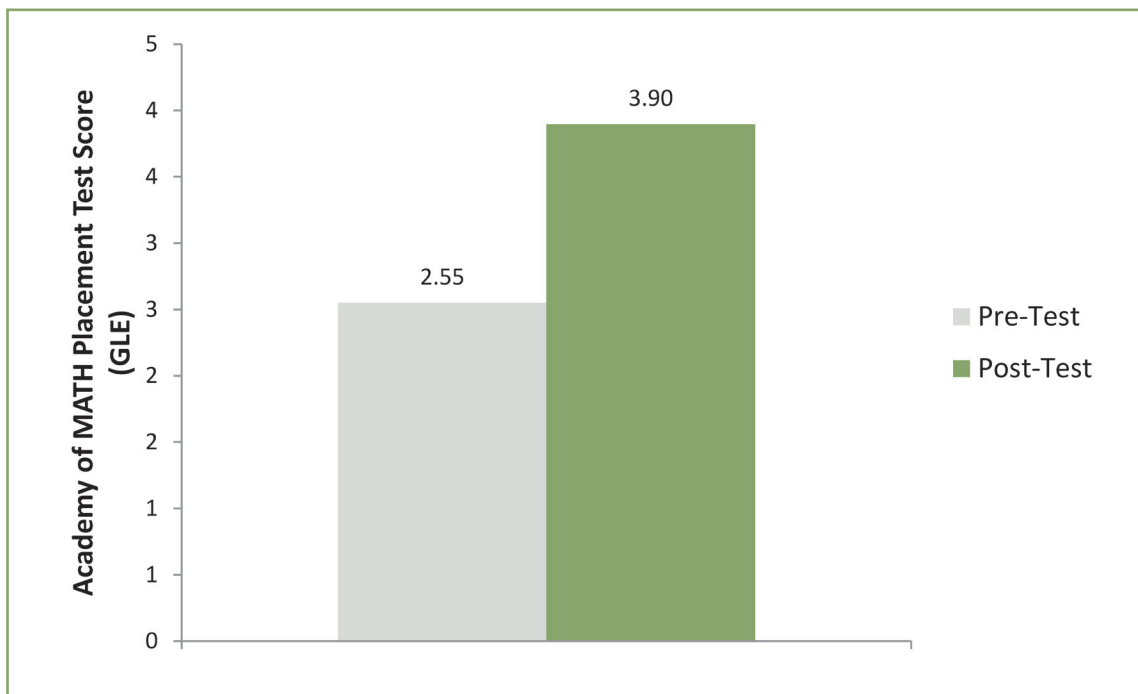
Academy of MATH Placement Test

Table 8 summarizes the gains achieved by treatment students on the *Academy of MATH* Placement Test. Students who used the *Academy of MATH* made statistically significant gains of 1.35 grade level equivalent on this test (see Figure 2 for pre-test/post-test GLE scores).

Table 8: Mean *Academy of MATH* Placement Test Gains for Treatment Students

Outcome Measure	Gains (Mean)	Standard Error	t-value	df	p-value
AOM Placement (GLE)	1.35	0.21	6.56	25	0.00*

* Significant at the 0.01 level

Figure 2: Student's *Academy of MATH* Placement Pre-Test and Post-Test Scores

Correlations with *Academy of MATH* Placement Tests

The correlation coefficients described in the following section are summarized in Table 9. The goal of this section is to demonstrate that the *Academy of MATH* Placement Test provides a measure of students mathematical ability that is consistent with other measures of mathematical ability.

As expected, *Academy of MATH* Placement Test pre-test scores were significantly correlated with all three DOMA subscales pre-test scores. Furthermore, *Academy of MATH* post-test GLE was significant with all DOMA subscale post-test scores. These results demonstrate that the *Academy of MATH* Placement Test reflect students mathematical ability.

Table 9: Correlations of *Academy of MATH* Placement Test Pre-Test and Post-Test GLE with DOMA Subscales

Outcome Measure	Pre-Test			Post-Test		
	r	N	p-value	r	N	p-value
DOMA Number and Operations	.70	51	0.00**	.70	51	0.00**
DOMA Fractions	.34	51	0.01*	.54	51	0.00**
DOMA Measurements	.60	51	0.00**	.71	51	0.00**

* Significant at the 0.05 level, ** Significant at the 0.01 level

6.2 STUDENT LEARNING COMPARISON

This section presents a comparison of the learning gains of students in the treatment and control group. Results are presented for the same measures (i.e., DOMA subscales, *Academy of MATH* Placement Test) that were in the previous section.

Question 2: How does the mathematics performance of students in treatment groups compare to that of students in control groups?

Descriptive Comparisons

DOMA

As presented in Table 10 and Figure 3, results reveal that treatment students scored higher, on average, than control students by the end of the year on most DOMA subscales. The average gains of the treatment group were significantly greater than the control group gains on both the Numbers and Operations and Measurement subscales. The difference between average gains of the treatment group and the control group did not significantly differ on the Fractions subscale.

Table 10: DOMA Grade Level Equivalent Scores by Condition and Subtest

Outcome Measure	Treatment Group Gains (Mean)	Control Group Gains (Mean)	Mean Square Error	F	df	p-value
DOMA Number and Operations	0.77	0.44	0.24	5.94	1,49	0.02*
DOMA Fractions	1.05	1.28	3.02	0.22	1,49	0.64
DOMA Measurements	0.41	0.00	0.43	4.90	1,49	0.03*

* Significant at the 0.05 level

Figure 3: Student's GLE Gains on DOMA Subscales by Group
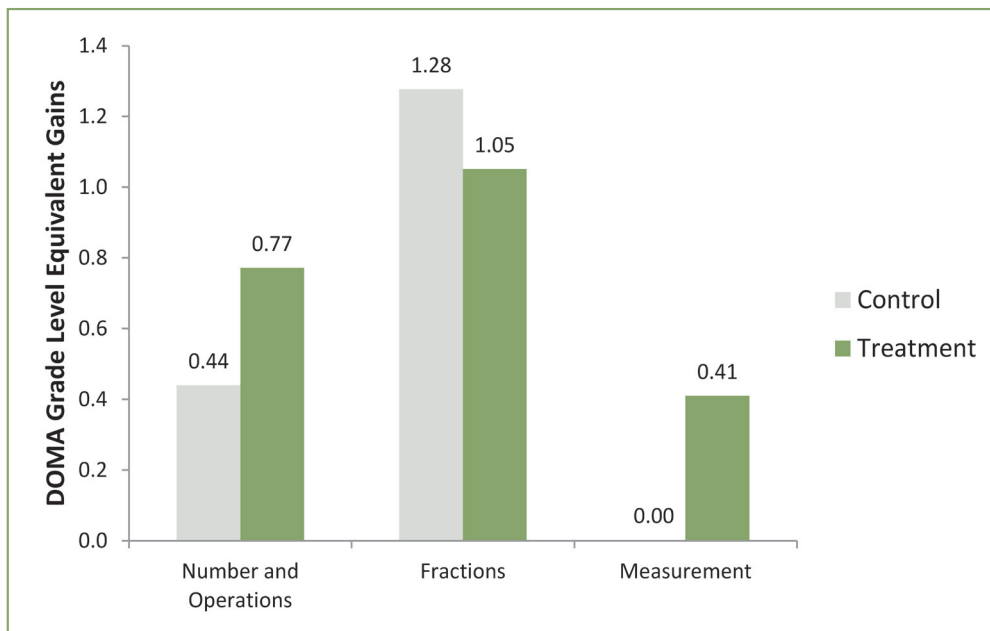
Academy of MATH Placement Test

The results displayed in Table 11 reveal that treatment students achieved, on average, greater gains over five months than students in the control group on the *Academy of MATH* Placement Test. The average gains of the treatment group were 0.67 grade levels higher than the gains of the control group, which is statistically significant, ($p < .05$). At the conclusion of the study students in the treatment group scored 0.74 grade levels higher than students in the control group (see Figure 4 for pre-test/post-test GLE scores).

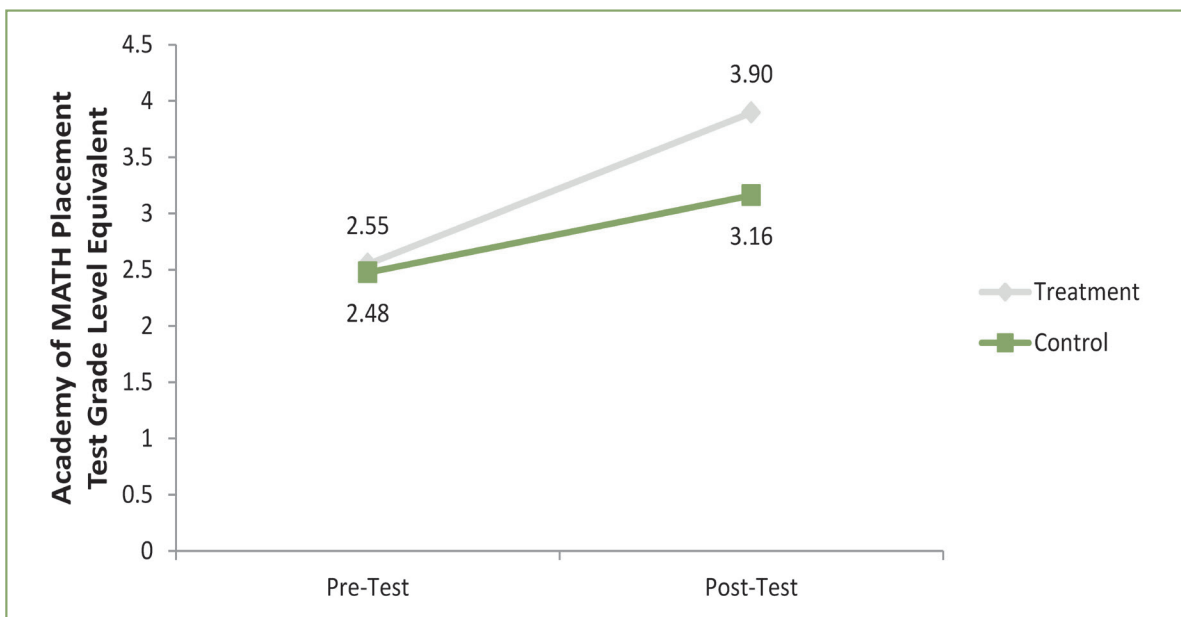**Figure 4**: Student's *Academy of MATH* Placement Test Scores by Group

Table 11: *Academy of MATH* Placement Test Grade Level Equivalent Gains by Group

Outcome Measure	Treatment Group Gains (Mean)	Control Group Gains (Mean)	Mean Square Error	F	df	p-value
AOM Placement Test GLE	1.35	.068	1.12	5.00	1	0.03*

* Significant at the 0.05 level

### Effects of *Academy of MATH* on Students' Mathematical Gains by Various Student Characteristics

Although the percentage of students in different demographic categories did not significantly differ from the treatment to control group (see Table 4) certain groups of students were not well represented in the current study. For example, the vast majority of students included in the current study received a free or reduced lunch, were proficient in English, and were not identified as Special Education students. Therefore, the following section will report on the effect of the *Academy of MATH* on students of different gender and ethnicity.

To accomplish this, several two-factor between-subjects ANOVA was conducted.

Gender

Overall, students in the treatment group achieved significantly greater gains than students in the control group on all measures except DOMA Fractions (see Tables 10 and 11). Furthermore, training in the *Academy of MATH* was equally effective for both male and female students (none of the Condition x Gender interactions approached significance (all $p > .39$; see Figure 5).

Figure 5: Gains on All Measures by Group and Gender
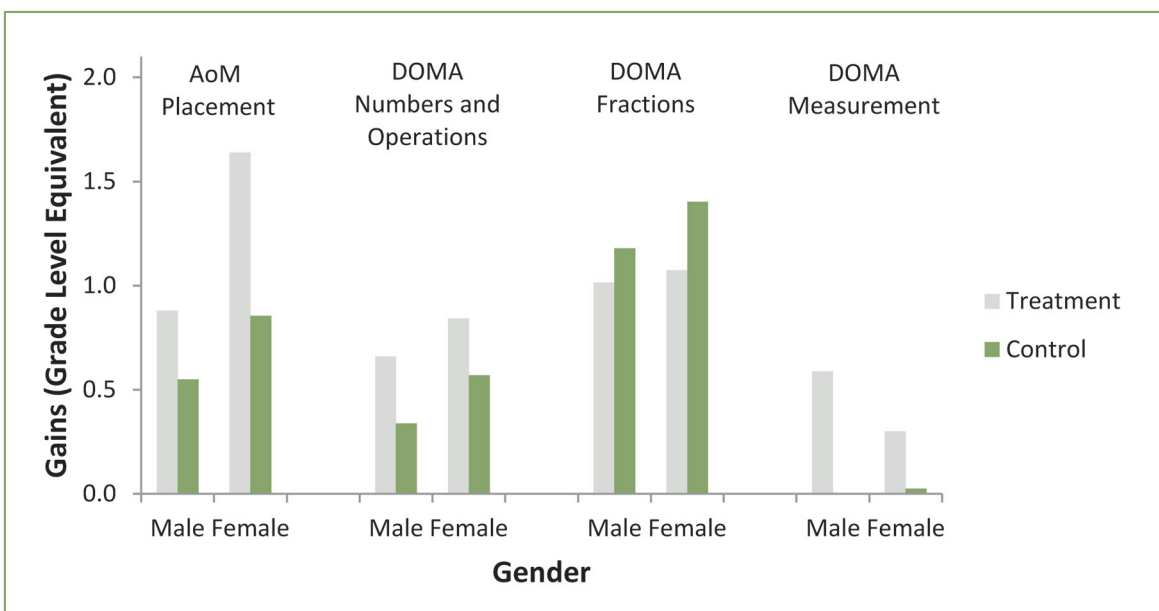
Ethnicity

To increase the power of the analyses African American and Hispanic students were combined into a single group and contrasted with Caucasian students. Recall, that overall students in the treatment group achieved greater significantly gains on most measures than students in the control group (see Tables 10 and 11). As was the case for the analysis of gender none of the Condition x Ethnicity interactions approached statistical significance (all $p > .20$; see Figure 6). Meaning that training in the *Academy of MATH* was equally effective for students of all ethnicities.

Figure 6: Gains on All Measures by Group and Ethnicity
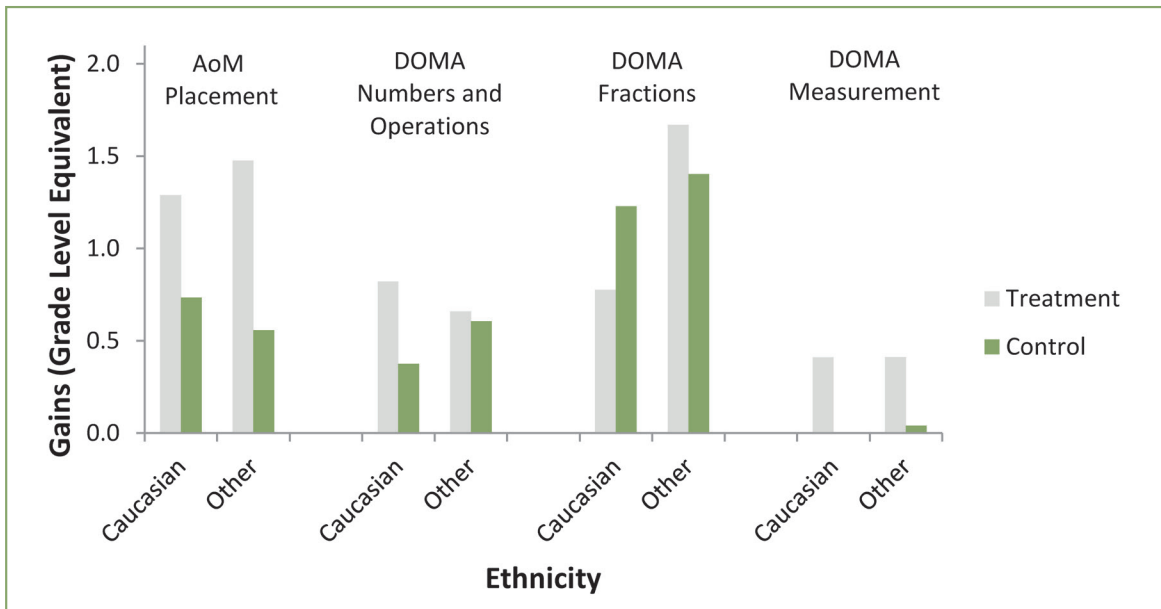
6.3 LIMITATIONS OF STUDY

There are limitations for this evaluation study that readers should take into account when interpreting the study's results. The sample size had sufficient power to detect main effects of the program by condition. However, the power to detect effects among subgroups decreased as student-level characteristics divided the data into smaller subsamples. For this reason, caution is warranted in generalizing study results to these subpopulations.

7. CONCLUSION

This study of the *Academy of MATH* program was conducted to measure the effectiveness of the program on Tier II and Tier III students who are struggling with mathematics. Westwood Elementary School from Manchester Tennessee participated in the study. The findings in the report represent a sample of 51 students in Grades 2–4 who were involved in the randomized controlled trial of the *Academy of MATH* as a pull-out intervention. Students were randomly assigned to treatment or control groups.

The students who participated in the *Academy of MATH* program, compared to students in the control group, demonstrated significant learning gains during the study period. Students improvement in general level of mathematics achievement, overall mathematics abilities, Numbers and Operations and Measurement. These results indicate that participating in the *Academy of MATH* program for the duration of this study was associated with large gains in overall mathematics ability, numbers and operations, fractions, and measurement.

Study findings suggest that the gains experienced by the *Academy of MATH* program participants, overall, were significantly higher of those experienced by children in the control group using "business-as-usual" classroom intervention activities.

In sum, the results of this study indicate that the *Academy of MATH* program is useful to teachers in providing a comprehensive intervention to Tier II and Tier III kids that are straggling in mathematics. Teachers and students adapt easily to the program structure, pace, and routine. Results indicate that the program is successful in significantly improving childrens general level of mathematics skills as well as in the specific areas of numbers and operations, measurement and fractions.

ACKNOWLEDGEMENTS

Appendix A

Test-Retest Coefficients for Measures Used in the Current Study

Outcome Measure	Test-Retest Coefficient
DOMA Numbers and Operations	0.85**
DOMA Measurement	0.78**
DOMA Fractions	0.24
Academy of MATH Placement Test	0.55**

* p < .05, ** p < .001

Appendix B

Pre-Test and Post-Test Scores for All Measures by Group

	TREATMENT					
	Pre-Test			Post-Test		
Measure	n	Mean	SD	n	Mean	SD
DOMA Numbers and Operations	26	2.93	0.82	26	3.70	0.74
DOMA Measurement	26	2.53	0.88	26	2.94	0.96
DOMA Fractions	26	1.46	1.55	26	2.52	1.32
Academy of MATH Placement Test	26	2.55	1.16	26	3.90	1.10

	CONTROL					
	Pre-Test			Post-Test		
Measure	n	Mean	SD	n	Mean	SD
DOMA Numbers and Operations	25	2.80	1.03	25	3.24	1.08
DOMA Measurement	25	2.47	1.01	25	2.47	1.17
DOMA Fractions	25	1.01	1.45	25	2.29	1.23
Academy of MATH Placement Test	25	2.48	0.96	25	3.16	1.25