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The Impact Of A Structured Afterschool Mathematics Tutoring Program

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THE IMPACT OF A STRUCTURED AFTERSCHOOL MATHEMATICS TUTORING PROGRAM

by

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ABSTRACT

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In 2009, researchers at the University of Memphis implemented the afterschool program Jackson-Madison Intelligent Tutoring Systems Evaluation (J-MITSE), with the Jackson-Madison County Schools in Jackson, Tennessee. The program randomizes 6th grade students to either a treatment group that uses ALEKS software to tutor students in mathematics or a control group that uses human tutors with structured lesson plans. This thesis focuses on the control condition only to examine the pros and cons of a structured program that has specific topics scheduled, whether the afterschool program influences behaviors, attitudes, and math ability in the regular classroom, whether the human tutors in the program are reinforcing or introducing topics, and whether reinforcement in a structured environment contributes to gains in math scores. Results indicate that the control classroom, while mostly reinforcing topics from the regular school day, have positive effects on student behavior and performance in their regular classrooms.

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Introduction

As both national and international studies continue to show, there is a need to improve mathematics education in the United States. According to the 2007 Trends in International Mathematics and Science Study (TIMSS), only 10% of fourth-graders and 6 percent of eighth-graders in the United States scored at or above the advanced international benchmark in mathematics. Results from national studies similarly document the need for mathematics improvement, especially in the middle school grades (National Mathematics Advisory Panel, 2008). The 2009 Nation's Report Card released by National Assessment of Educational Progress (NAEP), reported that only 39% of the nation's public school fourth-graders were at the Proficient level in mathematics. In the same report for the state of Tennessee, results showed that locally fourth-grade students were below the national average with only 28% scoring at the Proficient level. Results were similar for public school eighth-graders. Nationally, only 32% scored at the Proficient level in mathematics, while 25% of the public school eighth-graders in the state of Tennessee attained the Proficient level (U. S. Department of Education, 2009).

Schools are not able to handle these problems by themselves, since students spend less than 20% of their waking hours in a school classroom. Afterschool programs are necessary to complement the efforts of schools and teachers nationwide (Afterschool Alliance, 2004). In addition, the need for successful educational initiatives such as tutoring for the lower-performing students has become increasingly important due to the demands of the No Child Left Behind Act (NCLB), which places an emphasis on improving students' standardized test scores. Supplemental Educational Services (SES) are required of low-performing schools according to NCLB: AYP and School Improvement. The NCLB legislation further defines these supplemental services as tutoring and other academic instruction provided outside the regular school day (NCLB, 2001). Because individual school districts are allowed to structure their own SES for Title 1 Schools, services vary greatly. Teachers, parents, administrators, and researchers are searching for ways to help struggling math students increase their achievement. With working and single parents, as well as grandparents and guardians raising children, afterschool programs are becoming more prominent in order to alleviate stresses that are placed on families due to the burden and difficulty of schoolwork (Parkay & Stanford, 2001).

In order to deal with the issues brought to light by the reports and to adhere to the NCLB policy, a team of researchers at the University of Memphis implemented the afterschool program Jackson-Madison Intelligent Tutoring Systems Evaluation (J-MITSE), with the Jackson-Madison County School System in Jackson, Tennessee. The program focuses on the system's 6th grade students. The program is a randomized experiment in which students were assigned to either a treatment group or a control group. The treatment condition used a learning software program to tutor the students in mathematics while the control condition used human tutors with specific structured lesson plans to tutor students in mathematics. The overall goal of the experiment is to compare the effectiveness of the tutoring software in raising student achievement in mathematics to that of the human tutors.

This study focuses on the control condition using human tutors in a structured classroom setting. Information related to the experimental group using the tutoring software, ALEKS, can be found in a document produced by the principle investigators of the project (Hu et. all, 2011). In particular, this study answers the following research questions for the teacher-led classroom:

(1) What are the pros and cons of an afterschool mathematics program that focuses on a specific set of scheduled topics?

(2) Is what the students are doing in the afterschool program influencing their classroom behaviors, attitudes, and math ability in the regular classroom?

(3) Are the human tutors in the afterschool program reinforcing or introducing topics?

(4) Do students who are reinforcing math in a very structured environment show gains in math scores?

To do this, the study will focus only on the control condition and use data from the first year of the J-MITSE Project collected in 2009-2010 academic year.

Background

Numerous types of approaches to afterschool tutoring programs have been discussed in the literature. The approaches have included using teachers to tutor students in an afterschool setting, building partnerships with universities to employ college students to tutor students, and using technology to enhance or remediate student learning. As a general guideline, each approach should provide students with the integration of theory and practice through experience (NCTM, 1991). Human tutoring is currently a popular approach to assisting students with deficits in education. For example, the federal government has begun making an investment to help prepare students academically by using out-of-school hours through its 21^{st} Century Community Learning

Centers (21^{st} CCLC) funding. This program supports the creation of community learning centers that provide academic enrichment opportunities during non-school hours for children, particularly those who attend high-poverty and low-performing schools. The program aims to help students meet state and local student standards in core academic subjects, such as reading and math as well as- offering students a broad array of enrichment activities that can complement their regular academic programs. In addition, the scope of the program also includes offering literacy courses and other educational services to the families of participating children. Even though one of the main focuses of the programs has been academics, results have not indicated a significant gain academically for participating students. This is possibly due to the lack of structure of the current programs. In fact, rather than simply assisting students with homework (i.e., having the afterschool programs merely be homework tutoring), the Profile and Performance Information Collection System (PPICS), a web-based data collection system designed to capture information regarding the state administered 21st CCLC Programs, finds it is of more importance to emphasize the core academic subjects. It is noted that afterschool programs that are geared toward structured learning in such content areas are desirable (National Center for Educational Evaluation and Regional Assistance, September 2009).

Another approach to afterschool programs using human tutors that has been proposed is that of using college students to tutor K-12 students. For example, the tutoring program implemented by a school district and university in rural Pennsylvania called “The After School Math Tutoring Program” successfully uses this approach. This program developed an afterschool math tutoring program for elementary-aged students that utilized college students in the role of tutors. The tutors were recruited through mathematics programs at a local university, students that were at-risk of failing mathematics were recommended by teachers, while classroom teachers volunteered to coordinate tutoring activities. They maintained a 2:1 child-tutor ratio in the 90-minute, 1 day per week program that included helping students with homework, skill reinforcement, educational games, computer labs, and a 15-minute snack time. The expenditures of the program were funded by a grant used to pay teachers and to purchase materials (Baker, Rieg, & Clendaniel, 2006).

In "The After School Math Tutoring Program", each child had a folder with information from the classroom teacher to guide tutoring with homework assignments and skills that needed to be practiced. Future math topics and upcoming test information was also provided. Two assessments were administered as a pre-/post-test: (a) a math inventory (either the Brigance Math Inventory or the Scott Foresman math text inventory) and (b) the Aiken's Attitude Survey to assess changes in students' feelings. Over the course of a year, the math inventory assessment showed gains of 72% or better by students while their attitude assessment results improved over 50%. For the last academic year, 86% (73 out of 85 students) increased their math inventory scores, 11% decreased, and 3% stayed the same. The program has ongoing success and has the support of parents, teachers, students, the local university, and school district personnel. This overwhelming support played a part in the success of the program (Baker, et al., 2006).

The use of computer technologies as a tutor in afterschool programs is also finding success in raising student performance levels in mathematics. In a recent study for the U.S. Department of Education by the National Partnership for Quality Afterschool Learning at Southwest Educational Development Laboratory (SEDL), technology for afterschool programs was examined. Since the No Child Left Behind Education Act of 2001 (NCLB) requires that every student be technology literate by the time they finish the eighth grade, the Enhancing Education Through Technology (EETT) initiative (2001), a component of NCLB, has provided approximately $500-700 million annually to schools across the nation to support the integration of technology in the classroom. YouthLearn, a nonprofit organization created by the Morino Institute and led by Education Development Center, Incorporated (EDC), offers youths and educators the assistance needed to start and strengthen technology in both afterschool and in-school programs. YouthLearn approaches technology both as a set of skills to be mastered and as a powerful tool to be used in everyday activities such as homework, research, and communication.

Carnegie Learning's Cognitive Tutor programs represent an innovative application of technology, artificial intelligence, and cognitive science. The Carnegie Learning Cognitive Tutor was developed at Carnegie Mellon University as a research project. The Cognitive Tutor mathematics program offers an innovative approach to improving student performance. Based on a cognitive model that simulates the ways in which students think about and attack mathematics problems, the programs engage students in real-world, problem-solving activities, so they can connect prior knowledge with the new skills and concepts they learn (WestEd, 1995-2007). The success in the Pittsburgh Public Schools inspired the transition to a commercial model so that the effective curricula could be widely disseminated to schools around the country.

These programs give students the opportunity to receive individualized attention, maximizing the amount of time spent actively engaged in learning and mastering fundamental math skills. The U.S. Department of Education has recognized Cognitive Tutor as one of only two exemplary mathematics programs in the country. These programs have shown significant learning gains for eighth grade algebra students (Anderson, Corbett, Koedinger, & Pelletier, 1995; Koedinger, Anderson, Hadley, & Mark, 1997).

An example of a program that uses the Cognitive Tutor in an afterschool setting is Learning Zone. Learning Zone is a California state-approved supplemental program. Learning Zone researchers identified and addressed six content areas that most often become gaps in a student's understanding of algebra. It is the only afterschool service in the nation licensed to use the Carnegie Learning Cognitive Tutor. Learning Zone is not designed for tutoring for a specific class or SAT preparation. Instead, students who participate in Learning Zone work closely with a certified mathematics teacher and trained coaches and focus on the basics. When students enroll with the Learning Zone, they take the Learning Gap Assessment (a written diagnostic test) from which a Personal Learning Plan (PLP) is created. The PLP details what the student needs to learn to succeed in algebra. Learning Zone curriculum is a combination of Cognitive Tutor software and other materials developed at WestEd by experts in the field of mathematics education. These materials combine hands-on exercises with paper-pencil activities to give the student a deeper conceptual understanding of each mathematical idea (WestEd, 1995-2007).

Whether gains in math achievement found in prior studies are moderate or profound, the keys to success in tutoring programs are a long-term commitment, specific program goals, and preparation of mentors/tutors. If the program results in academic achievement losses, it is usually due to lack of commitment from the tutor or student and the management of the program (Zuelke & Nelson, 2001; McCluskey et al., 2004). “Effective teaching requires continuing efforts to learn and improve” (NCTM, 2000).

The J-MITSE Project

In 2009, researchers at the University of Memphis received a 4-year grant from the Institute of Educational Sciences (IES) to improve the skill levels of 6^{th} grade students with deficiencies in mathematics in the Jackson-Madison County School District. Three cohorts of sixth-grade students will participate in the program, one for each year of the study. This paper focuses on data collected during the first year of study only.

This project was designed to evaluate the efficacy of the Intelligent Tutoring System (ITS) ALEKS (Assessment and Learning in Knowledge Spaces) in helping middle school students in West Tennessee whose state test score results are below the state average in mathematics. ALEKS is a Web-based intelligent tutoring system (ITS) that instructs students on the mathematical topics that they are most ready to learn. The system design was motivated by research at New York University and the University of California, Irvine, by a team of software engineers, mathematicians, and cognitive scientists with support from a National Science Foundation grant. ALEKS is fundamentally different from other educational software- because it has an artificial intelligence engine that assesses each student individually and continuously. It provides each student with a personalized curriculum to meet the learning goals of individual students. ALEKS assesses students' current knowledge, instructs students on the topics they are most ready to learn, and evaluates student performance on problems related to those topics.

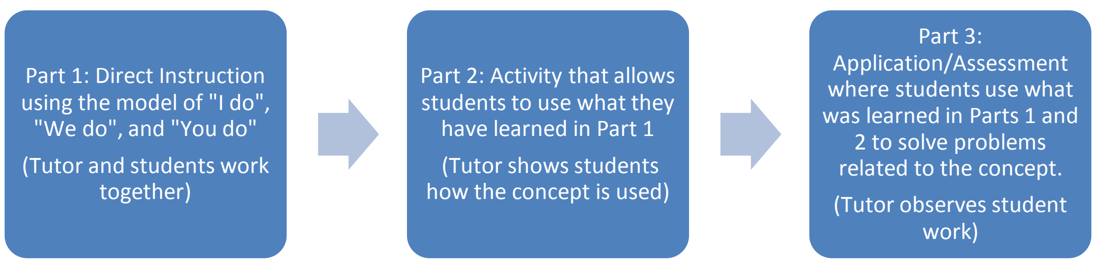
The key features of the implementation and testing of ALEKS include its use of an afterschool delivery setting, the random assignment of students to a treatment or control condition, communication with parents reporting student progress on the system (bi-monthly reports to parents on the student progress), and the incentive-driven retention design available to participants.

The students in the ALEKS condition are referred to as the treatment group, while the control group is in a teacher-led condition. The control program is taught by teachers who guide the students' work on mathematics topics related to the material covered on the sixth grade Tennessee Comprehensive Assessment Program (TCAP) achievement test.

The control group had identical attendance and achievement incentives to those of the treatment group. A point system was used to reward students throughout the program. Learners in both the treatment group and the control group received points based on attendance. Learners completing 100% of their assigned tasks received 10 bonus points at the end of the two-week period while those completing only 50% received only 5 points. Gift certificates were distributed. The gift certificate values were determined based on the number of points a learner had accumulated. In addition to these incentives, students completing the program received a certificate of completion at an end-of-the-school-year awards ceremony.

Both the treatment and control students also followed the exact same schedule. The afterschool learning activity consists of a total of 60 minutes of mathematics and two 20-minute breaks twice per week after school. More specifically, students in the program follow a 20-20 model consisting of a 20-minute break after each 20-minute mathematics session, repeated three times. This study will focus on the outcomes of the control classroom only; thus from this point on only the control classroom will be discussed.

Each of the three 20-minute intervals of mathematics instruction in the control classroom follows the model:



Description of the Teacher Led Classroom (Control Condition)

Mathematics content for the control condition was selected to ensure a distribution of mathematics topics covered was similar to those covered in the experimental condition, but without the individual tailoring of topics to students. The control students received remedial mathematics training in a classroom environment without computers or tailoring. The teacher-led condition of the afterschool program contained 40 different lesson topics from the Tennessee 6^{th} grade curriculum that represent the lowest level of student achievement.

The lesson plans are divided into three portions to give the students exposure to a topic and practice applying the topic. Part 1 is direct instruction. During the initial 20-minute period, the human tutor provides direct instruction on a concept. There is a direct instruction pattern of "I do" (the tutor follows a scripted lesson plan and does an example, explaining all reasoning out loud), "We do" (the tutor and students work examples together), and "You do" (the students work an example on their own). Part 1 of the included lesson plan in Appendix A defines and describes the Triangle Inequality Theorem. As seen in the lesson, the teachers first show students the relationship between the side lengths of a triangle. The teacher is also prompted to remind students of inequality symbols and their meaning as related to the theorem in the lesson. Second, the teachers are instructed to go over examples. For each of these examples, all steps are explicitly shown in the lesson plan. Teachers are told to show students all three combinations of the sums of side lengths each time in this "We do" portion so that they could see a step by step process to follow in the "You do" portion.

Part 2 of each lesson consists of an activity. This activity occurs during the second 20-minute period. This is used to allow the students to connect and apply what they have learned in Part 1. In many cases, the activity period involves working with manipulatives. In other cases, it is a more active application of what they have learned in Part 1. For example, students might order rational numbers using a "human number line" or graph ordered pairs by standing on a grid created on the classroom floor or outside using sidewalk chalk. During the activity time, students might also create their own problems using "real world" data or information. Regardless of the specific activity, the goal is for the students to see the connection between what they learned in Part 1 to their application in Part 2. In the example lesson plan in Appendix A, the activity portion involved using dry spaghetti and rulers. Students break/snap the spaghetti into three pieces and use the pieces to determine if a triangle can be formed. A ruler is provided for the students to measure the pasta pieces in centimeters to verify the lengths of the three sides. Students used a chart to organize their measures and determine if they have formed a possible triangle or if it was impossible with their “noodles”. Through this activity, students are able to see the Triangle Inequality Theorem and review measurement in this hands-on activity.

Part 3 is the application/assessment portion of a lesson. During the final 20-minute period, the students use what they have learned in Parts 1 and 2 to solve problems related to the topic. This period allows the teacher to assess how well the students understand the concept covered in the day’s lesson. The teacher spends this time walking around monitoring the students’ work and answering questions. In addition to these daily assessments, quizzes are given every two weeks, and students are rewarded points for prizes on the basis of their quiz performance. Notice in the included lesson plan in Appendix A that students work individually during this portion. The teacher is provided with both problems and solutions to aid in monitoring progress. In this particular lesson, students are asked to use higher order thinking skills in the last two questions. The assessment/application allows students to realize there could be more than one answer. Each lesson included a time for students to share their solutions in a non-threatening manner.

Fidelity of the implementation for the control group was assessed by: (1) the extent to which the teacher kept students working on mathematics in each of the 20-

minute intervals, (2) the extent to which the teacher recorded and tracked student point earnings, (3) the extent to which the time schedule was being followed, and (4) the extent of student involvement and focus throughout the tutoring time. These assessments were carried out by the external evaluator of the JMITSE project.

Data and Methods

Afterschool programs traditionally assist students with school work and strive to help them academically. Since the teacher-led condition (control group) of the J-MITSE Project varies from the traditional approach and consists of a very structured and scripted environment, it is important to look at various aspects of the program that has specific topics on pre-determined dates. In particular, as stated above, this study aims to answer the following questions:

1. What are the pros and cons of an afterschool mathematics program that focuses on a specific set of scheduled topics?
2. Is what the students are doing in the afterschool program influencing their classroom behaviors, attitudes, and math ability in the regular classroom?
3. Are the human tutors in the afterschool program reinforcing or introducing topics?
4. Do students who are reinforcing math in a very structured environment show gains in math scores?

To do so, we use data collected from the external evaluators of the project, Center for Research in Educational Policy (CREP), surveys of the teachers implementing the J-MITSE program and data from the standardized test scores (TCAP) for all students in the 6^{th} grade in the Jackson-Madison County School District. The J-MITSE program was run at the four middle schools in Jackson-Madison County School District. At school 1 there were 8 in the teacher led condition, at school 2 there were 35, at school 3 there were 11, and at school 4 there were 39. These numbers indicate the students that took both the pre-assessment and post-assessment and participated throughout the entire program. Each school had additional students that participated in the program. We here describe the data and methodological approaches used to answer each research question.

Research Question 1

To determine the pros and cons of an afterschool mathematics program that focuses on a specific set of scheduled topics, surveys administered by CREP as well as surveys to the 10 teachers of the control condition administered by the author were analyzed. CREP conducted eight, ten-minute observational sessions per group on a given day. During these visits, CREP recorded the time on task, the quality of time on task, and the number and nature of student interactions with the human tutor. Additionally, CREP gathered information from the various stakeholders' perceptions of and experiences in the J-MITSE Project. Participating students, program faculty, program facilitators, and school principals were surveyed on likes and dislikes of the program.

The survey conducted by the author specifically surveyed the teachers leading the control condition. It was used to gauge teacher perceptions of the J-MITSE experience. All answers remained anonymous. Teacher surveys contained the 2 open-ended questions: (1) As you implement the teacher-led condition of the J-MITSE project, what do like about the program? What do you feel works particularly well in the classroom? and (2) As you implement the teacher-led condition of the J-MITSE project, what do you dislike about the program? What do you feel does not work well? A total of 10 teachers out of 17 responded to the surveys.

Research Question 2

To determine whether the program reinforced or introduced topics learned in the school day classroom, this study examined the alignment of the topics covered in J-MITSE with those in the school district pacing guide. When discussing the lesson plans that were used in the control group, not only is the choice of topics significant as they are aligned with state standards and local curriculum guides, but the timing of their presentation in the afterschool program is important. Forty topics (1 for each program session) were selected for program coverage from the list of Tennessee Comprehensive Assessment Program (TCAP) Student Performance Indicators (SPIs) representing lowest levels of student achievement. SPI items are covered at an average rate of one SPI per session. To determine reinforced topics vs. introduced topics, the program schedule is compared extensively with the district-wide pacing guide (click here for a direct link to the pacing guide). The Jackson-Madison County School System has designed a system-wide curriculum pacing guide for state objectives. This pacing guide was created when the state implemented new mathematics standards in 2009. This pacing guide assists classroom teachers in staying within a given time frame for each unit of study. This guide further ensures that each objective is taught prior to state testing and allows students that transfer within the system to lose the minimal amount of information and instruction. By using this pacing guide and the schedule for the afterschool tutoring program, we count the number of reinforced topics versus the number of introduced topics. Then, it can be determined if the topics taught each afternoon are introduced by the teacher-led condition or if they are reinforced in the afterschool setting.

Research Question 3

Another significant aspect of the program to address is the question: Is what the students are doing in the afterschool program influencing their classroom behaviors, attitudes, and math ability in the regular classroom? To assess changes in student classroom behavior, classroom teachers of participating students were asked to complete CREP's "Student Mathematics Classroom Behavior Questionnaire." This twenty-item questionnaire asks teachers to report on items such as how often each student turns in homework and participates in class. The questions were divided into two sections: Mathematics Attitude and Mathematics Performance. Possible responses ranged from 0 (strongly disagree) to 5 (strongly agree). This questionnaire is based on the classroom teacher questionnaire that is a component of the U.S. Department of Education's Profile and Performance Information Collection System for the 21st Century Community Learning Centers afterschool program. The results of this questionnaire are analyzed to determine if behaviors, attitudes, and math ability in the regular classroom are impacted by the after school program. School 1 had 27 responses to the pre-evaluation and 14 responses to the post-evaluation, School 2 had 42 pre-evaluation responses and 38 post-evaluation responses, School 3 had 31 pre-evaluation responses and 37 post-evaluation responses, and School 4 had 40 pre-evaluation responses and 42 post-evaluation responses.

Research Question 4

When looking at the control condition of the J-MITSE project, it is of interest to determine if students who are receiving math tutoring in a very structured environment show gains in math scores. A comparison of TCAP scores for the 135 participating students' 5th grade (2009) and 6th grade (2010) will show if the students improved their previous performance level. Since the state standards for Tennessee and state level tests (TCAP) both changed at the beginning of the 2009-2010 school year due to the push for more rigor at the state level and in conjunction with the America Diploma Project, student mean scores are converted to z-scores so that they can effectively be compared.

In addition to student TCAP scores, the CREP survey pertaining to Mathematics Performance is used. This survey questioned the students' classroom teachers to determine such things as whether students were meeting grade-level math standards, were able to solve multi-step problems without assistance, were earning passing grades on classroom assignments and tests, and whether students completed assignments, activities, and homework adequately.

Results

Each research question is answered below separately. Broader implications are then discussed in the following discussion and conclusion section.

What are the pros and cons of an afterschool mathematics program that has specific topics scheduled?

Results from the 10 teacher surveys administered by the author indicated several strengths of the program. Three teachers included the hands-on, manipulative activities, the 20 minutes on and 20 minutes off " time approach" was mentioned by 7 of the teachers, the provision of step by step organized and clearly laid out lesson plans was noted by 5 of the teachers, the rewards for student attendance by 2 of the teachers, the sequencing and alignment with the state standards and the district-wide curriculum pacing guide by 4 of the teachers, the provided opportunities for students to interact with each other and the teacher during the math game and activity time by 3 teachers, the good higher order thinking questions by 1 of the teachers, and the feedback provided for parents and students was stated by 2 of the teachers.

Areas of the program that the teachers felt needed improvement included no reinforcement or re-teach opportunities, lack of calculators for the program, no documentation for the control group teachers to view student assessment results, lack of supplies in a timely fashion which inhibited some of the lesson plan activities, the fact that some skills were not mastered before moving on to the next topic, and the lack of a review day prior to assessment.

CREP conducted a survey of teachers, students, and faculty to produce their annual report at the end of the first year. Specific responses by teachers of the control condition included that the control condition lesson plans were easy and clearly written, and teachers appreciated the “I do it; we do it; you do it” format. It was also noted that instruction was standards-based and research-driven. Teachers and facilitators indicated that they appreciated the opportunity to develop a relationship between the community and the University of Memphis, and getting to know students and their parents more. The program also gave principals and teachers “the opportunity to get paid to do something they enjoyed doing, anyway.” Students in the control condition stated that their parents were “glad when they got in the program,” and were glad when their grades started going up. Program faculty stated that on a community level, children were not "going home to empty houses," were given a little extra food that they might not have had the chance to eat otherwise, and they were retaining some of the learning and exposure during school-day lessons.

According to the annual report by CREP, responses to the control group setting were consistent with the teacher surveys. Some of the stated pros of the control group setting in the after-school program were the 20-20-20 time frame approach, the alignment to the state and local curriculum standards, and the provision of step by step organized and clearly laid out lesson plans. All stakeholders found positive aspects of the program that benefited the schools and students. Some of the cons of the program that continued to be expressed were the lack of time to re-teach and review and the lack of supplies in a timely manner.

Are the human tutors in the afterschool program reinforcing or introducing topics?

When comparing the After-School Program Curriculum Outline and the district-wide curriculum pacing guide, it is apparent that the majority of the 40 lesson topics were being reinforced in the afterschool setting rather than being introduced. Only 7 of the individual lesson topics were introduced to the students in the teacher-led condition. Topics that were introduced include how to solve problems involving ratios, rates, and percents, translating between verbal expressions/sentences and algebraic expressions or equations, solving one-step linear equations using the algebra tiles, solving two-step linear equations using the algebra tiles, solving contextual problems involving area and circumference of circles, determining the surface area of prisms and cylinders, and determining the volume of prisms and cylinders. Topics that were reinforced in the program include using area models to represent multiplication of fractions, solving problems involving addition and subtraction of fractions and mixed numbers, creating and solving contextual problems that lead naturally to division of fractions, solving problems involving multiplication and division of fractions and explaining the procedure used, solving problems involving the addition and subtraction of decimals, solving problems involving the multiplication and division of decimals, converting between decimals and fractions, converting between decimals, fractions, and percents, using concrete, pictoral, and symbolic representations for integers, solving one-step inequalities corresponding to given situations and representing the solution on a number line, using the order of operations and parentheses to simplify expressions and solve problems, modeling the commutative, associative, and distributive properties to show that two expressions are equivalent, using equations to describe simple relationships shown in a table or graph, writing equations that correspond to given situations, modeling algebraic expressions using algebra tiles, rewriting expressions to represent quantities in different ways, solving two-step linear equations using number sense, properties, and inverse operations, writing and solving two-step linear equations corresponding to given situations, using algebraic expressions and properties to analyze numeric and geometric patterns, selecting the qualitative graph that models a contextual situation and writing a contextual story modeled by a given graph, graphing ordered pairs of integers in all four quadrants of the Cartesian coordinate system, generating data and graph relationships between two quantities, exploring basic properties of triangles and quadrilaterals using a protractor and ruler, classifying triangles by side lengths and angle measures, investigating the sum of the angles of a triangle and a quadrilateral using various methods, finding a missing angle measure in problems involving interior/exterior angles and/or their sums, modeling and using the Triangle Inequality Theorem, relating the area of a trapezoid to the area of a parallelogram and solving problems involving the area of trapezoids, and developing and using formulas to determine the circumference and area of circles. This implies that the students were reinforcing skills that were taught in the regular classroom during the traditional school day. Eighty two and one-half percent of the topics were reinforced in the teacher-led condition, while 17.5% of the topics were introduced. This alignment allows students to come to the afterschool setting with prior knowledge of a topic and apply it in different ways to possibly solidify the concepts. While comparing time frames on the pacing guide with the lesson outline, even the topics that are introduced in the control group are reinforced in the regular hours of school within 7-10 days. The only topics that are in the afterschool program that do not appear specifically in the state standards and the local pacing guide are solving one-step and two-step linear equations using the algebra tiles. The standards state that students must be able to model algebraic expressions using algebra tiles and the afterschool programs took that a step further with equations.

Is what the students are doing in the afterschool program influencing their classroom behaviors, attitudes, and math ability in the regular classroom?

The impact of the afterschool program on behavior, attitude, and mathematical performance in their regular school day classroom was surveyed by CREP at the beginning and end of the program. This survey asked student's regular school day teachers a series of questions that resulted in a way to uncover the possible effects of the teacher-led condition on students in their day to day classroom. The classroom teachers responded to the questions for each student. The means in Table 1 represent only the students that had responses for both the pre-evaluation and the post-evaluation from the 135 participating students (School 1 had 8 students, School 2 had 34 students, School 3 had 11 students, and 38 students for School 4).

Considering that the target population of the program was the students previously scoring in the 40th percentile or below on 5th grade TCAP assessments, the gains in the means indicated several areas where the program was influential. Areas where mean values reflected gains for all four of the participating schools were attentiveness in math class, positive attitude toward math, and passing grades on math tests. Other areas that three of the four schools had improvements in were students volunteering for extra credit or more responsibilities in math class, coming to math class motivated to learn, working well with others (i.e. groups/teams), earning passing grades on classroom assignments, turning in math homework on time, completing math homework adequately, persistence until math problems are solved, independently solving math problems, using a variety of approaches to solve a problem, easily grasping new math concepts, and ability to solve multi-step problems without assistance. Overall, the survey indicated gains in both mathematics attitude and mathematics performance as observed by their classroom teacher.

Do students who are reinforcing math in a very structured environment show gains in math scores?

Using TCAP scores from two consecutive school years, 2009 and 2010, for the 135 students from the Jackson-Madison County school district that participated in the

Table 1.
Students Mathematics Classroom Behavior

	School 1		School 2		School 3		School 4	
Attitude Measures	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Student attends math class	4.00[a]	3.88	4.23	4.14	4.82	4.64	3.92	3.95
Student is attentive in math class	3.5	3.63	2.97	3.14	3.27	3.91	2.72	2.92
Student behaves in math class	3.63	3.5	3.14	3.06	3.27	3.91	2.82	3.03
Student appropriately participates in math class.	2.88	3.25	2.94	2.86	3.64	3.64	2.72	2.87
Student volunteers for extra credit or more responsibilities in math class.	1.25	3	1.91	2.46	2	3.55	2.23	2
Student comes to math class motivated to learn.	2.75	3.75	2.69	2.66	2.46	3.55	2.59	2.72
Student has a positive attitude towards math.	2.75	3.63	2.69	2.71	2.36	3.64	2.64	2.72
Student works well with others (i.e. groups/teams)	2.75	3.88	3.06	2.77	3.09	3.64	2.97	3.26
Student completes classroom assignments/activities adequately.	3	3.63	3.17	2.54	2.73	3.82	3.03	3
Performance Measures								
Student earns passing grades on tests.	2.25	3	2.46	2.54	2.36	3.73	2.41	2.59
Student earns passing grades on classroom assignments.	2.75	3.5	2.94	2.86	3	3.64	2.59	2.8
Student turns in math homework on time.	3.13	3.88	2.97	2.77	2.73	3.73	2.92	3.18
Student completes math homework adequately.	2.75	3.88	3.06	2.74	2.91	3.55	3	3.05
Student meets grade-level math standards.	2.88	3.5	2.86	2.37	2.73	3.64	2.33	2.31
Student persists until math problems are solved.	2.13	3.25	2.51	2.4	2.09	3.36	2.31	2.54
Student independently solves math problems	2.38	3.25	2.66	2.37	2.64	3.64	2.51	2.56
Student uses a variety of approaches to solve a problem.	1.88	3.5	2.31	1.94	2	3.55	2.23	2.39
Student is able to solve word problems without assistance.	1.25	3	2.31	2.11	1.36	3.55	2.31	2.13
Student easily grasps new math concepts.	2.13	3.25	2.31	1.94	2.27	3.46	2.26	2.39
Student is able to solve multi-step problems without assistance.	2.25	2.88	2.11	2.03	1.27	3.36	1.87	2

[a]Survey responses were: 0=Strongly Disagree, 1=Disagree, 2=Slightly Disagree, 3=Slightly Agree, 4=Agree, 5=Strongly Agree

teacher-led condition of the J-MITSE Project, it is shown that the mean scale scores went from 487.28 ± 24.70 in 2009 to 702.33 ± 98.19 in 2010. These mean scores imply that the students in the control group did make gains in learning during the year. Table 2 shows the descriptive statistics.

Table 2.
Descriptives for TCAP 2009 and TCAP 2010 for Students in the Teacher-Led Condition

Variable	N	Mean	SD	Min	Max
5th Grade (2009)	135	702.33	98.19	243	795
6th Grade (2010)	135	487.28	24.28	402	542

Due to the change of standards, assessments and scales of the TCAP between 5th and 6th grade throughout the state of Tennessee, comparisons were very difficult. Table 3 reflects all scores converted to z-scores so that a better comparison can be made between the scores from 2009 and 2010. The z-scores show that the 6th grade scores were significantly better (since $t = -3.82$ with $Pr(T<t) = .0001$). Once again, this implies that the students in the teacher-led condition achieved learning gains during the year-long program. It is not possible to determine if this gain is due strictly to the after-school program, but nonetheless, there are gains.

Table 3.
Z-Scores for TCAP 2009 and TCAP 2010 for Students in the Teacher-Led Condition

Variable	N	Mean	SE
Zscale Score 5th Grade (2009)	135	-0.62	0.06
Zscale Score 6th Grade (2010)	135	-0.30	0.10
Difference (2009-2010)	135	-0.31	0.08

In addition to the standardized test scores, the CREP Survey dealing with Mathematics Performance can also be used to determine the classroom teachers' perception of student improvement in mathematics performance. The classroom teachers responded to the questions for each student. Dealing with academic gains, all four schools reflected a gain in mean scores for students earning passing grades on tests. For School 1, the pre-evaluation mean was 2.25 and it rose to 3 in the post-evaluation, School 2 had a pre-evaluation mean of 2.46 and a post-evaluation mean of 2.54, School 3 had the largest gain in response with 2.36 for the pre-evaluation mean and 3.73 for the post-evaluation mean, and School 4 showed a pre-evaluation mean of 2.41 and a post-evaluation mean of 2.59. Other survey questions where three of the four participating schools reflected gains in mathematics performance were dealing with students earning passing grades on classroom assignments, students completing math homework adequately and turning it in on time, students persistence until math problems are solved, students independently solving math problems, students using a variety of approaches to solve a problem, students easily grasping new math concepts, and students ability to solve multi-step problems without assistance.

As indicated, the CREP Survey for Students Mathematics Classroom Behavior revealed that as the students in the control condition were evaluated by their day to day classroom teacher, students improved on passing math tests, passing classroom assignments, and completing math homework adequately. Each of these assists the students in making academic gains in the classroom. Gains in overall TCAP scale scores also indicate success.

Discussion and Summary

Despite best efforts, many students are not able to perform at a proficient or advanced level of mathematics with their daily classroom instruction alone. Ways to meet the needs of students must adapt to ensure success as districts and schools strive to meet the criteria of the NCLB Act and the Tennessee First to the Top (as one of the 1st states to receive the Race to the Top funding) goals. At the heart of improving student achievement is a focus on student performance goals. One of those goals is young students' academic readiness (First to the Top, 2010). As educators, we have an obligation to seek ways to challenge all students and prepare them to compete in the future. Afterschool programs provide a possible supplement to help students increase achievement. The need for effective afterschool programs is evident nationwide. The benefits of mathematics tutoring include, but are not limited to, helping students catch up with or get ahead of their peers, preparing students for important exams, allowing students the benefit of regaining control of their education, and helping students master difficult math concepts. Between the 6th grade and the 8th grade students make a transition from basic mathematical concepts to more complex, specialized math subjects. Math tutors for this age group must help students who are struggling with math to catch up with their peers or at least make progress toward necessary basic math skills (TutoringTeach, 2009).

The J-MITSE project was created with this in mind. The control group consisted of an afterschool mathematics program with specific topics scheduled. The pros of the program in year 1 revealed by the stakeholders were the 20 minutes on, 20 minutes off time schedule approach, the provision of step by step organized and clearly laid out lesson plans, and the sequencing and alignment with the state standards and the district-wide curriculum pacing guide. The cons were dealing with what the teachers saw as a lack of time for re-teaching prior to assessments and lack of supplies in a timely manner.

When determining if the human tutors in the afterschool program were reinforcing or introducing topics, it was evident with 82.5% of the curriculum topics occurring in the afterschool setting after they had already occurred in the classroom setting, that the majority of the lessons were giving the students a different approach to concepts that had been introduced at a previous time. Since students in this program were originally selected from 6th graders that were deficient (40th percentile or below) in mathematics achievement on 5th grade TCAP, this reinforcement was an attempt at helping students succeed in an area of weakness. Of the 7 topics that were introduced in the control setting, two of them dealing with algebra tiles were not in their 6th grade standards; yet, they allowed students to utilize a "required" manipulative in a new way. This hands-on approach, in the lessons on solving one-step and two-step equations using algebra tiles, as well as most of the lessons, allowed students to visually see the reason behind the mathematical steps and algorithms.

While trying to determine if student participation in the afterschool program influenced their classroom behaviors, attitudes, and math ability in the regular classroom, it became evident through the CREP surveys that the participating students did improve on all three throughout the school year. Different circumstances at each school led to some variation in responses. One particular school (School 2) had noticeably more post-evaluation means lower than pre-evaluation means. This school dealt with the 2nd largest student participation with 77% of the students remaining in the program the entire year. With the larger number of students in the program and the student population as a whole at this participating school, discipline issues were more prevalent. The teachers at this school also indicated a lack of administrative support. Both of these factors may have contributed to the responses in the post-evaluation and the lack of influence the program appeared to have. Even though responses varied from school to school, the results of the annual report at the end of year 1 indicated that the program was an asset to all stakeholders throughout the district.

Although, due to the study design, it is not possible to determine if control students' gains are directly caused by the afterschool program itself, it is evident that students who are reinforcing math in a very structured environment do show gains in both the classroom and on standardized tests. These gains may be as simple as the ability to better complete homework, nonetheless, they are gains.

The results of year 1 of the J-MITSE project imply that a structured environment, receiving instruction from qualified teachers in a prescribed manner, improves mathematical performance. As schools and parents nationwide grapple with ways to improve math scores and deal with numerous financial burdens and budget cuts, the teacher-led condition of the J-MITSE project not only appears to be a beneficial program, but also an inexpensive way to improve student performance. The program utilized certified staff members from the school district who were interested in supplementing their income. There were no expenses on technology, outsourcing, facilities, or curriculum. Teachers in the program had a vested interest in the program's success since they are in their own district. The teachers also had the privilege of seeing these students in their school building daily (even though, by restriction of the study design, none of the teachers were the classroom teacher of the students) and watching them progress in attitude, behavior, and achievement.

As the future of this program and other structured afterschool tutorial programs are considered, the teachers are valuable resources for suggestions. Their biggest concerns were retention and re-teaching, which are concerns in every classroom nationwide today. Since the program was utilizing structured lesson plans and a specific time frame each day, teachers were not allowed to interject additional information or problems. As educators, they wanted to continue on one topic until the students mastered it. This was not allowed since the program's structure was to reinforce classroom lessons in a scripted, hands-on environment. When adaptations are considered, one possibility would be to allow the teachers to send students to the afterschool program according to the topic(s) covered. Classroom teachers would be given a year-long schedule of program topics and a specific timeframe to make reservations for students that would benefit from individual topics. This may assist the tutors by giving them a classroom full of students that have similar academic needs. One session per each assessment period might also be set aside for re-teaching or review. These recommendations are based upon the desire to see the lower level students succeed.

When recommending possible afterschool mathematics programs, the structured environment should be considered in various settings. Gifted students could participate in structured enrichment programs where their activity portion of the lesson could involve more logic and reasoning skills, while their assessment involved research and design. Students that typically perform at the basic/proficient level could sharpen math skills needed daily to grow and improve such as measurement and data analysis. Lower performing students could utilize the structure to learn the most basic skills needed prior to application. Programs could be adapted for all age groups. Pre-kindergarten students could be placed in a structured afterschool environment to allow them to gain the skills necessary to begin their education while high school students utilize the setting for standardized test preparation. The key to utilizing the 20 minutes on and 20 minutes off time frame and the step by step organized and clearly laid out lesson plans is realizing it is a tool to aid all students at all levels to enjoy learning and want to come back the next day.

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Appendix A

J-MITSE Control

Lesson Plan

Session 35

Objective-TSW model and use the Triangle Inequality Theorem.

Part I – Direct Instruction – 20 minutes

Introduction-show students the relationship the side measures of a triangle must have.

What is the Triangle Inequality Theorem? The Triangle Inequality Theorem states that any side of a triangle is always shorter than the sum of the other two sides. In other words, if you add any two sides, the sum must be greater than the remaining 3^{rd} side.

This theorem helps students to see that there is a relationship between the sides of a triangle. Three random lengths will not necessarily form a triangle. Students must understand inequality to use the Triangle Inequality Theorem.

Remind students that < is the symbol for less than and > is the symbol for greater than. These symbols will be used to show the relationship of the side measures of a triangle.

Teacher-led examples-

In order to use the Triangle Inequality Theorem, we must know what it is asking us to show. When given 3 possible side lengths of a triangle, to determine if the 3 sides form a triangle, 3 sums must be "checked".

Example 1: Given the lengths 8, 11, and 16, determine if a triangle can be formed.

To do this, we must check all 3 combinations. Remember that each sum must be greater than the remaining length.

8 + 11 = 19 which is greater than 16

8 + 16 = 24 which is greater than 11

11 + 16 = 27 which is greater than 8.

Since all 3 "combinations" are true, then 8, 11, 16 ARE sides of a triangle!

Example 2: Given the lengths 4, 6, and 10, determine if a triangle can be formed.

Is 4+6>10? NO. It is equal to 10, so we can stop right there. These are NOT lengths that form a triangle. We know that 6 + 10 >4 and 10 + 4 > 6, but it must be true for all three.

Example 3: Given the lengths 2, 7, and 8, determine if a triangle can be formed.

Is 2 + 7> 8? Yes. Is 7 + 8> 2? Yes. Is 2 + 8 > 7? Yes. Since all 3 inequalities are true, then 2, 7, and 8 are side lengths that form a triangle.

Example 4: Given the lengths 4, 5, and 11, determine if a triangle can be formed.

Is 11 + 5 > 4? Yes. Is 4 + 11> 5? Yes. Is 4 + 5 > 11? No; therefore a triangle can NOT be formed.

Part II – Activity – 20 minutes

Materials needed: dry spaghetti, rulers

During this activity, you will compare the sum of the measures of any 2 sides of a triangle with the measure of the 3rd side.

1. Break a piece of spaghetti into 3 pieces, and use the pieces to form a triangle. Measure each side length to the nearest tenth of a centimeter. In the table below, record the measures of each side of the triangle from smallest to largest; then, find the sum of the measures of the small and medium sides. Repeat this activity twice, with two other triangles, to complete the chart.

Small	Medium	Large	Small + Medium

Compare the sum of the measures of the small and medium sides to the measure of the large side for each triangle you created. Describe what you notice.

2. Break a piece of spaghetti into 3 pieces so that it is impossible to form a triangle. Measure each side of the non-triangle to the nearest tenth of a centimeter. In the table below, record the measures of each side of the non-triangle from smallest to largest; then, find the sum of the measures of the small and medium sides. Repeat this activity twice, with 2 other non-triangles, to complete the chart.

Small	Medium	Large	Small + Medium

Compare the sum of the measures of the small and medium sides to the measure of the large side for each non-triangle you created. Describe what you notice.

Part III – Application/Assessment – 20 minutes

Students should work individually during this segment. You should observe their work to determine whether or not they understand the concept of applying the Triangle Inequality Theorem.

I. Determine if each of the given sets of lengths can form a triangle using the Triangle Inequality Theorem. Be able to explain your answer using inequalities.
   1) 3, 6, 7 (answer: yes)
   2) 11, 15, 27 (answer: no)
   3) 1, 1, 5 (answer: no)
   4) 7, 7, 10 (answer: yes)
   5) 21, 26, 29 (answer: yes)
   6) 14, 20, 34 (answer: no)

II. Find a possible value for x so that the 3 sides can form a triangle.
   7) If the sides of a triangle are 5, 6, and x, what is a possible value for x? (answer: possible answers are 2, 3, 4, 5, 6, 7, 8, 9, 10)
   8) If the sides of a triangle are 3, 3, and x, what is a possible value for x? (answer: possible answers are 1, 2, 3, 4, 5)

If time permits after students have finished, have them share their answers with the class. Allow students to go to the board and show the class the 3 inequalities that were used to test the Triangle Inequality Theorem.