

Effects of an Extracurricular Program on Math Achievement

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Abstract

The purpose of this study was to determine if participation in an after school extracurricular math program would have on math achievement for middle school students. A test created by Northwest Evaluation Association was the measurement tool. This study involved use of a pretest/posttest intervention design. A pretest was given in September, 2012. The intervention took place for a period of three months, occurring once per week for one hour after school. At the conclusion of the intervention, a posttest was administered to participants. There were no significant achievement gains made. More research in after school programs to increase math achievement is needed.

CHAPTER I

INTRODUCTION

For many students, math class is their least favorite part of the day. By middle school, many students struggling with math have been labeled as such and are placed into remedial math classes, some of which are 90 to 100 minutes long. Due to the length of class time, students have been shown to lose focus during class, leading to missed instruction. This leads to a continuation of low math scores, which leads to students being placed in remedial math classes, which leads to low math scores, et cetera.... It creates a vicious cycle from which most students never benefit.

Remedial math classes tend to focus on basic mathematics skills with little time left for real-world problem solving strategies. The majorities of problems on math tests, including standardized tests, are real world-based or require the combination of two or more concepts. Often, students have not had enough practice with multistep or multiconcept problems and regress to a random guess of an answer. The unsuccessful completion of math tests lead to increased frustration with math, continued placement in remedial math classes, and even failure in math class or school in general.

Statement of Problem

With the introduction of No Child Left Behind and the continued importance placed on STEM, a student's success in math will continue to be based mostly on his/her standardized test scores. One suggestion widely used to increase test scores is participation in some form of enrichment activity outside the general math class. This study examines the impact of participation in an afterschool extracurricular math program increase on middle school students' achievement in math class.

Hypothesis

By increasing students' comfort level in math, he/she will relax in a testing situation and perform better. In order to make a student more comfortable with math skills, increased practice time in a low-stress environment is a proven benefit. This study hypothesizes that students participating in an after school enrichment program will not have statistically significant improvement in mathematics, as measured on a standardized test.

Operational Definitions

Math achievement is defined as a student meeting the academic standards as determined by the state or local school board. Math achievement in the state of Maryland is the ability to obtain a proficient score on the Maryland School Achievement (MSA) test. For this study, math achievement is obtaining a grade level score as defined by the test publisher. This is different from *improvement* in math in that improvement is defined as making gains in the mathematics score, not necessarily attaining the desired achievement score.

CHAPTER II

REVIEW OF THE LITERATURE

Satisfactory achievement in mathematics is essential to a successful schooling career. This literature review will discuss satisfactory mathematics achievement in late elementary and middle school students, identify challenges faced by schools and students in attaining satisfactory math achievement, and examine interventions for improving mathematics achievement. All research discussed in this literature review took place between 2002 and 2012.

The first section will discuss why satisfactory mathematics achievement is important and relevant. The second section will discuss what satisfactory mathematics achievement looks like. The third section of the literature review identifies the challenges schools face in attaining satisfactory mathematics achievement in all students. The fourth section identifies various interventions implemented in schools around the country to improve mathematics achievement.

Definition and Importance of Satisfactory Math Achievement

In the 1990's, the National Council of Teachers of mathematics led schools to examine how students were tracked and placed for math achievement (Spielhagen, 2006). Successful mathematics programs are designed to prepare all students to take algebra in 8th grade, leading to the more demanding courses in high school. Algebra concepts are introduced as early as 5th grade and then built upon as they progress through the middle grades (MacIver, Ruby, Balfanz, & Byrnes, 2003). MacIver et al. (2003) chose to measure satisfactory math achievement based upon state standards assessment scores compared to the norms across the entire state. This appears to be the standard measure of achievement, as Spielhagen (2006) and DeJarnette (2012) use state assessment comparison as a measurement of satisfactory math achievement.

Results of international studies on mathematics and Science exams show American schools fall behind other developed countries (DeJarnette, 2012). Spielhagen's (2006) examination of the TIMSS assessment suggests the United States 8th-grade mathematics curriculum is comparable to the average 7th grade curriculum for other developed countries. This has led to a need to increase rigor and opportunity to access algebra in middle and secondary schools around the country.

Identification of Satisfactory Mathematics Achievement

The release of the National Council of Teachers of mathematics' Principles and Standards for School Mathematics (PSSM) standardized the goals for the pedagogy of mathematics as well as competencies for students in Grades Pre-K – 12. Six fundamental principles are outlined which are essential in underlining a quality mathematics program (McKinney, Chappell, Berry, & Hickman, 2009). Mathematical teaching methodology plays an important role in student achievement, therefore the instructional practices of teachers is extremely influential in shaping students' mathematics achievement. With special regards to urban students, studies have shown hands-on and inquiry-driven lessons to be the most successful, yet least implemented (McKinney et al., 2009).

According to Valdez (2012), there is little evidence linking instructional effective and student test scores. This does not stop policy makers from creating policies directly linking teacher effectiveness and student achievement. While student achievement is generally improved with highly effective instruction, it is difficult to separate test scores from the myriad of other variables (socioeconomic status, gender, cognitive level, etc.) which lead to invalid correlations of teacher effectiveness and mathematics achievement. Therefore, satisfactory mathematics achievement has no direct link to effective instruction.

Challenges to Attaining Satisfactory Mathematics Achievement

As stated above, there are many challenges to improving a students' mathematics achievement to satisfactory levels. A myriad of other challenges exist as well. A students' motivation, or lack thereof, can be a deterrent to successful achievement. Studies have shown that a child's views of math's usefulness and importance decrease as they get older (Jacobs & Bleeker, 2004). Gender differences also are factors for varying achievement levels; boys tend to enjoy their math and Science classes more than girls in early elementary grades. By twelfth grade, these differences generally disappear.

Race, and subsequently socioeconomic status, has also been a subject of study for those troubled with attaining satisfactory math achievement. According to Buckley (2010), an increase in diversity in all US schools can lead to students from lower SES backgrounds being denied adequate mathematics instruction. Therefore, mathematics has "served as a gatekeeper to opportunities, such as mathematics- and science-based majors and careers" (Buckley, 2010, p. 51). The so-called "achievement gap" has been narrowing, but it is only restricted to low-level elementary skills, not the deep conceptual understanding of mathematics or the ability to make sense and solve real-world problems. These skills, while being assessed on a more consistent level, are not being developed in lower performing schools.

The National Council of Teachers of mathematics values equity as an essential component of effective instruction. Having a diverse class that does not achieve at satisfactory levels is not desired and is usually combated with a holistic, "one-size-fits-all" approach (Buckley, 2010). Buckley (2010) also discusses different levels of reform: individual class levels make little-to-no difference in a whole system approach, whereas higher level reform requires individual buy-in in order to create real change.

Proper analysis of data is needed to suggest successful interventions. This idea is posed by Burns, Coddling, Boice, and Lukito (2010), who suggest that since an average of 20% of elementary students require support, or interventions, beyond the typical classroom instruction. The difficulty arises in how to measure these assessments to provide effective interventions. There are two different assessment approaches: curriculum-based measurement and curriculum-based assessment for instructional design. While similar, these two approaches differ in purpose: one assesses the effectiveness of an intervention, whereas the other uses data to suggest an intervention.

Interventions for attaining satisfactory mathematics achievement

Studies have shown that raising math achievement has proved difficult, especially in fraction computation and real-world problems (Bottge, Henrichs, Mahta, & Hung, 2002). To solve this problem, researchers at Vanderbilt University developed an anchor-based instruction model in which students navigate through videos to solve geometry, algebra, and other real-world problems. These anchors are easily relatable to middle school students, who work with the characters in the video to analyze pieces of information related to solving the problems. Research from this quasiexperimental study showed those who worked with the anchored curriculum outscored those who received a traditional curriculum on the contextualized and transfer tests. There was no difference found between the groups on the computation and real-world problems tests.

An after school math tutoring program is well supported by parents, teachers, students, and school districts. With math tutoring programs, there are three overlapping categories: tutoring programs, mentoring programs, and university-school partnerships (Baker, Reig, & Clendaniel, 2006). For the after school tutoring program, at-risk students are identified and

matched with tutors from a local university. The pairs meet one day a week for 90 minutes after school, completing homework and refining a skill. Through surveys of students, parents, and teachers, almost all responses were positive. Students and tutors were able to form bonds through positive relationships, and although there were challenges, the benefits to the students were considered to be well worth the time and effort, as long as there was district support.

Rothman and Henderson (2011) chose to study whether tutoring programs are effective means to improving math achievement as measured by an assessment. The assessment is a standardized test given at the end of the seventh grade. No states studied showed the students enrolled in the after school tutoring program made no appreciable gains on the assessment but a positive impact on relationships was reported in this scenario.

After school programs are designed to improve student's mathematical achievement in collaboration with teachers' planning and in class instruction (Sherman & Catapano, 2011). Studies have demonstrated that increased time spent on academic activities lead to higher math achievement, as long as the teacher is satisfactory and the activities are well designed. Sherman and Catapano (2011) designed and implemented an after school program in which pre- and post-assessments were used to measure growth. According to the results of the study, the t-test values on the pre- and post-assessment show a large difference in the areas of concepts and applications. Learning opportunities and teacher retention are two growing issues for all schools, and solid after school programs are the cornerstones for successful schools.

With the introduction of No Child Left Behind (NCLB), some schools had to adapt complex reforms, which then had to be replaced after a couple of years. Duke and Landahl (2011) conducted a prospective study to determine whether school reforms had been effective interventions for attaining satisfactory math achievement. The school used in the study has a

new principal with a specific focus on collaboration in the school. Through surveys and questionnaires, it was determined that collaboration between school teachers led to more consistent classroom instruction and, in turn, increased assessment scores in math.

Summary

In conclusion, four concepts have been identified in this literature review in regard to attaining satisfactory mathematics achievement. First, satisfactory math achievement has been defined and the importance of it has been discussed. Second, the components of effective instruction leading to successful math achievement have been identified and explained. Third, several challenges in attaining satisfactory math achievement have been discussed and explored. Finally, a number of possible interventions were suggested which could counter some of the challenges to attaining satisfactory mathematics achievement. The following chapters of this study will focus on the impact of after school supplemental curriculum programs on middle school students.

CHAPTER III

METHODS

This study examined the impact of participation in an after school extracurricular math program and on middle school students' achievement in math class.

Design

This study used a quasiexperimental design with a pretest/posttest assessment strategy. The assessments were used to measure the effectiveness of the intervention, which included additional instruction of grade-level skills in a relaxed, small group, after school setting.

Participants

The participants in this study were 53 middle school students whose ages ranged from 10 through 15. There were 22 sixth-grade students, 16 seventh-grade students, and 15 eighth-grade students who attended the after school program. These students attend a low-performing middle school in Baltimore County, MD.

This was a purposive sample because the students had been identified as low performing due to their scores on the Maryland State Assessment (MSA) the previous school year (2011–2012). All students who received a score of Basic on the MSA the previous school year were invited to attend the program. Of the 53 students, 12 have an IEP and 9 are ELL.

Instrument

The test designed for use in this study was the Measures of Academic Progress (MAP) assessment created by Northwest Evaluation Association. The MAP assessment is aligned to current Maryland State Curriculum standards and includes multiple choice questions answered on a computer. The questions increase in difficulty when a question is answered correctly and decrease in difficulty when a question is answered incorrectly.

Upon completion, participants receive an overall score, which is used by the researcher to determine an improvement plan. Participants take the MAP assessment three times a year: fall, winter, and spring. The fall assessment, taken in early September, sets a baseline for each participant. The winter assessment, taken in mid-December, provides the first measurement after interventions have been introduced. Each MAP assessment is taken in a large group setting in the participants' math class.

Procedure

The researcher began with the fall MAP assessment taken by participants in their mathematics class. All groups participated in the fall assessment, which was administered during the same week. If a participant was absent during his/her group's testing session, he/she participated in a make-up session later in the week. Participants did receive their RIT scores at the end of the assessment, along with a breakdown of four standards and their RIT scores for each standard.

After analyzing the data from the fall assessment, the researcher determined Maryland State Standards 2 and 3 were most deficient. Participants then attended one to eight study sessions held after school every Tuesday for eight weeks. Participants were separated by grade level with two or three math teachers working with each group. During each session, material from Standards 2 and 3 was presented differently from the curriculum in a small group setting. Participants were provided with a snack at the beginning of the session while they worked on their homework, on which they were able to receive help on from the teacher in charge.

Participants then took the winter MAP assessment in their mathematics class. The winter assessment used the participant's fall score to begin the assessment at a level comfortable

to the participant. The winter assessment measured the same standards as the fall assessment but used different questions.

CHAPTER IV

RESULTS

This study was conducted to determine the impact of participation in an after school extracurricular math program on middle school student's achievement in math class.

Pre and post test data were gathered on low-achieving, sixth- to eighth-grade students. Data were analyzed to determine if there were significant differences from pre- to posttest using the dependent t (sometimes referred to as the paired t) test (see Table 1). There were no statistically significant findings.

Table 1

Dependent t or Paired t test comparison of Fall to Winter (i.e., pre to post) test scores

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Winter (Post) Test	199.28	53	12.838	1.763
	Fall (Pre) Test	200.66	53	13.784	1.893

		Mean	Std. Deviation	t	df	Sig. (2-tailed)
Pair 1	Winter (Post) Test - Fall (Pre) Test	-1.377	6.948	-1.443	52	.155

CHAPTER V

DISCUSSION

This study was conducted to determine the impact of participation in an after school extracurricular math program on middle school students' achievement in math class. Attending an after school program did not appear to consistently increase math achievement scores as analyzed in Chapter IV.

Threats to Validity

All experiments contain threats to external and internal validity. External validity refers to the ability to generalize from the sample selected for the experiment to a larger population. This study used a small sample of students attending a low-income school. Since all of the students attend one school, it is difficult to generalize the impact of the intervention for a larger population of students. These students were specifically chosen due to their low scores on math tests previously. The study focused on math strategies only, so the potential for impacts on other subjects could not be determined. The time frame of the study was three months, which is not insignificant but could be improved by allotting more time between pretest and posttest.

Due to the nature of the study conducted, various threats to internal validity exist. The study was conducted using a purposive sample, meaning participants were selected and not randomly chosen. Non-randomization of a sample leads to a threat to the internal validity of the study. A purposive sample also eliminates the ability to create a control group. The inability to compare a study to a random control group also provides a threat to the internal validity of the study.

Connections to Previous Studies

Numerous studies recommend extracurricular programs as a way of increasing math achievement. In general, this study does not support those results. For example, Baker et al. (2006) studied an after school tutoring program for at risk students and found results to be very positive. One difference between the two studies was a university partnership, which was present in the Baker et al. study. Tutoring from an individual closer in age to the student may have been more beneficial to the student as opposed to tutoring from a teacher.

This study does find connections with Rothman and Henderson's 2011 study of tutoring programs improving math achievement. The Rothman study showed students who attended the after school program did not make significant gains on the assessment. The researcher's study also found no significant gains, although the findings are surprising based on the improvement on exit tickets given during the researcher's after school program.

Implications

The findings of the study conclude that participation in an after school extracurricular program does not directly increase math achievement. There is no significant connection between attendance in the program and success in math achievement. To improve this study in the future, certain accommodations can be made.

Future research could expand on these results in many ways, including increasing time, frequency, and sample size. The population for the study was specialized and purposive, so future studies could use larger populations. With more time, the study could last an entire school year or even multiple years, showing growth of a student's math achievement over a longer period of time. It would also be beneficial to allow a more broad spectrum of students to

participate in the after school program, which will provide more randomization and a more complete result.

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