

RUNNING HEAD: Math in Focus: Singapore Math and Student Achievement

MATH IN FOCUS: SINGAPORE MATH AND THE STUDENT ACHIEVEMENT OF 4TH GRADE

STUDENTS

By

CASEY KUSKA

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Professional Education Faculty

Northwest Missouri State University Missouri

Department of Professional Education

College of Education and Human Services

Maryville, MO 64468

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Abstract

This study was completed to find if there was a significant difference in student achievement on the 4th grade MAP Mathematics test when Math in Focus: Singapore Math is used to guide the curriculum. Research shows that the world mathematic rankings placed Singapore in the top three for a series of years based on their Ministry of Education deciding to change the way mathematics is taught focusing on real world problem solving skills rather than on memorization. This lead to schools in the United States adopting this curriculum developed in Singapore with the idea of increasing student achievement in the United States. Finding in this study show that Math in Focus: Singapore Math does not increase student achievement on the 4th grade MAP Mathematics assessment. The reasoning behind the decline in student achievement is not pinpointed but lack of exposure to the curriculum for an extended period of time is a potential reason. After compiling and review of the findings of this study, current research and literature, and statistical data from the state, it is found that there is a need to continue research on Math in Focus: Singapore Math to determine the success of the math curriculum in large, urban school districts.

Introduction

Background, Issues, and Concerns

The mid-west, urban, school district has changed the math curriculum from 2012-2013 to the 2013-2014 school year. This change was made with the anticipation of the Common Core State Standards being implemented in Missouri. By changing the curriculum, students were taught different materials during the year yet still evaluated by the MAP test at the conclusion of the year. The district went from a Scott Foresman based math curriculum to the Math in Focus: Singapore Math curriculum. Some may wonder whether Math in Focus: Singapore Math is an effective program to aid in teaching math curriculum at the 4th grade level.

Practice Under Investigation

The practice under investigation is the study of the effectiveness of the Math in Focus: Singapore Math curriculum in the 4th grade classroom.

School Policy to be Informed by Study

Every school in the state of Missouri uses the MAP test to evaluate student knowledge at the end of the school year, so if there is a difference in scores based on the change in curriculum, the district should re-evaluate the effectiveness of the Math in Focus curriculum.

Conceptual Underpinning

The conceptual underpinning of the change in curriculum to Math in Focus: Singapore Math is that the test scores in Singapore are significantly higher than the test

scores in the United States. While competing on the world stage, the United States has fallen significantly behind other countries such as Singapore and is attempting to catch up in math testing. Singapore was chosen as the model to adopt due to their world ranking of number 2 across all countries in mathematics (Weisenthal, 2013). Math in Focus: Singapore Math is the curriculum choice many schools are using to bridge that academic gap. The main aspect that makes this a better model than what is currently used is the use of real world problem solving and the concrete-pictorial-abstract methodology for understanding mathematical concepts. The extensive use of problem solving skills to understand real world mathematical processes will help students understand the reasoning and deter from simple memorization. Piaget's cognitive learning theory is evident in this deeper understanding of mathematics presented in Singapore Math stating, "It is not sufficient just to assimilate ideas but also to accommodate ideas learned through drill, practice, and reflection (Kheong, 2009, p. 1)."

The large, urban district in the Midwest is one of the first districts in the region to adopt the Math in Focus curriculum. They based their decision on the success of other schools in large metropolitan areas that have similar demographics. Schools in Kentucky have had success in the adoption of the Math in Focus curriculum (Warren, 2010).

Statement of the Problem

If there is a gap in student achievement on the 4th grade MAP assessment, then the school district should revisit the implementation of Math in Focus: Singapore Math.

Purpose of the Study

To determine if Math in Focus: Singapore Math increases student achievement on the 4th grade MAP assessment.

Research Question

RQ#1: Is there a significant difference in student achievement between students taught with Math in Focus: Singapore Math and students not taught with Math in Focus: Singapore Math?

Null Hypothesis

There is not a significant difference in student achievement between students taught with Math in Focus: Singapore Math and students not taught with Math in Focus: Singapore Math.

Anticipated Benefits of the Study

To determine if the Math in Focus: Singapore Math curriculum is beneficial to 4th grade student MAP assessment results.

Definition of Terms

MAP - Missouri Assessment Program - end of year assessment given by the state of Missouri in response to "No Child Left Behind."

DESE - Department of Elementary and Secondary Education - government agency tasked with the operation of public schools in Missouri.

Summary

A study was done to determine if the Math in Focus: Singapore Math curriculum improves student achievement on the MAP test. If the t-test results show that there is a

significant difference in test scores, we will need revisit the curriculum and make changes based on test results. After the study is complete, the district will be able to make an educated decision on the success and continuance of the Math in Focus: Singapore Math curriculum.

Review of Literature

Countries have been evaluated and compared on the international scale for years. According to the National Center for Education Statistics, the United States ranks 31st in mathematics, twelve positions below the average. The same rankings have Singapore ranked 2nd in mathematics (Weisenthal, 2013). As high as Singapore scored on mathematics testing in 2012, they were not always at the top of the mathematics rankings. “In 1984, Singapore scored 16th out of 26 nations in the Second International Science Study (SISS). Then, in 1995, the nations students placed first in the Trends in International Mathematics and Science Study (TIMSS)” (The History of Singapore Math, n.d. p. 1). This success in Singapore continued ranking in the top three in 2003, 2007, and 2009 (Pepper, 2014).

This turnaround in mathematic success was not accidental, but because of the careful consideration of the Ministry of Education in Singapore. Senior Minister of State, Ms. Grace Fu, said in a 2008 speech at the Ministry of Education, “Mathematics is no longer just counting, calculation, measurement, and the study of shapes and motions of physical objects. It now involves the study of quantity, structure, space and change. This has come about through the use of abstraction and deductive reasoning” (Fu, 2008, p. 2). In July of 1998, the Ministry of Education in Singapore initiated a study of math curriculum looking at scope and sequence of textbooks that resulted in a tighter content focus (The History of Singapore Math, n.d.) “The Singapore math curriculum has evolved over 20 years. In the 1980s, the focus of the curriculum was on conceptual learning and problem solving. In the late 1990s, based on the thinking school concept,

the Singapore Math curriculum expanded to develop different forms of thinking (creative, critical, and enquiry-based) through participation in math activities and solving mathematical problems” (Kheong, 2009, p. 1). This new tighter content focus removed concepts that relied on recalling information, information covered in other subjects, technical details, and content no longer relevant in real-world practice (The History of Singapore Math, n.d.). The new program developed was called, “My Math Pals are Here!” which is currently used in 80% of schools in Singapore (Math in Focus: The Singapore Approach Research Base, n.d.). This math curriculum focused on problem solving and real world application of mathematic skills. It consisted of a three-tier understanding of math concepts, concrete to pictorial to abstract (Math in Focus: The Singapore Approach Research Base, n.d.). This program was then converted into the English version being adapted in schools in the United States known as “Math in Focus: Singapore Math.” This mathematic approach offers an opportunity for students to explore problem solving and place a greater emphasis on real world problem solving. The Singapore Mathematics Problem Solving Framework includes Skills, Concepts, Processes, Metacognition, and Attitudes (Clark, n.d.). Andy Clark shares five major reasons for performance differences from Singapore to the United States.

1. “Problem solving is embedded in Singapore texts, not as a separate activity but central to every skill and concept discussion.
2. The problems that Singapore students work on are much more complex than those in typical U.S. texts. Two- and three- step problems are the norm.
3. Non-routine, as well as routine problems are included in every grade level.

4. Students are taught specific problem solving strategies in a carefully sequenced manner beginning in second grade. The most famous of these- model drawing- is used to solve word problems initially, but once acquired as a skill, it becomes useful for solving non-routine problems as well.
5. Student attitudes are addressed and supported (Clark, n.d.).”

By identifying these differences with the Singapore Math curriculum, schools in the United States are beginning to gain ground in mathematics on the international ranking assessments.

Schools in the United States are adopting the Singapore Math approach by use of the Math in Focus: Singapore Math program. New Jersey’s Edison Township School District began a year long pilot of Math in Focus during the 2011-2012 school year looking to improve students’ overall skill in math (Study Finds Houghton Mifflin Harcourt’s Singapore Math Program Dramatically Raises Student Math Achievement in New Jersey School District, 2012). The data showed that the new program was an overwhelming success for this New Jersey district. Third graders showed an improvement from 17% to 76% on pre-post tests of students scoring 70% on these assessments. In fourth grade, 39% of students scored 70% or higher on the post test where as only 5% scored 70% on the pre-test (Study Finds Houghton Mifflin Harcourt’s Singapore Math Program Dramatically Raises Student Math Achievement in New Jersey School District, 2012). The large gains were a result of the instruction guided by the Math in Focus curriculum piloted by the school district.

Schools in Kentucky showed similar success in their Math in Focus investment. Nine schools in Fayette County began the largest-scale experiment in the country, according to Natalee Feese, the Fayette Schools' math coordinator (Warren, 2010). Warren (2010) reports that it was too soon to see the results but after talking to teachers, statements such as, "I know I'm teaching math at a much higher level now than I ever taught it before and the students are grasping it more quickly," and "That's almost two years of progress in just four or five months," radiate the success of the math program (p. 1-2).

More schools in the Fayette School District continue to join the Singapore Math curriculum. After seeing the growth that is possible with this new approach, seven to eight more schools are jumping on board. Liberty Elementary recorded a 12% gain in African-American third graders reaching proficiency on standard test cutting their achievement gap in half. Harrison Elementary African-American fourth graders showed a 20% gain while Yates Elementary eliminated its third-grade African American achievement gaps (Warren, 2011).

Another study done in Franklin Lakes, New Jersey noticed similar results. They noticed that students who were studying Singapore Math were putting their children as much as a year ahead of students in other math programs as they grasp complex problems more quickly (Hu, 2010). Mr. Bill Jackson, a math coach in the Scarsdale, New Jersey, school district said that "students moved through a three-step learning process: concrete, pictorial, abstract. American math programs typically skip the middle step and lose students when making the jump from concrete to abstract" (Hu, 2010, p. 3).

Another school district in Massachusetts, North Middlesex School District, began experimenting with Singapore Math at select schools. Since starting the Singapore Math curriculum their test scores have improved leading the district to expand Singapore Math into all of their elementary schools grades 1-6 (Ware, 2004). Teachers in this school district have noticed the success of the students and believe it is based on the building of prior knowledge rather than the memorization of tables. An example is in second grade students are exposed to shapes, in third grade they find the perimeter and area of those shapes, and in fourth grade students find the area and perimeter of the shapes with an unknown side, thus building on their prior knowledge from previous years (Ware, 2004).

Research Methods

Research Design

A t-test will be conducted to compare the 4th grade MAP test results in math from the years of 2013 and 2014. The independent variable was the use the Math in Focus: Singapore Math curriculum used to drive math instruction in schools. The dependent variables will be the MAP test results from 2013 and 2014 of one 4th grade classroom.

Study Group Description

Scores from a classroom in an urban, Midwest district will be used to determine the success of Math in Focus. The classroom had 21 students in the class measured prior to the implementation of Math in Focus and 18 students in the class after the implementation of Math in Focus. The large, urban, Midwest district has had a free and reduced lunch rate from 2013 and 2014 of 68%. This is one of the higher free and reduced lunch rates in the metropolitan area. The school district has a demographic population of 11% Black, 16.5% Hispanic, and 63.5% White.

Data Collection and Instrumentation

Data will be collected from the DESE website specifically the district report card from the MSIP 5 evaluation of school districts.

Statistical Analysis Methods

A descriptive analysis using a t-test was conducted to determine there was a significant difference in academic achievement by altering the math curriculum to align with Math in Focus: Singapore Math.

Findings

A t-test was conducted to determine whether there was a relationship between Math in Focus: Singapore Math and student achievement on the 4th grade MAP test. The following table and graphs will depict the findings based on the raw MAP data found on the Missouri DESE website.

Figure 1

t-test analysis results for Pre and Post Math in Focus Mathematics MAP scaled scores

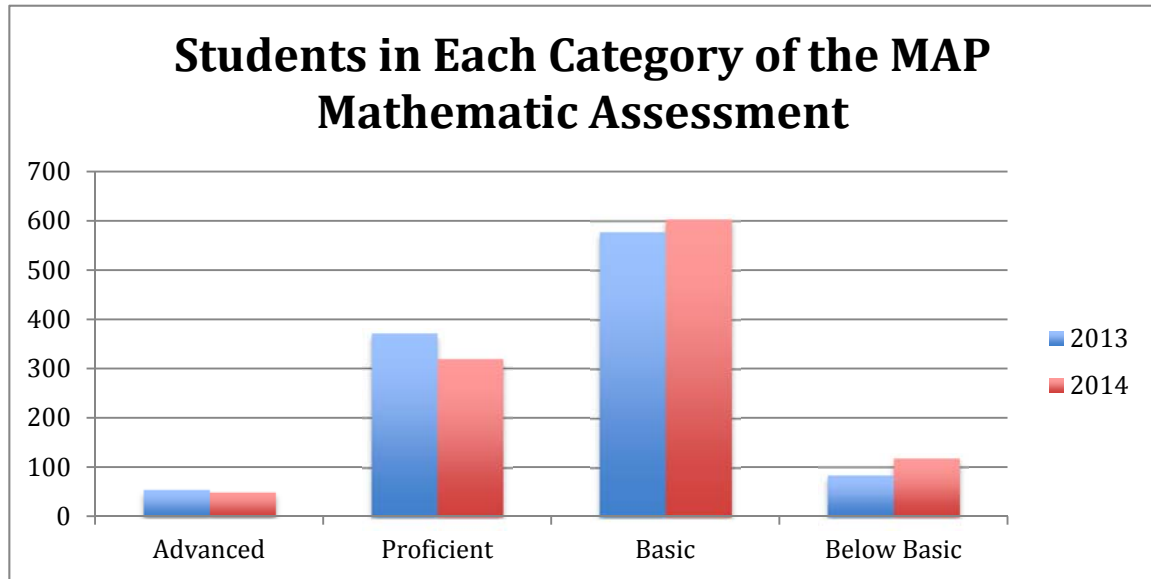
Source	Mean	Mean D	t-Test	df	p-value
Pre Math in Focus (21)	657.71				
Post Math in Focus (17)	647.50	-10.21	0.91	37	0.3677

Note: Significant when $p \leq 0.25$

The independent variable was use of the Math in Focus: Singapore Math curriculum. The dependent variable was the MAP Scaled Score. 38 students were split into two groups. There were 21 students in the group with the higher average MAP score and 17 students in the group with the lower average MAP score. The mean MAP scores for the Post Math in Focus group was 647.50 while the mean MAP scores for the Pre Math in Focus group was 657.71. The difference between the mean scores (Mean D) was -10.21. The t-test value was 0.91. The degrees of freedom were 37. The null hypothesis was: There is not a significant difference in student achievement between students taught with Math in Focus: Singapore Math and students not taught with Math

in Focus: Singapore Math. The null is not rejected because the p-value is 0.3677, which is more than the alpha level of 0.25. This means there is not a difference between Math in Focus, Singapore Math and increased student achievement on the MAP test. The Math in Focus curriculum resulted in lower scaled scores on the MAP test.

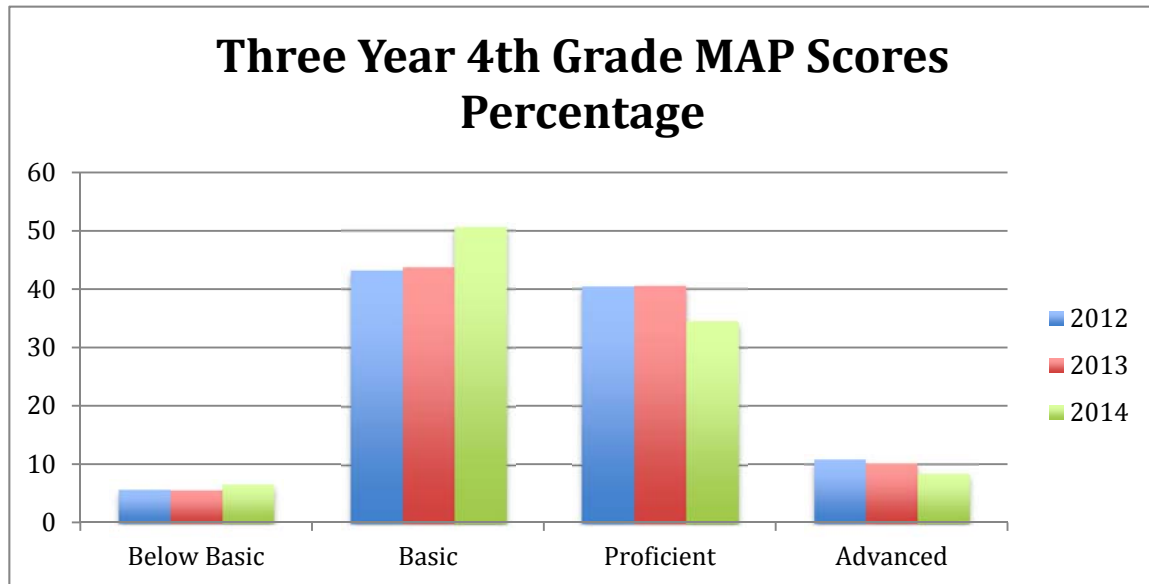
Figure 2



The mean of students in the advanced category of the MAP test was 51. The number of students dropped from 2013 to 2014 by 4 students from 53 to 49. The mean number of proficient students was 345. There were 371 in 2013 and that dropped to 319 in 2014. There were 56 less students in the top two categories of proficient and advanced in 2014 than there were in 2013. The mean number of basic students was 590.5. There were 577 basic students in 2013 and 604 in 2014. This was an increase of 27 students from 2013 to 2014. The mean number of below basic students was 100. There were 83 below basic students in 2013 and 117 below basic students in 2014. This was an increase in below basic students of 34 students. There was a total increase of 117 students in the bottom two categories from 2013 to 2014. 2014 was the year that

Math in Focus was implemented across the district in 4th grade. After this increase, the numbers of students in the top two academic categories decreased and the numbers in the bottom two academic categories increased.

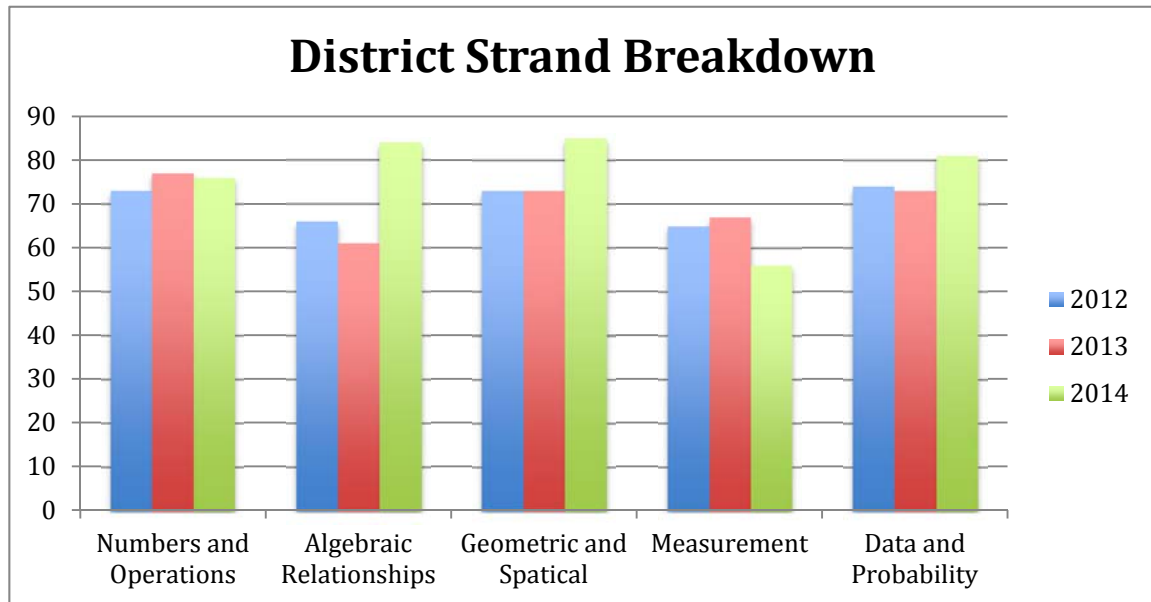
Figure 3



Below basic MAP scores decreased from 2012 to 2013 but then increased from 2013 to 2014. The lowest percentage of below basic scores was in 2013 while the highest percentage of below basic was in 2014 at 6.5%. Students scoring basic on the MAP test increased each year from 2012 to 2014. There was 43.3% in 2012, 43.7% in 2013 and 50.6% in 2014. The total percentage of students in the bottom two categories increased from 48.9% in 2012 to 57.6% in 2014. The percent of students who were proficient increased from 2012 to 2013 by 0.1%. The percent then decreased from 2013 to 2014 by 6%. The percentage of advanced students decreased over three years. There were 10.8% of students advanced in 2012, 10.2% in 2013 and 8.4% in 2014. There was a decrease in students in the top two categories from 51.2% in 2012 down to 42.9%

in 2014. Math in Focus was implemented in the 4th grade classrooms prior to the 2014 school year. This graph shows that there was an increase in the percentage of students in the bottom two academic categories and a decrease in the top two academic categories.

Figure 4



District breakdown of the MAP Mathematic at the 4th grade level shows that most scores increased after implementing Math in Focus: Singapore Math with the exception of Measurement, which suffered a substantial loss in percentage. Numbers and operations dropped by 1% from 2013 to 2014. Algebraic Relationships, Geometric and Spatial, and Data and Probability all had increases of 8% or more with Algebraic Relationships increasing 23%. Measurement declined by 11% from 2013 to 2014. Measurement and Numbers and Operations were the only two strands that show a decrease with Measurement being a significant decrease. This decrease happened after the implementation of Math in Focus: Singapore Math in the 2014 school year.

Conclusions and Recommendations

After researching the effect of Math in Focus: Singapore Math on the student achievement on the 4th grade MAP test, it is determined based on the research that Math in Focus: Singapore Math did not help students reach higher achievement levels. The t-test revealed that the p-value was 0.3677, which was higher than the alpha level of 0.25. This means that the null hypothesis: There is not a significant difference in student achievement between students taught with Math in Focus: Singapore Math and students not taught with Math in Focus: Singapore Math is not rejected.

The research shows that as a school district, the number of students in the top two performance levels declined after implementing Math in Focus across the 4th grade levels. By dropping from 51.2% in 2012 down to 42.9% in 2014 the results verify the lack of improvement on the MAP end of year assessment.

The conceptual underpinning shows the success of Singapore Math in the country of Singapore from 1995 to 2007. Over a period of 12 years, Singapore went from near the bottom to the top of the mathematic world rankings and has continued to stay there (Weisenthal, 2013). During this time, “My Math Pals are Here!” was the primary text used to teach mathematics in Singapore. The English version, Math in Focus: Singapore Math was translated and distributed in the United States. With this success in Singapore over a period of years, it is hard to recommend changing an entire curriculum that has had success in other countries. The strand breakdown encourages sticking with Math in Focus and seeing what happens in the upcoming years. With gains

at the district level in each of the strands with the exception of Measurement and Numbers and Operations, there may be future study focusing on the long-term success of Math in Focus. A possible explanation for the drop in Measurement is the lack of Measurement in the 4th grade text due to the measurement units coming in the 2nd and 3rd grade curriculum guide.

After concluding this study, there are some additional studies that can be performed to get further information about Math in Focus: Singapore Math and the program's success in urban school districts. This test could be done in the upcoming years to truly gauge the success of the program. The first year in a new program often results in lower test scores because it is new and the students have not participated in the prior knowledge needed for success in Math in Focus: Singapore Math they would be exposed to in earlier grade levels. The background information is not always present and is taught in different places in the curriculum. This research could show that the scores could be trending back up after the implementation of a new program.

Another study that could be conducted would be to look at different grade levels. A researcher could access the DESE historical data from the 3rd and 5th grade MAP tests to determine if they noticed a similar decline in student achievement. Determining the success of a math program could be determined by reviewing more than just the success of one grade level. Another similar study could be administered across the high school levels when the same students reach their final year of school. What is the graduation rate of the students who performed poorly on their 4th grade

MAP test? Did the curriculum they were taught as they advanced through school fill in the missing areas

Questions arise as to the success of Math in Focus: Singapore Math across a school district. If a researcher chose to do this same study over a period of four to five years, how will the scores represent the Singapore Math curriculum? What could the scores be of students who have been taught through the Math in Focus: Singapore Math curriculum from the time they enter Kindergarten through the time they take the 4th grade MAP test? Would this fill in the missing gaps evident by figure 4 and the gap created in the Measurement strand? This continuance of research over the upcoming years will show the true effect of Math in Focus on the 4th grade MAP scores.

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