Report on the Effectiveness of Mathnasium Learning Center Teaching on Student Performance on Standards-based Mathematics Tests

Report on 2016 Student Testing Data

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August, 2017

Introduction

Mathnasium is a learning center which students may attend after school to boost their math skills. The center is highly specialized; teaching only math. The program is for students in grades 2 through 8 and high school. Students attend the center once or twice a week, for about an hour. Like a gym or health club, members pay a monthly fee and can drop–in anytime. The goal is to significantly increase a student's math skills, understanding of math concepts, and overall school performance, while building confidence and forging a positive attitude toward the subject.

The company has sought to determine the effectiveness of its program, and has commissioned several qualitative and quantitative studies since 2004.

This study was conducted using results of 2016 school year paired pre- and posttest data for Mathnasium students across its over 720 learning centers. Using a single group non-experimental pre-posttest design, this study was to determine whether there exists a positive treatment effect on mathematics testing performance of elementary and middle school children as a result of their attending the Mathnasium teaching center.

The Study

To see whether students' performance on tests of math skills are improving as a result of Mathnasium tutoring, two math tests were given to students, one at the beginning of the study period (pretest), and one at the end (posttest).

The students who participated in this study are Mathnasium customers who also attend local elementary schools, and represent a broad cross-section across all centers located in the United States

Students are placed at a specific learning level within the Mathnasium curriculum based on an initial interview at the Mathnasium Center, a review (if possible) of recent testing results from school, and whether or not they are able to pass a pre-test at the level one lower than their current grade. These data are used to place the student at the level where they begin the Mathnasium learning process. This is the level where the subject's pre-test and post-test are given.

Between the two tests, each student attended the Learning Center a few times per week for mathematics tutoring. The treatment period, the time between pre- and posttest, averages 3 months. Students whose treatment period was fewer than 2 months or longer than 4 months are excluded. These data were loaded into a MySQL relational database management system.

The instruments used in this study are the Mathnasium Assessments. These tests have been aligned to math standards from all States in which Mathnasium operates, including the State where Mathnasium is headquartered, California. A sample portion of a Mathnasium Assessment is included in the Appendix. The pre- and posttests are equivalent, containing the same level and number of questions and testing the same exact skills. The tests have been independently validated by an experienced credentialed

mathematics teacher, showing that they test at grade-level and that the content is consistent with state standards.

The design of this statistical study is a 'Single Group Pretest-Posttest Design' (Figure 1). This design compares the same group of participants before and after the program. The purpose of the single group pretest-posttest design is to determine if participants improved after receiving the program. As is common with most any statistical work, there are limitations and threats to this design which are noted in the Conclusions section of this report.

Figure 1. Single Group Research Design based on Kerlinger (1973)

Students at the Mathnasium Learning Center form a single group. The group receives the treatment for a average period of three months. O represents the pre- and posttests.

O X O

The null hypothesis of this study is that attending the Learning Center will have no causal effect on posttest performance. A two-tailed *t-test* comparing matched pairs of pre- and posttest results was used to statistically determine if there is a significant difference between the two test scores across the study population.

Table 1. Statistical results

Title	N	Pretest mean	Pretest SD	Posttest mean	Posttest SD	Mean of differences	df	t
Mathnasium Assessment 1	922	58.14	19.13	85.91	15.33	27.77	921	-53.87
Mathnasium Assessment 2	1252	59.19	16.82	83.13	15.91	23.94	1251	-66.07
Mathnasium Assessment 3	1799	56.01	16.44	79.77	16.62	23.76	1798	-83.20
Mathnasium Assessment 4	1515	52.87	16.85	74.65	17.86	21.78	1514	-75.59
Mathnasium Assessment 5	1336	55.32	17.28	77.25	17.95	21.93	1335	-65.15
Mathnasium Assessment 6	1093	59.91	19.31	78.81	18.56	18.89	1092	-56.37
Mathnasium Assessment 7	1060	58.78	18.85	78.54	17.58	19.76	1059	-56.93
Algebra Readiness	434	52.59	18.71	72.88	19.28	20.29	433	-36.67

Analysis

Once the pre and posttest data was collected, the data were entered into Microsoft Excel, and manipulated to combine and match student pairs of data. This information was then sorted by test level. The data set contained 9,424 records of individual students who have taken matched pre- and posttests. Data for testing levels 1 through 7 were provided for this study and all levels with > 20 paired records were included.

The *t-test* analysis was performed on the data collected. The calculations were run using the "R" statistics package with a RMySQL add-in library in order to access the MySQL

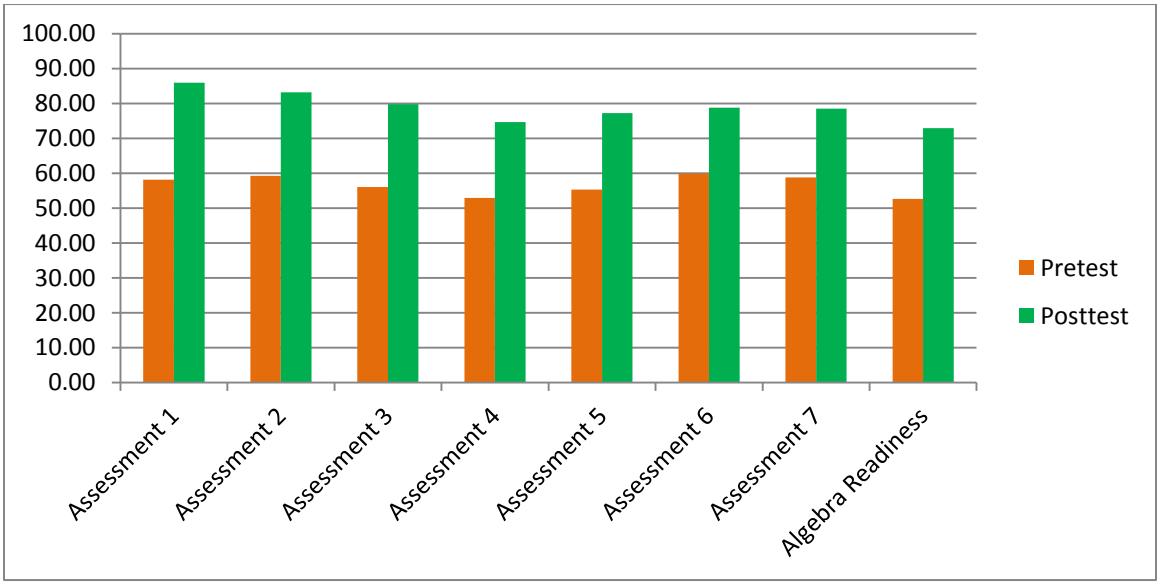
paired pre- and posttest data. A statistically significant difference in the testing scores between pre- and posttest is shown at the 95% confidence level (Table 1). The p-value is not displayed in the table as all are significantly smaller than .000002 (1.816e-06).

Conclusions

The statistical results show a positive treatment effect across all grades analyzed. The mean improvement between pre and post-tests percentage correct across all grades analyzed ranges from 18.9 to 27.7. The students performed significantly better on a math posttest after receiving instruction through the Learning Center (refer to Figure 2).

While these results show a positive treatment effect, there are a number of threats to the statistical results. The study is not experimental in design, and could benefit from a more controlled environment. This research is designed to supplement other studies to determine the effectiveness of the learning center. This design has inherent limitations, namely participants may improve over time without intervention of any kind, and these changes can be mistakenly attributed to the program under evaluation. This design could not indicate whether the program solely caused improvement in participants; as there is no way to distinguish between changes over time due to other factors and effects specific to the program. As a single group design, this study was easier to implement and less expensive study than experimental design, but did not include a control group, which could isolate the treatment effect and bias.

Figure 2. A graphical comparison of mean pre- and posttest results for Mathnasium Assessments



Another threat is the position of student treatment period in the school year, and variation testing dates among study students. This study has the average length of time between pre- and post-test of 3 months. The tutoring period was largely during the school year. Having the treatment period over a summer school break could reduce the influence on

student improvement that caused by school math classes. Further, the pretest could be administered uniformly to students before the start of their tutoring visits to the learning center. The treatment period dates could also be more tightly controlled across the study group. That is, the study group's start and stop date could be set to the same date.

While there are limitations to the statistical results in this study, there are important strengths. The results of this study are reasonably consistent across all grades, and average improvement in student test scores is positive.

When the statistical significance shown by the data is coupled with qualitative feedback from parents that Center attendees demonstrate more enthusiasm towards learning math, and their children's grades improved, the results of this study are very positive.

Appendix A: References

American Educational Research Association (AERA), American Psychological Association (APA), and National Council on Measurement in Education (NCME). (1999). *The Standards for Educational and Psychological Testing*.

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Appendix B. Sample Pages from Mathnasium Internal Pretests used in this Study

• Mathnasium Checkup #5 •

Date _____ Grade _____ Name _____

1) half of 60 = _____ **2)** half of 84 = _____

3) half of 38 = _____ **4)** half of 250 = _____

5) half of 9 = _____ **6)** half of 73 = _____

7) half of _____ = 12 **8)** half of _____ = $24\frac{1}{2}$

9) a *quarter* of 36 = _____ **10)** a *quarter* of 13 = _____

List *all* the factors of:

11) 12 _____

12) 48 _____

Find the GREATEST COMMON FACTOR (GCF) of:

13) 6 and 8 GCF = _____ **14)** 30 and 45 GCF = _____

Find the LEAST COMMON MULTIPLE (LCM) of:

15) 6 and 8 LCM = _____ **16)** 10 and 12 LCM = _____

17) Circle all of the PRIME numbers: 1, 2, 7, 38, 45, 53, 57, 73

18) Circle all of the COMPOSITE numbers: 2, 5, 27, 37, 46, 51, 87

Continue the patterns.

19) 0, 1, 3, 7, 15, 31, _____ **20)** 0, 1, 1, 2, 3, 5, 8, 13, _____

32) Name three fractions that are *equivalent* to $\frac{4}{7}$:

$\frac{4}{7}$ = _____ = _____ = _____

Reduce to *lowest terms*:

33) $\frac{12}{16}$ = _____

34) $\frac{18}{42}$ = _____

35) Write as a MIXED NUMBER. $\frac{31}{9}$ _____

36) Write as an IMPROPER FRACTION. $4\frac{3}{5}$ _____

37) Circle the fraction with the *greatest* value: $\frac{12}{13}$, $\frac{19}{20}$, $\frac{8}{9}$, $\frac{77}{99}$

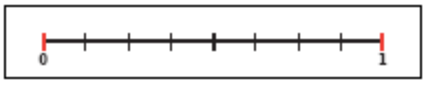
38) Arrange in **order** from *smallest* to *largest*: 0, 1, $\frac{1}{2}$, $\frac{5}{8}$, $\frac{9}{10}$, $\frac{2}{5}$

_____, _____, _____, _____, _____, _____

39) Arrange in **order** from *smallest* to *largest*: 0, 1, $\frac{1}{8}$, $\frac{5}{11}$, $\frac{8}{15}$, $\frac{1}{2}$

_____, _____, _____, _____, _____, _____

40) Name five fractions whose values are *between* $\frac{1}{2}$ and $\frac{7}{8}$.



_____ _____ _____ _____ _____