

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

Report on 2012-2013 Student Testing Data

Prepared by

John B. Watson, Ph.D. and the staff of



Watson Education
San Diego, California.

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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 2012-2013 school year paired testing data for Mathnasium students across its 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 for an average period of 3 months.

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.

The instruments used in this study are the Mathnasium 'Core' and 'Original' assessment tests. 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 'Original' test 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.

Between the two tests, each student attended the Learning Center a few times per week for mathematics tutoring. The treatment period averages 3 months.

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 minimal period of three months. O represents the pretest and posttest.

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.

Analysis

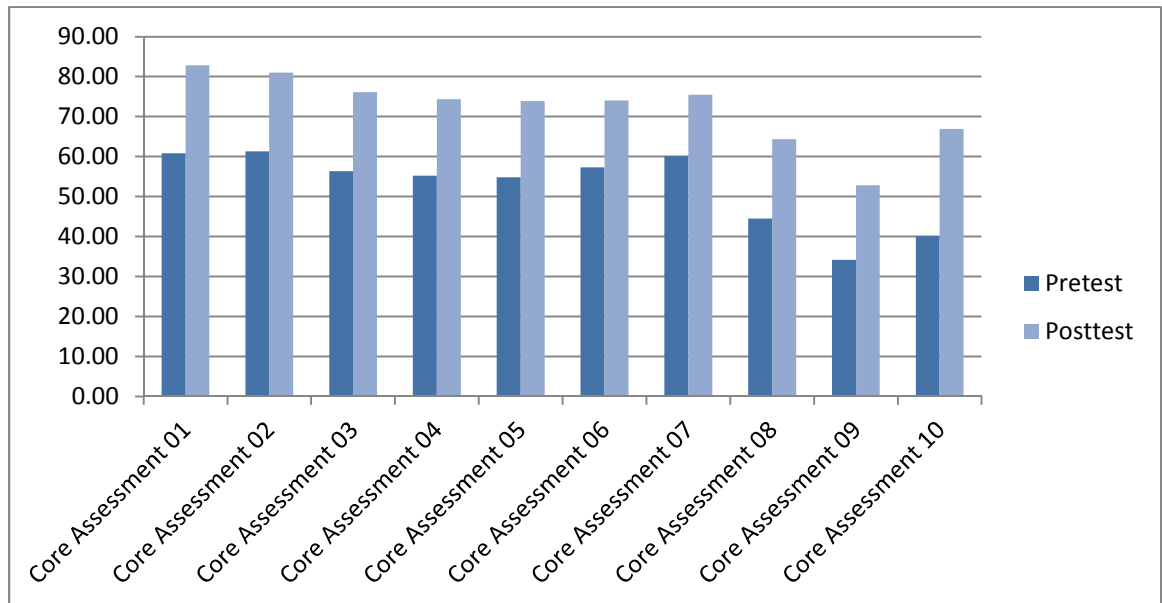
Once the pre and posttest data was collected, the data were entered into Microsoft Excel, and manipulated to combine and match student pairs of data. This information was then sorted by test level. The data set contained 3,424 records of individual students who have taken pre- and posttests. Data for testing levels 1 through 12 were provided for this study and all levels were included.

The *t-test* analysis was performed on the data collected for test levels 1 through 12. The calculations were run using the Data Analysis Add-in statistical functionality within Microsoft Excel, and several of the statistical results were confirmed using TexaSoft Winks SDA 6.0. A statistically significant difference in the testing scores between pre- and posttest is shown at the 95% confidence level (Table 1).

Table 1. Statistical results

Assessment	N	Pre-test Mean	Posttest Mean	df	t	p
Core Assessment 01	296	60.80	82.82	295	-1.0	-0.10
Core Assessment 02	443	61.34	81.03	442	-1.1	-0.02
Core Assessment 03	406	56.36	76.13	405	-7.0	-0.05
Core Assessment 04	351	55.24	74.39	350	-7.2	-0.03
Core Assessment 05	276	54.79	73.90	275	-9.6	-0.10
Core Assessment 06	223	57.27	74.02	222	-9.0	-0.14
Core Assessment 07	188	60.12	75.50	187	-3.2	-0.02
Core Assessment 08	110	44.49	64.38	109	-7.6	-0.13
Core Assessment 09	36	34.15	52.83	35	-4.0	-0.07
Core Assessment 10	19	40.06	66.93	18	-1.7	-0.04
Original_Assessment 01	139	47.81	79.19	138	-6.4	-0.01
Original_Assessment 02	156	54.43	79.42	155	-5.8	-0.17
Original_Assessment 03	214	56.12	78.51	213	-8.8	-0.10
Original_Assessment 04	166	51.14	73.38	165	-6.6	-0.09
Original_Assessment 05	120	53.08	73.72	119	-8.2	-0.14
Original_Assessment 06	82	57.15	76.74	81	-9.6	-0.16
Original_Assessment 07	81	60.85	72.06	80	-1.1	-0.09
Original_Assessment 08	62	48.01	64.63	61	-5.4	-0.07
Original_Assessment 09	31	37.83	58.05	30	-4.3	-0.05
Original_Assessment 10	8	33.24	67.76	7	-5.1	-0.18

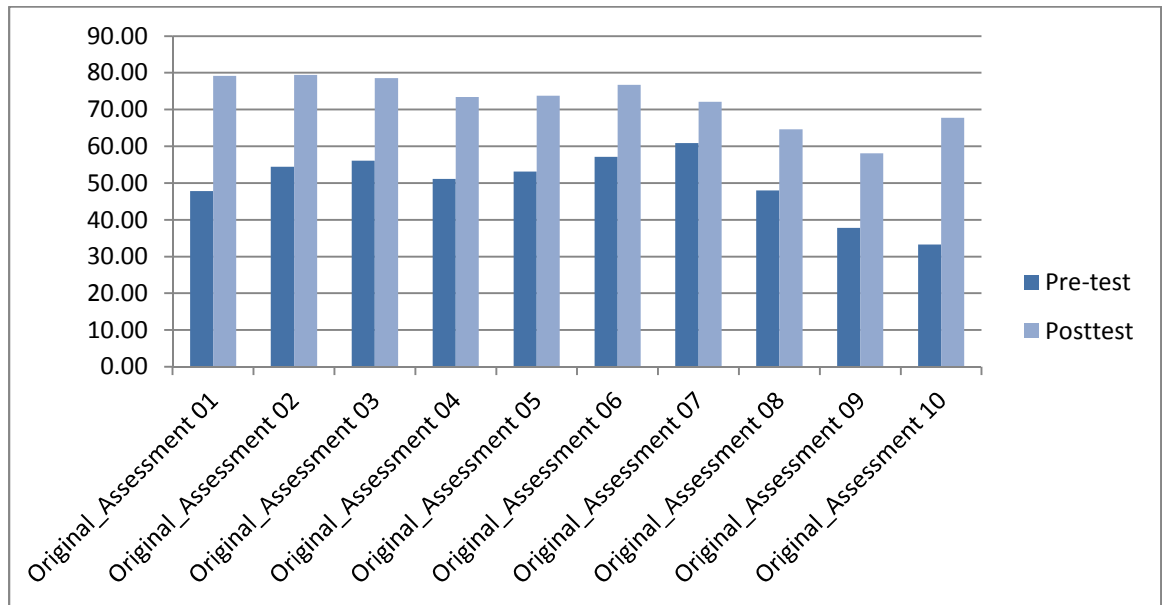
Figure 2. A graphical comparison of mean pre- and posttest results for Core Assessments



Conclusions

The statistical results show a positive treatment effect across all grades analyzed. The improvement in mean scores between pre and post-tests across all grades analyzed ranges from 11.22 to 34.53. The students performed significantly better on a math posttest after receiving instruction through the Learning Center (refer to Figure 2 and 3).

Figure 3. Graphical comparison of Original Assessment mean pre- and posttest results



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.

Another threat is the position of student treatment effect in the school year. 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.

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*.

Kerlinger, F. M. (1973). *Foundations of behavioral research*. New York: Holt Rinehart & Winston.

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Trochim, W. (2000). *The Research Methods Knowledge Base*, 2nd Edition. Atomic Dog Publishing, Cincinnati, OH.

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Appendix B. Sample of Mathnasium Internal Pretests used in this Study

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• Math Checkup #5 •

Show all work – neatly

Date _____	1) $7,349 + 321 + 6 + 75 = \underline{\hspace{2cm}}$	2) $\begin{array}{r} 4,423 \\ 5,576 \\ 1,917 \\ + 8,082 \\ \hline \end{array}$	
Grade _____	3) $\begin{array}{r} 3,482 \\ - 724 \\ \hline \end{array}$	4) $\begin{array}{r} 70,000 \\ - 9,123 \\ \hline \end{array}$	5) $\begin{array}{r} 63,905 \\ - 5,348 \\ \hline \end{array}$
Name _____	6) $\begin{array}{r} 896 \\ \times 87 \\ \hline \end{array}$	7) $\begin{array}{r} 2,753 \\ \times 524 \\ \hline \end{array}$	8) $\begin{array}{r} 45,000 \\ \times 20,000 \\ \hline \end{array}$
	9) $9 \overline{) 7,290}$	10) $16 \overline{) 51,232}$	11) $79 \overline{) 53,205}$

12) $3.24 + 7.2 =$ _____ 13) $3.69 + 7.2 + 3 =$ _____

14) $18.79 - 3.2 =$ _____ 15) $8 - 1.75 =$ _____

16)
$$\begin{array}{r} 3.42 \\ \times 1.1 \\ \hline \end{array}$$

17)
$$\begin{array}{r} 0.25 \\ \times 0.25 \\ \hline \end{array}$$

18) $1.2 \overline{) 1.56}$

19) $0.25 \overline{) 875}$

Write your answers in simplified form.

20) $\frac{3}{8} + \frac{3}{8} =$ _____ 21) $2\frac{3}{8} + \frac{5}{6} =$ _____

22) $7 - 4\frac{3}{8} =$ _____ 23) $8\frac{2}{3} - 2\frac{3}{4} =$ _____

24) $\frac{8}{9} \times \frac{3}{4} =$ _____ 25) $4\frac{4}{5} \times \frac{1}{2} =$ _____

26) $\frac{8}{9} \div \frac{2}{3} =$ _____ 27) $3\frac{9}{10} \div \frac{3}{5} =$ _____

Draw a rectangle below. Label the length $12\frac{1}{2}$ feet and the width 2 feet.

28) Find the PERIMETER of the rectangle. _____

29) Find the AREA of the rectangle. _____

30) Write the number in words: 87,654,321

31) Write the number in words: 5.234

32) 25% of 20 = _____

33) 8% of 300 = _____

34) 16% of 225 = _____

35) 12% of 130 = _____

36) 10% of the apples in a barrel were rotten. The barrel contained a total of 120 apples. How many apples were *not* rotten? _____

A bag contains 5 red M&Ms, 4 green M&Ms, and 3 blue M&Ms.

37) What is the ratio of blue M&Ms to green M&Ms? _____

38) What is the ratio of green M&Ms to red M&Ms? _____

39) What part of the M&Ms are red? _____

- 40) 3,000 pounds of sand is used to fill sandboxes. 1,000 pounds was used to fill the big sandbox, and the rest was used to fill four equal-size sandboxes. How much sand was put in each of the smaller sandboxes?
- _____

- 41) Martha and George take turns baby-sitting. Martha works for 4 hours and George works for 2 hours. They are paid a total of \$24.00.

How should they share the money so that each person gets a fair share?

Martha = _____ George = _____

- 42) $7 + -3 =$ _____ 43) $-9 + 7 =$ _____
44) $-8 + -7 =$ _____ 45) $-1 + 2 + -7 + -2 =$ _____
46) $4 - 7 =$ _____ 47) $-3 - -7 =$ _____
48) $-5 + \underline{\quad} = -2$ 49) $-4 - \underline{\quad} = 9$

- 50) Round to the nearest *thousand*: 1,237,421: _____
51) Round to the nearest *hundredth*: 24.3472: _____
52) Round to the nearest *tenth*: 129.9521: _____
53) What is the *sum* of 10 and 2? _____
54) What is the *product* of 10 and 2? _____
55) What is the *quotient* of 10 and 2? _____
56) What is the *difference* of 10 and 2? _____

Define in your own words:

57) DENOMINATOR _____

58) MULTIPLE _____

59) FACTOR _____

What is the next number in the pattern:

60) 0, 1, 3, 6, 10, 15, _____

61) 0, 1, 1, 2, 3, 5, 8, 13, _____

List *all* the factors of:

62) 12 _____

63) 60 _____

What is the GCF (Greatest Common Factor) of:

64) 18 and 24 GCF = _____

65) 75 and 125 GCF = _____

What is the LCM (Least Common Multiple) of:

66) 6 and 8 LCM = _____

67) 10 and 12 LCM = _____

A bag contains 10 red marbles, 8 white marbles, and 6 blue marbles. If one marble is picked from the bag, what is the probability that the marble will be:

68) a blue marble _____?

69) *not* a white marble _____?

70) A furlong is one-eighth ($\frac{1}{8}$) of a mile. What part of a mile is 6 furlongs? _____

Papa bear ate half of the pie. Mama bear ate half of what was left. Baby bear ate half of what was left.

71) What fractional part of the pie was left for Goldilocks? _____

72) What fractional part of the pie did Mama bear get? _____

73) Name five numbers between $\frac{1}{4}$ and $\frac{3}{4}$: _____, _____, _____, _____, _____

74) Circle the fraction with the *greatest* value: $\frac{12}{13}$, $\frac{19}{20}$, $\frac{3}{7}$, $\frac{77}{99}$

75) Arrange in order from *smallest* to *largest*: 0, 1, $\frac{1}{2}$, $\frac{5}{12}$, $\frac{5}{8}$

76) $\frac{3}{4}$ of 20 = _____

77) $\frac{5}{8}$ of 24 = _____

78) $\frac{1}{5}$ of _____ = 7

79) $\frac{3}{5}$ of _____ = 9

80) half of 20 = _____

81) half of 30 = _____

82) half of 100 = _____

83) half of 150 = _____

84) half of 7 = _____

85) half of 21 = _____

86) half of 99 = _____

87) half of $7\frac{1}{2}$ = _____

88) half of _____ = 8

89) half of _____ = $4\frac{1}{2}$

90) half of _____ = $24\frac{1}{2}$

91) half of _____ = $5\frac{3}{4}$

Appendix C. Sample Test Alignment to California State Standards

Grade 5, Test PT5A

2a	Number Sense	2.1 Add, subtract, multiply, and divide with decimals; add with negative integers; subtract positive integers from negative integers; and verify the reasonableness of the results.
2b	Number Sense	2.1 Add, subtract, multiply, and divide with decimals; add with negative integers; subtract positive integers from negative integers; and verify the reasonableness of the results.
3a	Number Sense	2.1 Add, subtract, multiply, and divide with decimals; add with negative integers; subtract positive integers from negative integers; and verify the reasonableness of the results.
3b	Number Sense	2.1 Add, subtract, multiply, and divide with decimals; add with negative integers; subtract positive integers from negative integers; and verify the reasonableness of the results.
—	Number Sense	2.1 Add, subtract, multiply, and divide with decimals; add with negative integers; subtract positive integers from negative integers; and verify the reasonableness of the results.
4a	Number Sense	2.1 Add, subtract, multiply, and divide with decimals; add with negative integers; subtract positive integers from negative integers; and verify the reasonableness of the results.
4b	Number Sense	2.1 Add, subtract, multiply, and divide with decimals; add with negative integers; subtract positive integers from negative integers; and verify the reasonableness of the results.
4c	Number Sense	2.1 Add, subtract, multiply, and divide with decimals; add with negative integers; subtract positive integers from negative integers; and verify the reasonableness of the results.
5a	Number Sense	2.2 Demonstrate proficiency with division, including division with positive decimals and long division with multidigit divisors.
5b	Number Sense	2.2 Demonstrate proficiency with division, including division with positive decimals and long division with multidigit divisors.
5c	Number Sense	2.2 Demonstrate proficiency with division, including division with positive decimals and long division with multidigit divisors.
6a	Number Sense	2.3 Solve simple problems, including ones arising in concrete situations, involving the addition and subtraction of fractions and mixed numbers (like and unlike denominators of 20 or less), and express answers in the simplest form.
6b	Number Sense	2.3 Solve simple problems, including ones arising in concrete situations, involving the addition and subtraction of fractions and mixed numbers (like and unlike denominators of 20 or less), and express answers in the simplest form.
6c	Number Sense	2.3 Solve simple problems, including ones arising in concrete situations, involving the addition and subtraction of fractions and mixed numbers (like and unlike denominators of 20 or less), and express answers in the simplest form.
7a	Number Sense	2.3 Solve simple problems, including ones arising in concrete situations, involving the addition and subtraction of fractions and mixed numbers (like and unlike denominators of 20 or less), and express answers in the simplest form.
7b	Number Sense	2.3 Solve simple problems, including ones arising in concrete situations, involving the addition and subtraction of fractions and mixed numbers (like and unlike denominators of 20 or less), and express answers in the simplest form.
7c	Number Sense	2.3 Solve simple problems, including ones arising in concrete situations, involving the addition and subtraction of fractions and mixed numbers (like and unlike denominators of 20 or less), and express answers in the simplest form.
9a	Number Sense	2.2 Demonstrate proficiency with division, including division with positive decimals and long division with multidigit divisors.
9b	Number Sense	2.2 Demonstrate proficiency with division, including division with positive decimals and long division with multidigit divisors.
9c	Number Sense	2.2 Demonstrate proficiency with division, including division with positive decimals and long division with multidigit divisors.
10a	Number Sense	2.5 Compute and perform simple multiplication and division of fractions and apply these procedures to solving problems.
10b	Number Sense	2.5 Compute and perform simple multiplication and division of fractions and apply these procedures to solving problems.
11a	Number Sense	2.5 Compute and perform simple multiplication and division of fractions and apply these procedures to solving problems.
11b	Number Sense	2.5 Compute and perform simple multiplication and division of fractions and apply these procedures to solving problems.
14a	Measurement and Geometry	1.1 Derive and use the formula for the area of a triangle and of a parallelogram by comparing it with the formula for the area of a rectangle (i.e., two of the same triangles make a parallelogram with twice the area; a parallelogram is compared with a rectangle of the same area by cutting and pasting a right triangle on the parallelogram).
14b	Measurement and Geometry	1.1 Derive and use the formula for the area of a triangle and of a parallelogram by comparing it with the formula for the area of a rectangle (i.e., two of the same triangles make a parallelogram with twice the area; a parallelogram is compared with a rectangle of the same area by cutting and pasting a right triangle on the parallelogram).
15a	Number Sense	1.1 Estimate, round, and manipulate very large (e.g., millions) and very small (e.g., thousandths) numbers.
15b	Number Sense	1.1 Estimate, round, and manipulate very large (e.g., millions) and very small (e.g., thousandths) numbers.
16a	Number Sense	2.5 Compute and perform simple multiplication and division of fractions and apply these procedures to solving problems.
16b	Number Sense	2.5 Compute and perform simple multiplication and division of fractions and apply these procedures to solving problems.
16c	Number Sense	2.5 Compute and perform simple multiplication and division of fractions and apply these procedures to solving problems.

16d	Number Sense	2.5 Compute and perform simple multiplication and division of fractions and apply these procedures to solving problems.
18a	Statistics, Data Analysis, and Probability	1.3 Use fractions and percentages to compare data sets of different sizes.
18b	Statistics, Data Analysis, and Probability	1.3 Use fractions and percentages to compare data sets of different sizes.
18c	Statistics, Data Analysis, and Probability	1.3 Use fractions and percentages to compare data sets of different sizes.
21a	Number Sense	2.1 Add, subtract, multiply, and divide with decimals; add with negative integers; subtract positive integers from negative integers; and verify the reasonableness of the results.
21b	Number Sense	2.1 Add, subtract, multiply, and divide with decimals; add with negative integers; subtract positive integers from negative integers; and verify the reasonableness of the results.
21c	Number Sense	2.1 Add, subtract, multiply, and divide with decimals; add with negative integers; subtract positive integers from negative integers; and verify the reasonableness of the results.
21d	Number Sense	2.1 Add, subtract, multiply, and divide with decimals; add with negative integers; subtract positive integers from negative integers; and verify the reasonableness of the results.
21e	Number Sense	2.1 Add, subtract, multiply, and divide with decimals; add with negative integers; subtract positive integers from negative integers; and verify the reasonableness of the results.
21f	Number Sense	2.1 Add, subtract, multiply, and divide with decimals; add with negative integers; subtract positive integers from negative integers; and verify the reasonableness of the results.
21g	Number Sense	2.1 Add, subtract, multiply, and divide with decimals; add with negative integers; subtract positive integers from negative integers; and verify the reasonableness of the results.
21h	Number Sense	2.1 Add, subtract, multiply, and divide with decimals; add with negative integers; subtract positive integers from negative integers; and verify the reasonableness of the results.
22a	Number Sense	1.1 Estimate, round, and manipulate very large (e.g., millions) and very small (e.g., thousandths) numbers.
22b	Number Sense	1.1 Estimate, round, and manipulate very large (e.g., millions) and very small (e.g., thousandths) numbers.
22c	Number Sense	1.1 Estimate, round, and manipulate very large (e.g., millions) and very small (e.g., thousandths) numbers.
25a	Mathematical Reasoning	1.1 Analyze problems by identifying relationships, distinguishing relevant from irrelevant information, sequencing and prioritizing information, and observing patterns.
25b	Mathematical Reasoning	1.1 Analyze problems by identifying relationships, distinguishing relevant from irrelevant information, sequencing and prioritizing information, and observing patterns.
26a	Number Sense	2.3 Solve simple problems, including ones arising in concrete situations, involving the addition and subtraction of fractions and mixed numbers (like and unlike denominators of 20 or less), and express answers in the simplest form.
26b	Number Sense	2.3 Solve simple problems, including ones arising in concrete situations, involving the addition and subtraction of fractions and mixed numbers (like and unlike denominators of 20 or less), and express answers in the simplest form.
27a	Number Sense	2.3 Solve simple problems, including ones arising in concrete situations, involving the addition and subtraction of fractions and mixed numbers (like and unlike denominators of 20 or less), and express answers in the simplest form.
27b	Number Sense	2.3 Solve simple problems, including ones arising in concrete situations, involving the addition and subtraction of fractions and mixed numbers (like and unlike denominators of 20 or less), and express answers in the simplest form.
28a	Number Sense	2.3 Solve simple problems, including ones arising in concrete situations, involving the addition and subtraction of fractions and mixed numbers (like and unlike denominators of 20 or less), and express answers in the simplest form.
28b	Number Sense	2.3 Solve simple problems, including ones arising in concrete situations, involving the addition and subtraction of fractions and mixed numbers (like and unlike denominators of 20 or less), and express answers in the simplest form.
29a	Number Sense	2.3 Solve simple problems, including ones arising in concrete situations, involving the addition and subtraction of fractions and mixed numbers (like and unlike denominators of 20 or less), and express answers in the simplest form.
29b	Statistics, Data Analysis, and Probability	1.3 Use fractions and percentages to compare data sets of different sizes.
30	Statistics, Data Analysis, and Probability	1.3 Use fractions and percentages to compare data sets of different sizes.