What Mathematics Vocabulary Terms Do First Graders Know?

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Contact Information

Sarah R. Powell

The University of Texas at Austin

srpowell@austin.utexas.edu

@sarahpowellphd

sarahpowellphd.com

Evidence-based mathematics resources for educators

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Acknowledgements

Gena Nelson
- American Institutes for Research

Mathematics Vocabulary

NCTM Focal Points	“develop vocabulary to describe” use “language”
Common Core Standards	use “language to describe”

Mathematics Vocabulary

Majority of assessment items require reading and interpretation of language

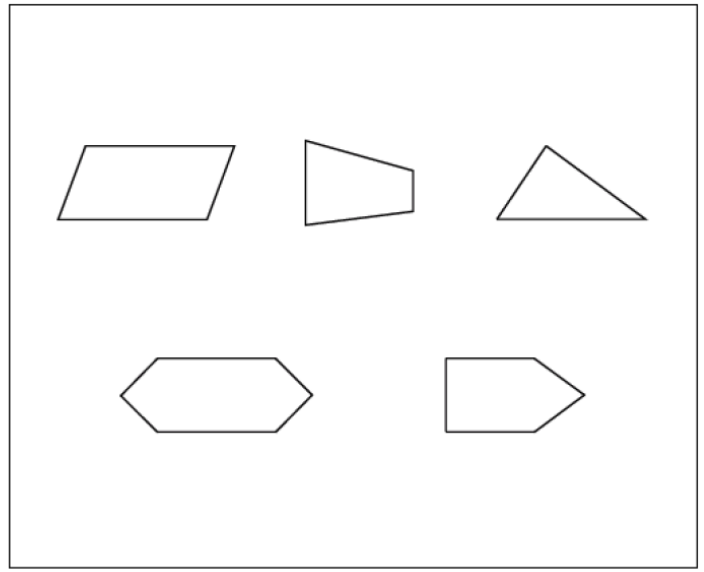
Kevin makes muffins.

- It takes 8 minutes to mix the batter.
- The muffins bake for 17 minutes.
- The muffins then cool for 5 minutes.

What is the total amount of time, in minutes, Kevin spends mixin
baking, and cooling the muffins?

2003

Click **all** of the shapes that are quadrilaterals.



Mathematics Vocabulary Instruction

Need to focus on academic language in early grades (Schleppegrell, 2012)

Few opportunities to explicit learn mathematics vocabulary (Monroe & Orme, 2002)

Most suggestions for teaching mathematics vocabulary rely on language arts strategies (Riccomini et al., 2015)

Research Questions

1. What is the technical adequacy of a measure of mathematics vocabulary designed for first-grade students?

2. What are the mathematics-vocabulary performance differences of first-grade students? What amount of variance is accounted for by general vocabulary and mathematics fluency?

3. Which mathematics-vocabulary items cause the most difficulty for students?

Participants

Table 1. Demographic Information for Participants

	n	%
Gender:		
Male	55	52.9
Female	49	47.1
Race/ethnicity:		
African American	12	11.5
Asian	1	1.0
White	37	35.6
Hispanic	54	51.9
English learners	1	1.0
Retained	7	6.7
Special education	3	2.9

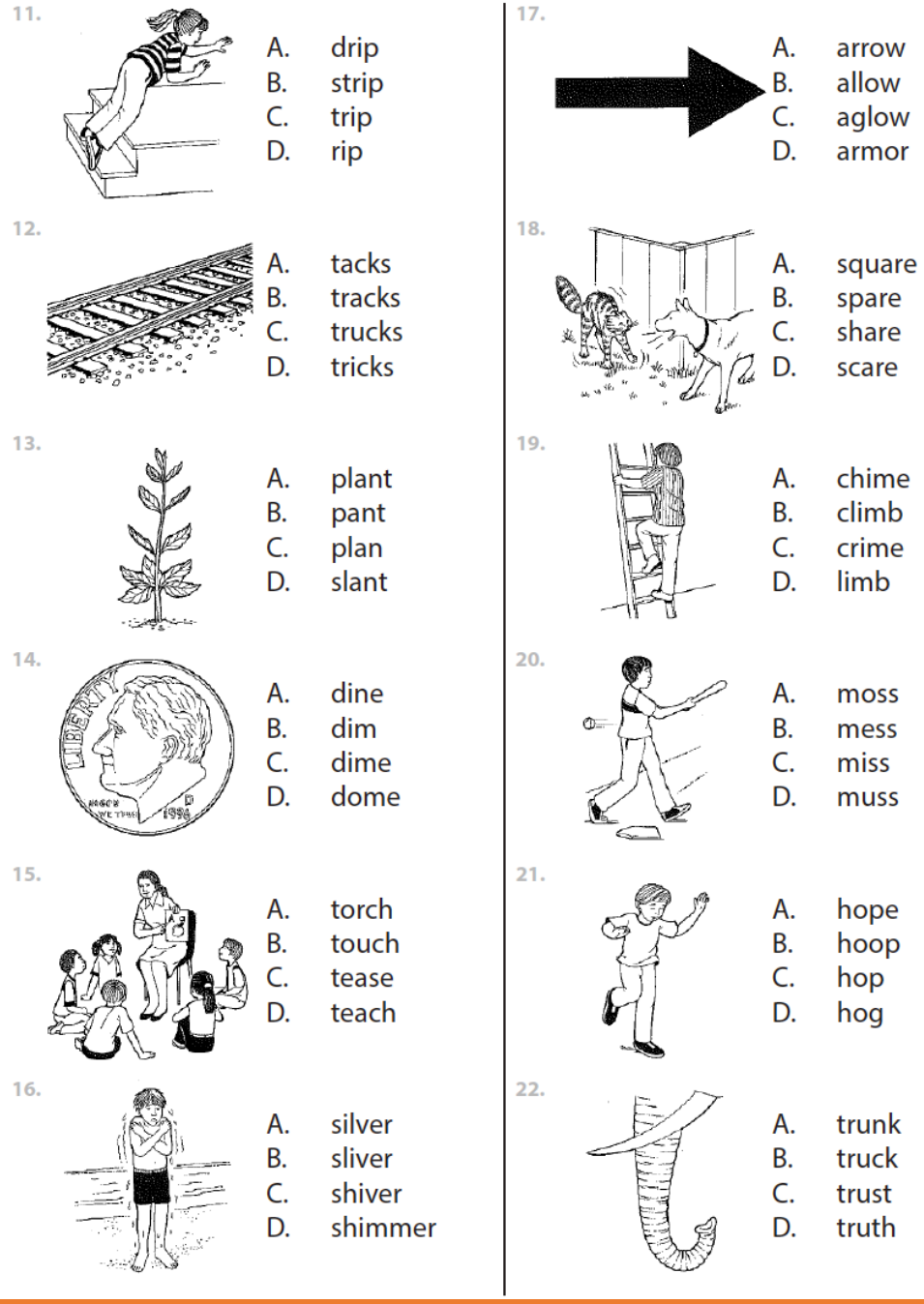
Measures

Gates MacGinitie Reading Test

Word Decoding Level 1

Students work for 20 min

α = .91



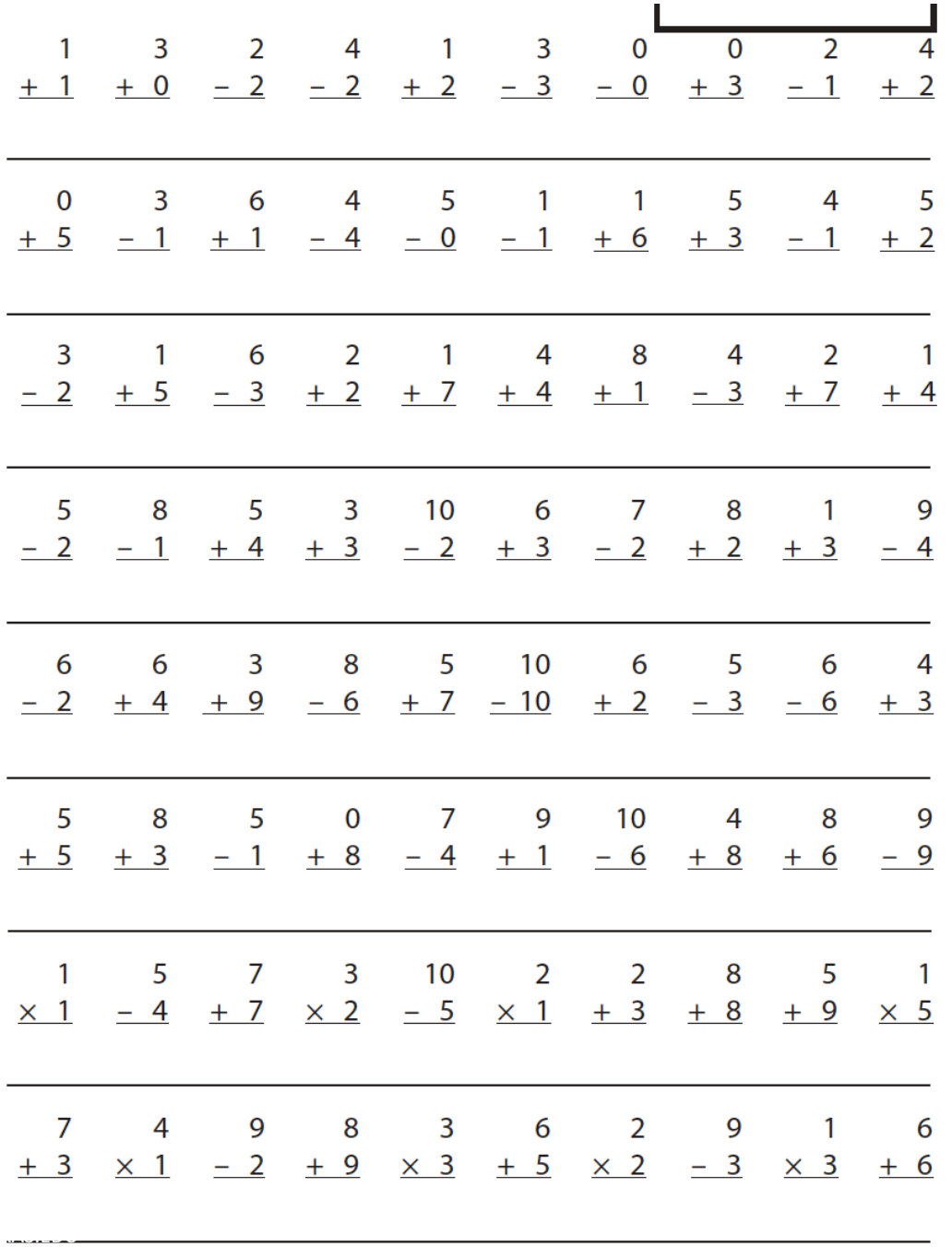
Measures

Woodcock-Johnson 4

Math Fluency

Students work for 3 min

α = .96



1 + 1	3 + 0	2 − 2	4 − 2	1 + 2	3 − 3	0 − 0	0 + 3	2 − 1	4 + 2
0 + 5	3 − 1	6 + 1	4 − 4	5 − 0	1 − 1	1 + 6	5 + 3	4 − 1	5 + 2
3 − 2	1 + 5	6 − 3	2 + 2	1 + 7	4 + 4	8 + 1	4 − 3	2 + 7	1 + 4
5 − 2	8 − 1	5 + 4	3 + 3	10 − 2	6 + 3	7 − 2	8 + 2	1 + 3	9 − 4
6 − 2	6 + 4	3 + 9	8 − 6	5 + 7	10 − 10	6 + 2	5 − 3	6 − 6	4 + 3
5 + 5	8 + 3	5 − 1	0 + 8	7 − 4	9 + 1	10 − 6	4 + 8	8 + 6	9 − 9
1 × 1	5 − 4	7 + 7	3 × 2	10 − 5	2 × 1	2 + 3	8 + 8	5 + 9	1 × 5
7 + 3	4 × 1	9 − 2	8 + 9	3 × 3	6 + 5	2 × 2	9 − 3	1 × 3	6 + 6

Measures

Mathematics Vocabulary Grade 1

Item stems read aloud by examiner

Spring 2015

Mathematics Vocabulary (1st Grade)

Answer the questions.

1. Circle the name of each coin.

A. dime
B. half dollar
C. nickel
D. penny
E. quarter

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B. half dollar
C. nickel
D. penny
E. quarter

A. dime
B. half dollar
C. nickel
D. penny
E. quarter

A. dime
B. half dollar
C. nickel
D. penny
E. quarter

2. Circle the set with the greatest.

3. Circle the set with the least.

4. In the box, write the double of 4.

In the box, write half of 6.

5. Subtract five circles.

Add four circles.

Divide into groups of three.

Multiply by two.

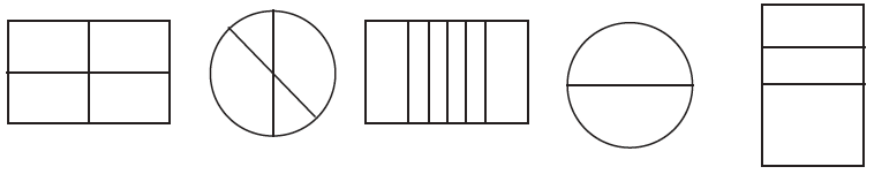
6. Write an odd number.

Write an even number.

Write a prime number.

7. Show skip counting by twos to 20.

8. Circle all that show equal shares.



9. Draw a set in the box that is equal.

10. Match each part to a word by writing a letter in the box.

$5 + 6 = 11$

$9 - 3 = 6$

A. addend
B. difference
C. equal sign
D. greater than
E. minuend
F. minus sign
G. plus sign
H. subtrahend
J. subtrahend
K. sum

11. Circle all that show counting back.

8, 7, 6, 5 3, 5, 7, 9, 11 14, 15, 13, 12 21, 20, 19, 18, 17

12. Circle all that show counting on.

2, 9, 7, 4 19, 18, 17, 16 9, 10, 11, 12, 13 3, 4, 6, 5

13. Label the clock hands.

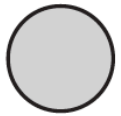
14. Draw a number line.

15. Circle the name of each shape.

A. circle
B. octagon
C. rectangle
D. rhombus
E. square

A. decagon
B. heptagon
C. hexagon
D. octagon
E. pentagon

A. decagon
B. heptagon
C. hexagon
D. octagon
E. pentagon



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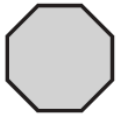


A. decagon
B. heptagon
C. hexagon
D. octagon
E. pentagon

A. octagon
B. parallelogram
C. rectangle
D. rhombus
E. trapezoid

A. decagon
B. heptagon
C. hexagon
D. octagon
E. pentagon

A. circle
B. octagon
C. rectangle
D. rhombus
E. square

16. Draw a triangle.

Draw a square.

Draw an oval.

Draw a line.

Draw a closed figure.

Draw an open figure.

17. Circle all that show an addition sentence.

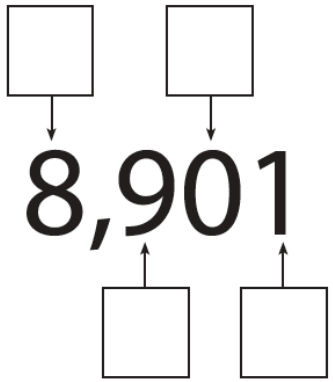
$9 - 2 = 7$ $8 = 6 + 2$ $10 - 3 = 7$ $4 + 6 = 10$ $7 + 3 + 1 = 11$

18. Circle all that show a subtraction sentence.

$2 = 8 - 6$ $4 = 3 + 1$ $6 + 9 = 15$ $12 - 3 = 9$ $9 = 9$

19. Draw circles to make ten.

20. Label the place value of each digit.



A. hundreds
B. millions
C. ones
D. tens
E. thousands

21. Draw a ball inside the box. Draw a star outside the box.

22. Circle the line that is longest.

_____

_____

_____

_____

23. Circle the line that is shortest.

_____

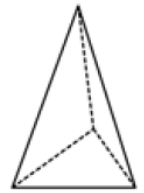
_____

_____

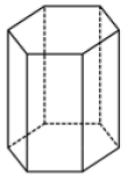
_____

24. Circle the name of each shape.

A. cone
B. cube
C. cylinder
D. sphere
E. square



A. hexagonal prism
B. hexagonal pyramid
C. rectangular prism
D. rectangular pyramid
E. triangular prism
F. triangular pyramid



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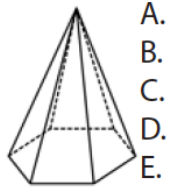

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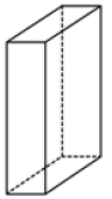
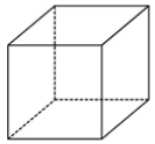


A. cube
B. cylinder
C. rectangular pyramid
D. square
E. triangular prism



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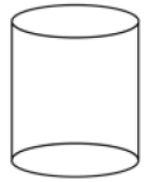

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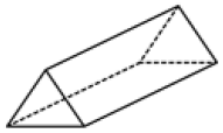


A. hexagonal prism
B. hexagonal pyramid
C. rectangular prism
D. rectangular pyramid
E. triangular prism
F. triangular pyramid

25. Write zero.

26. Circle the set that shows more.

27. Circle the set that shows less.

28. Draw lines to break the box into unequal parts.

29. Circle the sets the show equal.

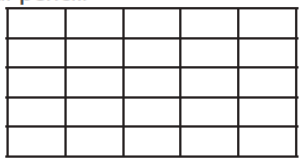
30. Draw tally marks to show 4.

31. Divide into thirds. Divide into half. Divide into quarters.

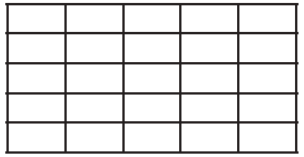
32. Separate 2 from the set.

33. Take away 4 from the set.

34. Color the bottom row with your pencil.



35. Color one column with your pencil.



1. What is the technical adequacy of a measure of mathematics vocabulary designed for first-grade students?

α = .85

Item-by-item analysis for reliability

- Deletion of only five terms would have increased α by .02
- Opted to keep all terms for analysis

2. What are the mathematics-vocabulary performance differences of first-grade students? What amount of variance is accounted for by general vocabulary and mathematics fluency?

Validity compared to Gates MacGinitie and Woodcock-Johnson

Table 3. Means, Standard Deviations, and Correlations

	Raw Score		Correlations	
Variables	*M*	*SD*	WD	MF
GMRT WD	27.57	8.56	–	–
WJ-III MF	31.17	14.29	.526	–
Mathematics Vocabulary	36.30	8.10	.697	.586

Note.—GMRT = Gates-MacGinitie Reading Tests; WD = word decoding; MF = math fluency; WJ-III = Woodcock-Johnson III.

2. What are the mathematics-vocabulary performance differences of first-grade students? What amount of variance is accounted for by general vocabulary and mathematics fluency?

Range: 15 – 55

No significant differences based on gender or retained status

Significant differences:

- For English learner (*n* = 1)
- Students with disabilities < students without disabilities
- African American < Hispanic < Caucasian

2. What are the mathematics-vocabulary performance differences of first-grade students? What amount of variance is accounted for by general vocabulary and mathematics fluency?

Table 4. Summary of Regression Analyses

Predictor	*B*	*SE B*	β	*t*	*p*	R^2	ΔR^2
Model 1:							
Intercept	18.088	1.940		9.325	<.001		
GMRT word decoding	.661	.067	.697	9.826	<.001	.486	
Model 2:							
Intercept	16.779	1.844		9.157	<.001		
GMRT word decoding	.509	.074	.538	6.874	<.001		
WJ-III math fluency	.172	.044	.304	3.881	<.001	.553	.067

Note.—GMRT = Gates-MacGinitie Reading Tests; WJ-III = Woodcock-Johnson III.

3. Which mathematics-vocabulary items cause the most difficulty for students?

Accuracy by item introduction:

Kindergarten	**67.1%**
First grade	**48.8%**
Second grade	**29.2%**

Accuracy by category:

Technical	**42.0%**
Subtechnical	**56.4%**
General	**91.1%**
Symbolic	**54.5%**

Future Research

Mathematics Vocabulary measure demonstrated strong reliability

Measure may be helpful for educators to determine which vocabulary terms need attention

We need to gain better understanding of how to efficiently teach and review mathematics vocabulary

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