What Mathematics Vocabulary Terms Do First Graders Know?
Contact Information

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Evidence-based mathematics resources for educators
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 mixing, baking, and cooling the muffins?
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>
<thead>
<tr>
<th>Gender:</th>
<th>n</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>55</td>
<td>52.9</td>
</tr>
<tr>
<td>Female</td>
<td>49</td>
<td>47.1</td>
</tr>
<tr>
<td>Race/ethnicity:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>African American</td>
<td>12</td>
<td>11.5</td>
</tr>
<tr>
<td>Asian</td>
<td>1</td>
<td>1.0</td>
</tr>
<tr>
<td>White</td>
<td>37</td>
<td>35.6</td>
</tr>
<tr>
<td>Hispanic</td>
<td>54</td>
<td>51.9</td>
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<tr>
<td>English learners</td>
<td>1</td>
<td>1.0</td>
</tr>
<tr>
<td>Retained</td>
<td>7</td>
<td>6.7</td>
</tr>
<tr>
<td>Special education</td>
<td>3</td>
<td>2.9</td>
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</tbody>
</table>
Measures

Gates MacGinitie Reading Test
Word Decoding Level 1

Students work for 20 min

$\alpha = .91$
Measures

Woodcock-Johnson 4
Math Fluency

Students work for 3 min

$\alpha = .96$
Measures

Mathematics Vocabulary Grade 1

Item stems read aloud by examiner
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


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

8,901

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

22. Circle the line that is **longest**.

[Diagram of lines]

23. Circle the line that is **shortest**.

[Diagram of lines]

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

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

A. cone  
B. cube  
C. cylinder  
D. sphere  
E. square
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 that show **equal**.

30. Draw **tally marks** to show 4.

31. Divide into **thirds**.

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?

\[ \alpha = .85 \]

Item-by-item analysis for reliability

- Deletion of only five terms would have increased \( \alpha \) 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>
<thead>
<tr>
<th>Variables</th>
<th>Raw Score</th>
<th>Correlations</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>SD</td>
</tr>
<tr>
<td>GMRT WD</td>
<td>27.57</td>
<td>8.56</td>
</tr>
<tr>
<td>WJ-III MF</td>
<td>31.17</td>
<td>14.29</td>
</tr>
<tr>
<td>Mathematics Vocabulary</td>
<td>36.30</td>
<td>8.10</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Predictor</th>
<th>$B$</th>
<th>$SE B$</th>
<th>$\beta$</th>
<th>$t$</th>
<th>$p$</th>
<th>$R^2$</th>
<th>$\Delta R^2$</th>
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</thead>
<tbody>
<tr>
<td><strong>Model 1:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intercept</td>
<td>18.088</td>
<td>1.940</td>
<td></td>
<td>9.325</td>
<td>&lt;.001</td>
<td></td>
<td></td>
</tr>
<tr>
<td>GMRT word decoding</td>
<td>.661</td>
<td>.067</td>
<td>.697</td>
<td>9.826</td>
<td>&lt;.001</td>
<td>.486</td>
<td></td>
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<tr>
<td><strong>Model 2:</strong></td>
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<tr>
<td>Intercept</td>
<td>16.779</td>
<td>1.844</td>
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<td>9.157</td>
<td>&lt;.001</td>
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<tr>
<td>GMRT word decoding</td>
<td>.509</td>
<td>.074</td>
<td>.538</td>
<td>6.874</td>
<td>&lt;.001</td>
<td>.553</td>
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<tr>
<td>WJ-III math fluency</td>
<td>.172</td>
<td>.044</td>
<td>.304</td>
<td>3.881</td>
<td>&lt;.001</td>
<td>.553</td>
<td>.067</td>
</tr>
</tbody>
</table>

Note.—GMRT = Gates-MacGinitie Reading Tests; WJ-III = Woodcock-Johnson III.
3. Which mathematics-vocabulary items cause the most difficulty for students?

<table>
<thead>
<tr>
<th>Grade</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kindergarten</td>
<td>67.1%</td>
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<tr>
<td>First grade</td>
<td>48.8%</td>
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<tr>
<td>Second grade</td>
<td>29.2%</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Category</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technical</td>
<td>42.0%</td>
</tr>
<tr>
<td>Subtechnical</td>
<td>56.4%</td>
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<tr>
<td>General</td>
<td>91.1%</td>
</tr>
<tr>
<td>Symbolic</td>
<td>54.5%</td>
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</tbody>
</table>
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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