

SOAR: Intervention Survey

GRADES
3 and Up

Operations and Algebraic Thinking:
Multiplication and Division

Operations and Algebraic Thinking: Multiplication and Division Survey Grades 3 and Up

The Operations and Algebraic Thinking Survey for multiplication and division is an informal survey designed for students who show indication, based on the universal screener, of not performing at a satisfactory level. The survey focuses on the common types of multiplication and division word problems and an understanding of the meaning of the factors. The survey allows the user to view student performance through the lens of sense-making, use of representations, use of strategies, and mathematical explanations.

Survey Categories

- I. Approaches to Solving Multiplication and Division Situational Word Problems—One-Digit Factors
- II. Interpreting Multiplication and Division Equations and Visual Models
- III. Approaches to Solving Multiplication and Division Situational Word Problems—One- and Two-Digit Factors

Four Mathematical Practices

Four mathematical practices can be used to determine an understanding of situational word problems. These include

- Making Sense of the Situational Word Problem;
- Using Representations to Show and Solve a Situational Word Problem;
- Using Problem-Solving Strategies; and
- Meaning of the Numbers in Context.

Rationale for the Design of the Survey

Research over the last several decades has revealed that good math problem-solvers develop a representation of the problem they are attempting to solve (Riley, Greeno, & Heller, 1983; Nathan, Kintsch, & Young, 1992; Halford, 1993; English, 1997; Pape, 2004; and others). Students construct a mental model of the information and the relationships among the elements of the problem. They use this information to select a solution strategy and then apply the strategy to find the answer. The better students are at recognizing the problem situation and representing it, the better their ability to solve more complex math problems (Stigler, Fuson, Ham, & Kim, 1986; Marshall, 1995).

Note: This survey has not been designed to measure a student’s ability to compute, though computation is required by the survey. It is suggested that either the universal screener or a separate computation assessment be used to measure computational skills.

Materials Needed

To administer this survey, you will need the Multiplication and Division Checklist and the following manipulatives for each category:

Category I: counters, square tiles (two different colors), hundreds chart, and grid paper

Category II: no manipulatives needed

Category III: base ten blocks (hundreds, tens and ones), 250 wooden sticks bundled into tens and ones, a set of 250 counters, and grid paper

You will follow the instructions given for each word problem in this survey, noting the appropriate indications on the checklist. Once the student has attempted each word problem, you will note the appropriate general observations on the checklist.

Administration of the Survey

The survey can be completed as a one-on-one interview (approximately 20 minutes for each section). The survey can be given to a small group of students as well. If the survey is used with a small group of students, it will be important to vary the students who are called on first as to minimize the influence other students' responses have on the results. This will help ensure you get an actual measure of each student's ability to solve the word problems.

- Students in Grade 3, whose performance on the universal screener suggests a need for additional support, will need to complete most of Category I and Category II.
- Students in Grade 4, whose performance on the universal screener suggests a need for additional support, may need to complete Categories I, II, and III. Some Grade 4th students may need to complete only Category II and Category III, depending on their level of entry.
- Students in Grade 5 to 6, whose performance on the universal screener suggests a need for additional support, may need to complete Categories I, II, and III. Some students may need to complete only Category II and/or Category III depending on their level of entry.

Before starting the survey, fill out the information on the top of the checklist, including the date on which you are giving the survey. As previously noted, a copy of each of the word problems is provided in the Student Prompt Book that should be used during the survey. The teacher is encouraged to read the word problems to the students since this is not a test of a student's reading ability.

Note: We recommend the use of the Student Prompt Book so that students are able to see and hear the word problem, as well as refer back to the word problem, as necessary. Students who are only hearing the word problems must rely on working memory to remember the word problem rather than making sense of the mathematics represented by the word problem.

Start the survey by saying: *"I like to learn about how my students are thinking about and solving problems. This is why we are meeting. I am going to give you a word problem. You can use any materials on the table to solve the word problem. Notice we have counters, square tiles, _____. I want you to talk out loud about how you are solving the word problem so I know how you are thinking about the situation. If you need a word problem repeated, please ask me to repeat the problem."* If needed, repeat this statement to them throughout the survey.


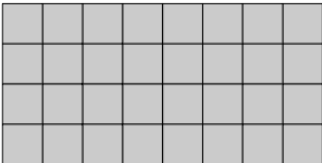

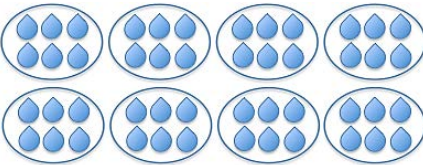
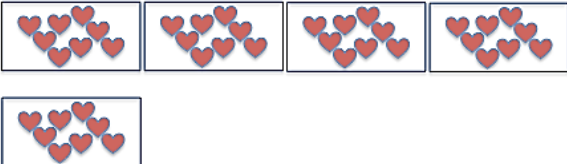
This survey is a tool designed to find out where students are in their learning; therefore, the interview questions provided on the next several pages are limited and reflect only those questions that probe for student understanding.

Note: *Italics* in the document call out teacher speech.

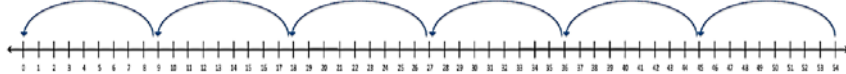

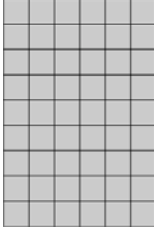
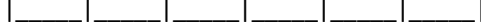
Category I: Approaches to Solving Multiplication and Division Situational Word Problems – One-Digit Factors

Item Number and Situational Word Problem	Interview Questions
<p><i>Equal Group and Array/Area Situational Word Problems with One-Digit Factors</i></p> <ol style="list-style-type: none"> Mary has 5 bags with 6 cookies in each bag. How many cookies does she have altogether? (Equal Group Multiplication, solving for an unknown product) The classroom has 6 rows of desks and each row has 7 desks. How many desks are in the classroom? (Array/Area Multiplication, solving for an unknown product) Jean has 18 pieces of candy. She wants to put 3 pieces of candy into each treat bag. If Jean wants to put all of her candy into treat bags, how many treat bags does Jean need? (Equal Group Division, solving for an unknown number of groups) Jean has 48 inches of rope. She cuts the entire rope into pieces that are 6 inches long. How many 6-inch pieces does she have? (Equal Group Measurement Division, solving for an unknown number of groups) Janice has 64 pieces of candy. She arranges them in a box with 8 pieces of candy per row. How many rows of candy will there be? (Array/Area Division, solving for an unknown number of groups) Jake has 24 stuffed animals. He puts an equal number of stuffed animals into each of 6 rooms in his house. How many stuffed animals go into each room? (Equal Group Division, solving for an unknown amount in each group) Marshall is making wreath bows. He uses 45 inches of ribbon to make 5 bows that are the same size. How many inches of ribbon does he use for each of the bows? (Equal Group Measurement Division, solving for an unknown amount in each group) There are 32 cans of soup stacked into 4 columns. How many cans of soup are in each stacked column? (Array/Area Division, solving for an unknown amount in each group) 	<p>Makes Sense</p> <ul style="list-style-type: none"> What do you know about the word problem? What do you have to figure out in the word problem? Tell me how you thought about the problem. What is the solution to the word problem?
<p><i>Multiplicative Comparisons with one-digit factors, ask students who are in Grade 4 and up</i></p>	<p>Creates Representations</p> <ul style="list-style-type: none"> Show me how you figured out the solution _____. Show how you can use the _____ to represent the word problem. Draw a picture to tell about the _____. Write an equation to tell about the _____.
<ol style="list-style-type: none"> Sam has 12 pencils. Sam’s brother has 3 times as many pencils as Sam. How many pencils does Sam’s brother have altogether? (Compare Multiplication, solving for an unknown product) An un-stretched rubber band is 7 centimeters long. When it is stretched it is 49 centimeters long. How many times shorter is the rubber band when it is not stretched than when it is stretched? (Compare Measurement Division, solving for the unknown scalar factor) 	<p>Uses Reliable Strategies</p> <ul style="list-style-type: none"> How did you figure out _____? Tell me what you did to figure out _____. <p>Provides Explanation</p> <ul style="list-style-type: none"> What do the numbers tell us about in the situation? Tell me what the numbers mean in the equation.

Category II: Interpreting Multiplication and Division Equations and Visual Models

Item Number	Interview Questions
<p>11 a-e Select the model(s) for 4×8? How does each selected model show 4×8?</p> <p>a. </p> <p>b. </p> <p>c. </p> <p>d. </p> <p>Note: For 10e, students in Grade 4 and up are expected to interpret multiplicative comparisons.</p> <p>e. </p>	<p>Makes Sense</p> <ul style="list-style-type: none"> Which models show 4×8? Tell me about the model(s) you selected. How does the model show 4×8? How did you figure out that the model shows 4×8? <p>Creates Representations</p> <p>Not applicable because models are provided.</p> <p>Uses Reliable Strategies</p> <p>Not applicable because students are not expected to use a strategy to relate the expression and the representation.</p> <p>Provides Explanation</p> <ul style="list-style-type: none"> Tell me about the factors, the 4 and the 8. Where do you see the factors in the model? Where do you see the solution to 4×8 in the model? How does the model show multiplication?

Category II: Interpreting Multiplication and Division Equations and Visual Models (continued)

Item Number	Interview Questions
<p>12 a-d Select the model(s) for $54 \div 9$? How does each selected model show $54 \div 9$?</p> <p>a. </p> <p>b. </p> <p>c. </p> <p>Note: For 9d, students in Grade 4 and up are expected to interpret multiplicative comparisons.</p> <p>d. $\frac{\quad}{\quad} = 9$ inches </p>	<p>Makes Sense</p> <ul style="list-style-type: none"> Which models show $54 \div 9$? Tell me about the models you selected. How does the model show $54 \div 9$? How did you figure the model shows $54 \div 9$? <p>Creates Representations</p> <p>Not applicable because models are provided.</p> <p>Uses Reliable Strategies</p> <p>Not applicable because students are not expected to use a strategy to relate the expression and the representation.</p> <p>Provides Explanation</p> <ul style="list-style-type: none"> Tell me about the numbers 54 and 9. Where do you see these numbers in the model? Where do you see the solution to $54 \div 9$? Tell me how the model shows division.

Category III: Approaches to Solving Multiplication and Division Situational Word Problems—One- and Two-Digit Factors

Item Number and Situational Word Problem	Interview Questions
<p>Equal Group and Array/Areas Situational Word Problems with One- and Two-Digit Factors</p> <p>13. The theater has 24 rows of seats. There are 9 seats in each row. How many seats are in the theater? (Array/Area Multiplication, solving for an unknown product)</p> <p>14. Lakeesha has 13 pieces of ribbon. Each ribbon is 18 inches in length. How many inches of ribbon does Lakeesha have altogether? (Equal Group Measurement Multiplication, solving for an unknown product)</p> <p>15. Deshawn puts 95 stamps into his stamp book. He puts 5 stamps onto each page. How many pages did he use for his 95 stamps? (Equal Group Division, solving for an unknown number of groups)</p> <p>16. Laurie has 168 pieces of candy. She arranges them on a tray into 12 rows. How many pieces of candy are in each row? (Array/Area Division, solving for an unknown amount in each group)</p> <p>Multiplicative Comparison Situational Word Problems with One- and Two-Digit Factors</p> <p>17. A sports video game costs \$58.00. A math video game costs 5 times as much as the sports video game costs. How much does the math video game cost? (Compare Multiplication, solving for an unknown product)</p> <p>18. John has 34 points in math. Jeanne has 6 times as many points than John. How many points does Jeanne have? (Compare Multiplication, solving for an unknown product)</p> <p>19. A trip from your house to the shopping center is 68 miles. A trip from your house to the movie is 17 miles. How many times further away is the shopping center than the movie theater from your house? (Compare Measurement Division, solving for the unknown multiplier/scalar factor)</p> <p>20. A sweater costs \$78.00 and a shirt costs \$13.00. How many times as much does the sweater cost than the shirt? (Compare Measurement, solving for the unknown multiplier/scalar factor)</p> <p>21. Fred has 261 baseball cards. Sam has 3 times fewer baseball cards than Fred does. How many baseball cards does Sam have? (Compare Measurement, solving for an unknown referent set, a factor)</p>	<p>Makes Sense</p> <ul style="list-style-type: none"> • <i>What do you know about the word problem?</i> • <i>What do you have to figure out in the word problem?</i> • <i>Tell me how you thought about the problem.</i> • <i>What is the solution to the word problem?</i> <p>Creates Representations</p> <ul style="list-style-type: none"> • <i>Show me how you figured out the solution _____.</i> • <i>Show how you can use the _____ to represent the word problem.</i> • <i>Draw a picture to tell about the _____.</i> • <i>Write an equation to tell about the _____.</i> <p>Uses Reliable Strategies</p> <ul style="list-style-type: none"> • <i>How did you figure out _____?</i> • <i>Tell me what you did to figure out _____.</i> <p>Provides Explanation</p> <ul style="list-style-type: none"> • <i>What do the numbers tell us about in the situation?</i> • <i>Tell me what the numbers mean in the equation.</i>