6

Math Intervention Strategies

MODEL AND SOLVE EQUATIONS USING MANIPULATIVES

Using manipulatives is the only way some students can truly understand the concepts being taught in math. Unfortunately, a prevailing myth in secondary education, especially high schools, is that manipulatives are for elementary children only. I am a strong advocate of using manipulatives and concrete representation for teaching math to students at the secondary level, including high school students.

I was always saddened when a new math teacher attempted to use algebra tiles to teach algebraic concepts and then gave up the effort because of negative feedback from either the students or math colleagues. New research in the field promoting a three-pronged approach to teaching math at the secondary level is encouraging. The Concrete Representation Abstract (CRA) approach is a breakthrough in thinking about secondary education.

Again, my goal in this chapter is twofold: First, to provide a sample lesson that teachers will be familiar with, such as the traditional scale activity and to demonstrate how to adapt that lesson to Response to Intervention philosophy; and second, to provide novel, new ideas through a sample lesson using a lesser-known device (geoboards). I also used very simple materials, such as strips of paper, out of consideration for teachers without a huge budget for purchasing manipulatives.

Research Background

Using manipulatives provides students a meaningful context for mathematical knowledge and helps them understand fundamental relationships associated with that knowledge (Witzel & Riccomini, 2010). Multiple embodiments (the use of many different models) allow students to focus on common characteristics and generalize to the abstract. "Helping students make connections between the concrete (e.g., models and manipulatives) and the abstract (e.g., generalizations and symbolic representations) facilitates understanding, promotes success at learning, and helps relieve mathematics anxiety" (Reys, Lindquist, Lambdin, Suydam, & Smith, 2009, p. 17).

In regards to secondary math such as algebra, Henri Picciotto (Picciotto, 2010) writes:

> Even though they cannot make algebra easy, manipulatives can play an important role in the transition to a new algebra course:
>
> - They provide access to symbol manipulation for students who had previously been frozen out of the course because of their weak number sense.
> - They provide a geometric interpretation of symbol manipulation, thereby enriching all students' understanding, and making a powerful connection to another part of mathematics.
> - They support cooperative learning and help improve discourse in the algebra class by giving students objects to think with and talk about. It is in the context of such reflection and conversation that learning happens.

There are four main commercial versions of algebra manipulatives ciotto, n.d.). In order of their appearance on the market, they are Algebra (Cuisenaire), the Lab Gear (Creative Publications), Algeblocks hwestern Publishing), and Algebra Models (Classroom Products). All four ide a worthwhile model of the distributive law. However, note that only the Gear and Algeblocks allow work in three dimensions.

adley S. Witzel is also an advocate of using manipulatives to teach math gh algebra. He describes the Concrete Representation Abstract method 2007). The CRA sequence of instruction consists of teaching students to mathematics problems through three levels of instruction, from the ulation of concrete objects to learning through pictorial representations y solving equations through abstract notation (Witzel, 2007).

CRA approach to teaching mathematics has proven to be beneficial ondary students with math difficulties in instructional settings ranging all groups to whole class instruction (Witzel, 2005). In fact, after receiv- instruction, students with learning disabilities had a success rate two to es higher than their traditionally taught peers. According to Witzel, the of the book *Solving Equations: An Algebra Intervention* (Witzel & 2010), CRA benefits students with math difficulties because it pres- mation in a multisensory way: visually, auditorily, tactilely, and kines- This multisensory approach causes the brain to process the

information several times in various formats, making it easier for students to memorize, encode, and retrieve the information later. In addition, CRA helps students solve abstract problems even if they cannot think fluently at the abstract level by giving them other levels of learning, both pictorial and concrete, to aid them in solving the problem (Witzel & Riccomini, 2010).

Learning Objectives

- To use manipulatives and symbols to represent situations and solve problems
- To solve linear equations

Addresses These Nonresponder Indicators

- The student has Attention Deficit Disorder.
- The student has difficulty following sequential procedures.
- The student has difficulty with abstract concepts.
- The student is unable to visualize math problems and concepts.
- The student lacks the foundational math skills required for advanced mathematics.
- The student's strategic planning ability is limited.

Materials Needed

- Balance scales
- Pennies or other tokens
- Rubber washers, toothpicks

Approximate Time Frame for Completion

This lesson plan may take more than one class period, depending on class length.

- Whole group strategy: 15 minutes
- Centers and small groups: 10 to 12 minutes each

Intervention Procedure and Scripts

Tier One/Whole group

Model on Balance Scale

1. Put the same number of pennies or tokens on each side of the scale.
   a. Ask students what equation this represents ($n = n$).
   b. In actuality, students may respond, "2 = 2" as opposed to "$n = n$."
   c. If students respond with "2 = 2," then seize the teachable moment to demonstrate how to substitute n as a variable.
   d. Demonstrate that if you subtract the same amount from each side, the scale remains balanced. For example, removing three pennies ($n - 3 = n - 3$) leaves the scale balanced.

Place ten pennies or tokens on each side of the scale.

Demonstrate that removing a number of pennies from one side results in an imbalance on the scale. (Removing five from one side results in the equation $n - 5 < n$.)

Remove five tokens from the other side of the scale to achieve a balance again. Then add twelve tokens to one side.

In order to make both sides balance again ($17 = 5 + x$), add one penny at a time until the scale balances ($17 = 5 + 12$). Therefore $x = 12$.

Demonstrate how to find the value of x by subtracting twelve from both sides of the equation.

Model several problems like this. Illustrate the step-by-step solution on the board as you demonstrate the solution process using the scale as a visual example.

Tier Two: Partner Activity

After modeling to the whole group, assign students to a strategic partnership.

For Tier One: Pair students in a mixed-ability group. Use the High with Middle, Middle with Low grouping strategy (see Figure 2.5 on page 18).

For Tier Two: Pair students in same ability groups and provide 10 minutes of intense coaching while other students are working on their own.

Use balance scales with pennies or tokens to practice solving simple linear equations ($x + 3 = 5$; $y + 7 = 9$; $n - 3 = 4$).

After students have the opportunity to solve a selection of problems, bring them back together as a group and ask probing questions to ensure understanding and promote critical thinking.

Ask: What did you have to do when you had a subtraction problem rather than an addition problem?

Discuss and reinforce the concept of adding or subtracting the same number from each side.

Application for All Three Tiers

One: Mixed-ability groups

Two: Same ability groups or peer tutoring

Three: Same ability groups with direct, intense coaching by the teacher or specialist

Station Center

At center, the students will begin to explore dividing both sides of an equation by the same number.

Give students a bag with a variety of different kinds of tokens. A sample bag would include five of one item and ten of another (for example, toothpicks and ten rubber washers).

2. Tell students that the toothpicks and rubber washers are an equation and they need to find out how many rubber washers each toothpick is worth.
3. First, they are to write the equation ($5t = 10w$), then solve it.
4. Have students model the solution of the equation by putting each toothpick on the table, then distributing the rubber washers. In this case, they would put out the five toothpicks. Then, after distributing the rubber washers, they would find that there are two rubber washers for each toothpick.
5. Model how to solve the equation by dividing both sides by five.

Manipulative Center

1. Have students use a scale and tokens in the class to solve linear equations provided by the teacher.
2. Use a virtual scale from a source like The National Library of Virtual Manipulatives (http://nlvm.usu.edu/en/nav/grade_g_4.html). Scroll down to "Algebra Balance Scales" to model and solve linear equations.

Tier Three

Provide intense instruction one on one with a math intervention specialist using activities from the manipulative center. Manipulatives, whether hands-on or virtual, are critical to helping students who struggle with math concepts to gain an understanding. It is also important to allow adequate frequency and time for skill building. Some students simply need more processing time.

Assessment Center

Students show their understanding of linear equations by completing the attached problems. Differentiate these problems by complexity (one-step problems, two-step problems, and challenge problems).

Application Examples

One-Step Problems

$4 + x = 17$

$n - 9 = 13$

$3b = 21$

$12 + j = 19$

$7 - m = 2$

Two-Step Problems

$6n + 3 = 21$

$2p + 1 = -7$

$5m - 2 = 18$

$-4y + 3 = -13$

$-2z - 5 = -4$

Challenge Problems

$4x - 5 = 7x + 3$

$2(3n + 4) - (x - 3) = 36$

$3x - 1 = 2x + 7$

Rubric: Using Math Manipulatives and Symbols with Efficacy

Criterion	1	2	3	4
Student uses manipulatives and symbols to represent situations and solve problems.	At the Teacher Center, student needs consistent support from teacher or peer to translate the items in the manipulative bags into linear equations, write the equations, and solve them.	At the Teacher Center, student translates the items in the manipulative bags into linear equations, writes the equations, and solves them, with teacher support.	At the Teacher Center, student translates the items in the manipulative bags into linear equations and writes the equations with minimal teacher direction. Student solves the equations independently and accurately.	At the Teacher Center, student independently translates the items in the manipulative bags into linear equations, writes the equations, and solves them accurately.
Student solves linear equations.	Student needs support to solve the one-step problems on the practice sheet accurately.	Student solves through the one-step problems on the practice sheet independently and accurately; needs support for two-step problems and longer.	Student solves through the two-step problems on the practice sheet independently and accurately.	Student solves through the "challenge" level problems on the practice sheet independently and accurately.

MULTIPLICATION OF FRACTIONS USING MANIPULATIVES ■

Geoboards are manipulative devices used to illustrate math operations such as fractions and geometry. Originally, they were made of wood with nails driven halfway in, and elastic bands were used to form shapes by wrapping

them around the nails. Today, they are available in a variety of designs and materials, including online virtual geoboards, but the basic design of pegs on a board remains. In this lesson we will use a geoboard to provide hands-on, visual representations of fractions.

Engineering professors at Rochester Institute of Technology, Worcester Polytechnic Institute, and Clarkson University have expressed to me their concern over the fact that many of the students in their engineering programs can plug in formulas to solve a math problem on paper, yet these same students cannot apply that math knowledge to building a physical product. Additionally, college-level technical programs all over the country understand and embrace the importance of hands-on practice and the use of manipulatives in their courses. Students at all ability levels need to not only understand abstract mathematical concepts but also the concrete application of those concepts.

Research Background

Several studies show that the long-term use of manipulatives in math produces greater achievement and improves student attitudes (Cebulla, 2000; Grouws & Cebulla, 2000, p. 15) Manipulatives give students objects to think with and talk about, and thus support cooperative learning (Picciotto, n.d.). When students use manipulatives, the teacher can see what mistakes they are making. Furthermore, it gives students the opportunity for multisensory learning, which helps students with high-incidence disabilities (Witzel, 2007).

Learning Objectives

- To use a geoboard as an area model for multiplying fractions, decimals, or percentages
- To teach students how to find the product of two fractions
- To provide students with a visual representation of a mathematical concept
- To teach students how to solve an abstract equation

Addresses These Nonresponder Indicators

- The student has Attention Deficit Disorder.
- The student lacks computational fluency.
- The student has difficulty linking prior knowledge with new information.
- The student has a weak foundation in fractions that impacts higher-level math acquisition.
- The student's skills are fragile; that is, the student possesses the necessary skills but is not yet fluent and automatic in those skills.
- The student has a performance (motivation) deficit: that is, the student has the necessary skills but lacks the motivation to complete the academic task.
- The student has spatial integration-processing difficulties that negatively impact math achievement.

- The student has a skill deficit (lacks the necessary skills to perform the academic task).
- The student struggles to effectively draw an array.
- The student struggles to find the abstract representation of a multiplication problem with fractions.

Materials Needed

- Geoboard
- Rubber bands in three different colors; for example, blue, yellow, red
- Paper and grid paper
- Toothpicks
- Colored pencils or markers

Note: There are a variety of other materials that may be used for these activities, including grid paper, whiteboards, popsicle sticks, etc. We use paper strips and toothpicks in our example simply because these materials are inexpensive as well as easy to obtain and work with.

Approximate Time Frame for Completion

This lesson plan may take more than one class period depending on class length.

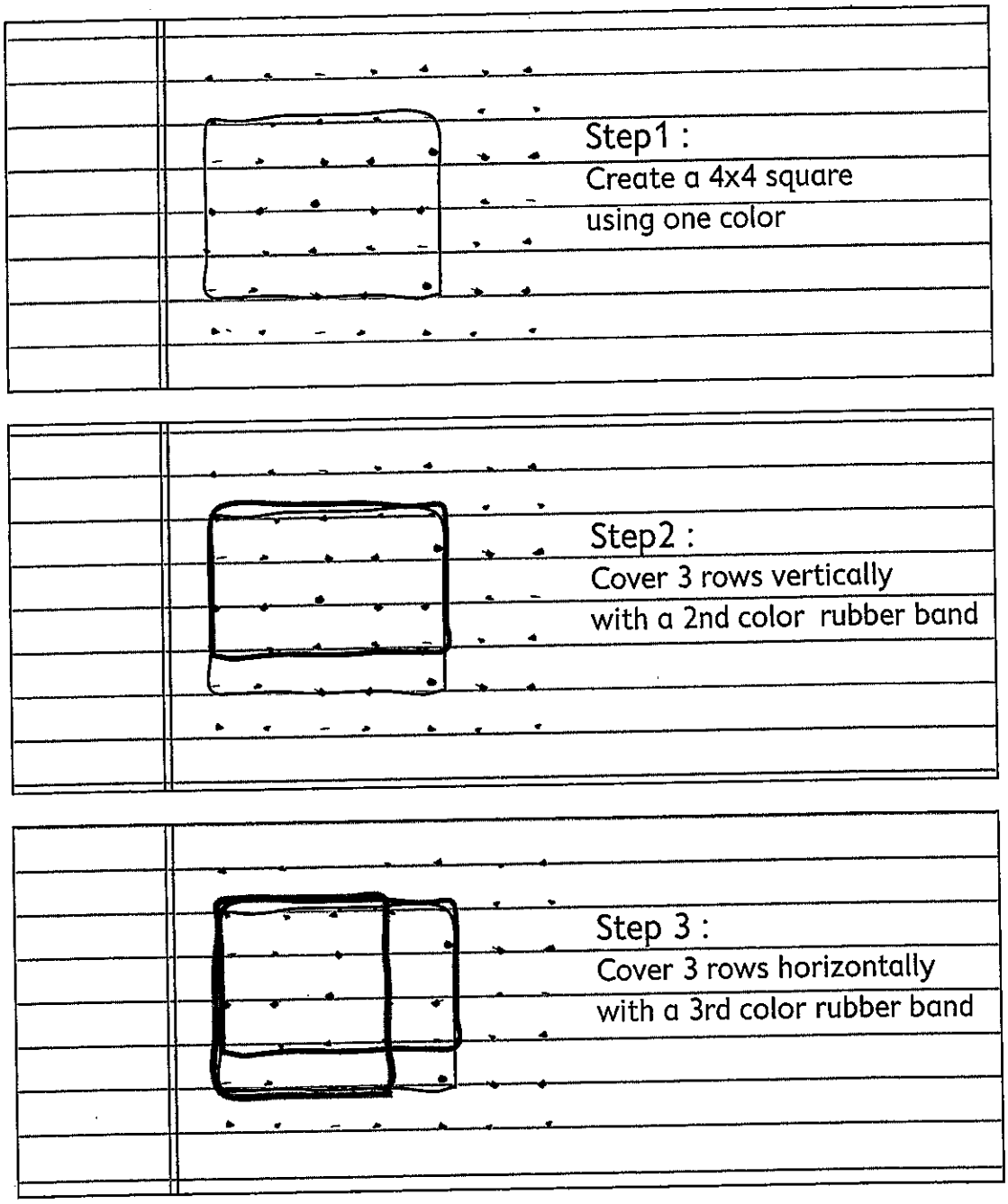
- Whole group strategy: 20 minutes
- Tier Two and Tier Three practice:15 minutes
- Tier One interventions: 15 to 20 minutes
- Extension learning: variable

Intervention Procedure and Scripts

Tier One:Whole Group

1. Access prior knowledge through demonstration.
   a. On a virtual geoboard, outline four rows by four rows with a yellow rubber band (Figure 6.1, page 110, Step 1).
   b. Using a red rubber band, show three rows by four rows (horizontally) on the left of the square (Figure 6.1, Step 2).
   c. Connect to new material: Write down the multiplication $\frac{3}{4}\times\frac{3}{4}$ and explain that this question can be read as: What is three quarters $\frac{3}{4}$ of ? Using a blue rubber band on the geoboard, outline another three rows by four rows (vertically) on the bottom of the square (Figure 6.1, Step 3).
   d. The part where the two areas overlap is nine out of sixteen squares. Go on to explain to the students how $\frac{3}{4}\times\frac{3}{4}=\frac{3\times3}{4\times4}=\frac{9}{16}$, nine units out of the sixteen of the four-by-four square.

Figure 6.1 Geoboard



2. Assign students to pairs: Use the High with Middle, Middle with Low grouping strategy (see Figure 2.5 on page 18). Explain to the students that they are going to work with a partner to practice multiplying fractions.
3. Give each pair a geoboard and assign a multiplication problem to them (for example, $\frac{4}{5}\times\frac{1}{2}$ or $\frac{6}{9}\times\frac{1}{3}$). You should assign according to level.
4. Have students use the geoboard to visualize their problem as demonstrated.

When all pairs have finished, ask one person from each pair to share their solution with the class.

After each presentation also explain to the students how you can calculate each multiplication:

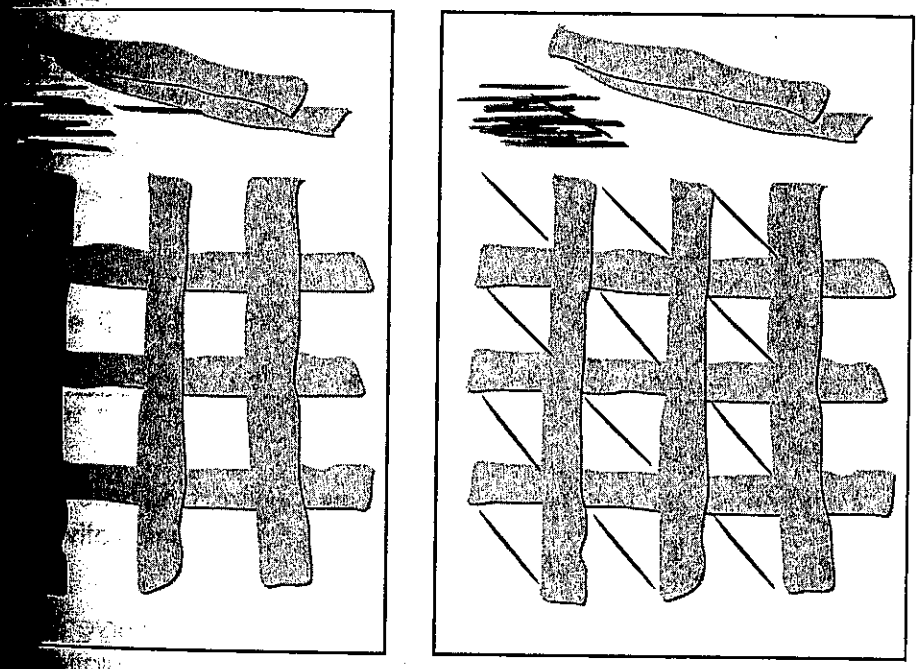
$\frac{3}{4} \times \frac{3}{4} = \frac{3 \times 3}{4 \times 4} = \frac{9}{16}$

Small Group (May Also Be Used at Tier One)

Put students in mixed-ability groups of two or three. Use the High with Middle, Middle with Low grouping strategy (see Figure 2.5 on page 18). Each group will need paper strips, grid paper, toothpicks, and colored pencils or markers.

Use paper strips to make your own mock geoboard out of paper strips and colored toothpicks (Figure 6.2, below).

Paper Strip Area Model



Explain that the denominator of each fraction in the multiplication problem determines the horizontal and vertical area of the model. For instance, in Figure 6.2, the denominator would be sixteen because there are four rows and four columns, or sixteen squares.

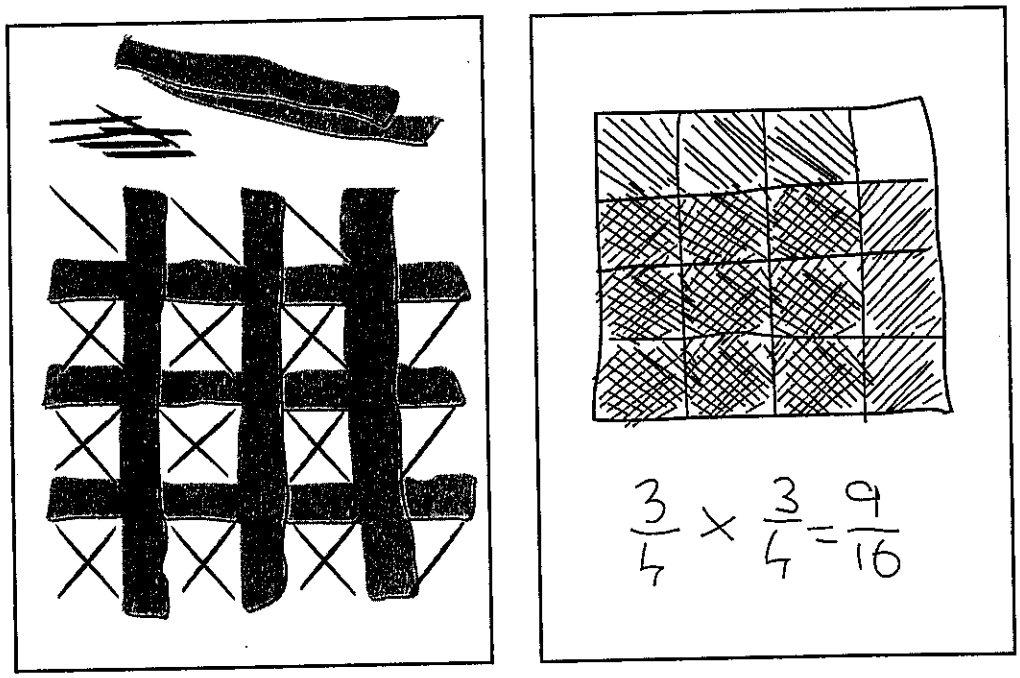
Then use toothpicks to mark parts of the area identified by the numerator of each fraction.

In Figure 6.2, nine of the squares are marked vertically, which would represent $\frac{12}{16}$ or $\frac{3}{4}$.

Then, as with the geoboard, students block off the multiplier horizontally using a different color toothpick (Figure 6.2, right).

5. To find the answer, students look at the units that have two toothpicks in them (numerator product) and the total area of the model (denominator product). Assign each group two or three multiplication problems appropriate to their ability.
6. Next, have students draw on grid paper what they did with the paper strips and toothpicks (Figure 6.3). Students will work together to complete the multiplication problems. Each person in the group will complete one problem, draw a visual representation of the problem, and write the abstract equation.

Figure 6.3 Paper Strip Area Model, Multiplying Fraction



Tier Three: One on One

1. Students work with a specialist or one on one with the teacher to master the skill. Instead of a geoboard, try using other manipulatives like cards to represent the units.
2. Provide intense instruction one on one with a math intervention specialist using activities from the manipulative center. Manipulatives, whether hands-on or virtual, are critical to helping students who struggle with math concepts to gain an understanding.
3. It is also important to allow adequate frequency and time for skill building. Some students simply need more processing time.

To Differentiate

- Differentiate by readiness and interest.

You may point out the similarities with multiplication of a fraction with a whole number: $3 \times \frac{6}{8} = \frac{3}{1} \times \frac{6}{8} = \frac{3 \times 6}{1 \times 8} = \frac{18}{8}$.

Make the connection with percentages or decimals.

- Use technology:

  National Library of Virtual Manipulatives (http://nlvm.usu.edu). Here you can find a virtual geoboard and a tool to show the multiplication of fractions. Another helpful website is http://www.MathEducationPage.org.

Assessment

Rubric: Multiplication of Fractions Using a Geoboard

Category	1	2	3	4
Uses Geoboard to Solve Equation	Makes no attempt to find either one of the fractions in the multiplication.	Finds both fractions on the geoboard, but does not place them correctly.	Correctly finds both fractions and identifies the area both cover, thus solving the problem. Does not write the abstract equation.	Correctly completes all steps: 1. Finds both fractions. 2. Places correctly on the board (left side and bottom). 3. Finds the correct answer. 4. Draws a representation. 5. Writes the correct equation.

Across the Curriculum

Whether in social studies, science, or math, teachers can use this approach to have their students find part of a part (for example, in recipes and discounts).

GRAPHING LESSON PLAN ■

Not only is the skill of understanding graphs, including reading them, creating them, or critically analyzing them, essential for the secondary math student, it's indispensable to students in English, social studies, science, and most other subjects. As I travel the country and speak to audiences of teachers at the secondary level, one area in math that is universally challenging is the skill of graphing.

Teachers tell me repeatedly that they have to stop their lessons and re-teach how to read graphs every time they encounter one in a lesson, text, handout, or news article. When I ask how long it takes to reteach the process, responses vary from 15 minutes to a full class period.

I not only included this sample lesson plan because of its necessity and familiarity, I would advocate that graphing be a skill that is practiced frequently even as a five-minute minilesson or part of an acceleration center activity.

Research Background

Graphing predictions prior to collecting data helps students evaluate relationships and establishes a foundation for the application of scientific and mathematical principles at their level of achievement. After data collection, students are able to see how their predictions correspond to actual data.

This process leads students to a better understanding of the nature of both science and mathematics. Science and math play a central role in modern culture. This process allows students to see how the two are linked and how these subjects are linked to actual data in everyday applications (Connery, 2007).

Learning Objectives

- To record daily temperature and student absences using a three-column table
- To use a variety of tools to create a scatter plot graph to display data collected
- To determine the type of correlation a scatter plot displays

Addresses These Nonresponder Indicators

- The student has difficulty making connections between data (concrete) and graphs (abstract).
- The student has difficulty visualizing abstract concepts.
- The student's skills are fragile; that is, the student possesses the necessary skills but is not yet fluent and automatic in those skills.
- The student is unable to apply math to real-life situations.
- The student's knowledge and understanding of multistep problems is limited.
- The student has math vocabulary difficulties.
- The student has a performance or motivation deficit (has the necessary skills but lacks the motivation to complete the academic task).
- The student has a skill deficit (lacks the necessary skills to perform the academic task).

Materials Needed

- Ample space to display data charts and scatter plot graphs; a classroom wall would be ideal
- For each student, a manila folder with graph paper (1 cm^2) stapled into the folder for individual data collection and graphing
- Ruler for each student
- Markers, dry-erase markers (if applicable), or colored pencils
- Magnets, Velcro, felt
- Card stock (for the graphs)
- Dry erase boards
- Construction paper
- Cellophane (to make overlays for the graphs)
- Ready-made examples of scatter plot graphs
- Sticky notes
- Round counters (beans, buttons, disks, or similar objects)
- Pegboard, pegs, and overhead transparencies (optional)

proximate Time Frame for Completion

his lesson can take place in one 60-minute period or two 30-minute seg-
. The data collection section must be completed during the two weeks
to the start of the graphing and analysis lesson.

Data Collection. Allow 5 to 10 minutes each day for students to record
the daily temperature and the number of absences in class. Students
hould record this information in a chart.

ter plot creation. This part of the lesson is broken up into two sections:
Whole group instruction: 15 minutes
mall group instruction: 10 minutes per group

analysis. This part of the lesson is broken up into two sections:
ole group instruction: 15 minutes
l group instruction: 10 to 15 minutes per group

n Procedure and Scripts

Group (Data Collection)

hould be taught and data collected beginning approximately
o the start of the lesson on making graphs.

likely not need intervention at this level, but it is provided below.

esources (newspapers, Internet, and television news) that
daily temperature.

ree-column table model on chart paper that shows the
ily temperature, and number of students absent.

ntry procedures for one day.

deling will only be necessary for one day. Students may work in
ation of the data collection (see below).

(May Also Be Used at Tier One)

airs and record daily data together.

ents, these partnerships can be mixed ability.
need Tier Two interventions, these partnerships should
and the teacher should check in with these groups to
s entered accurately.

Tier Three: One on One

Students will work one on one with a teacher to ensure that data collection is accurate.

Tier One:Whole Group (Scatter Plot Creation)

1. Display examples of scatter plot graphs throughout the room.
2. Ask students to make observations about each graph using sticky notes.
3. Share observations and build a definition of a scatter plot based on what students observed.
4. Explain that scatter plots are similar to line graphs.
5. A scatter plot has an x- and a y-axis. Each dot on a scatter plot represents a piece of data. In this case, the dots represent temperature and absences.
6. Scatter plots illustrate a correlation, or relationship, between data.
7. Create an x- and a y-axis on the chart.
8. Identify the x-axis as the daily temperature and the y-axis as number of absences.
9. Label appropriately.
10. Take the Day One. temperature and number of absences and plot them on the graph by marking a dot that lines up with the temperature on the x-axis and the number of absences on the y-axis. Prominently display this model scatter plot. Possible tools to use are a magnetic whiteboard or a felt board with Velcro counters.
11. Students use graph paper to create a scatter plot.

Tier Two: Partner Activity (May Also Be Used at Tier One)

1. After whole group modeling, students who need Tier Two Interventions are put into mixed-ability partnerships.
2. Partners receive coaching from the teacher.
   a. review of x- and y-axes
   b. organization of data on the x- and y-axes
   c. accuracy in plotting data

Tier Three: One on One

- Students receive one-on-one instruction from the teacher using additional tools and support. For example, use overhead transparency paper and dry erase markers to create a scatter plot.
- Make available the x- and y-axes with titles already created so the student only has to plot the information. The student uses the same x- and y-axes that the teacher used during whole class modeling and fills in the existing data. The student may use paper counters or magnets to manipulate the data.

Tier One: Whole Group (Scatter Plot Analysis)

1. Once all the data has been recorded, refer back to the class scatter plot. Complete this on your own or with one of your students who need Tier Three interventions as suggested above.
2. Make general observations and ask students to do the same. Encourage students to talk in pairs or groups and examine their own graphs.
   a. What do you notice about the data?
   b. How is it organized?
   c. Is there a pattern?
3. Explain that there are four types of correlations. Each can be determined by "eyeballing" the graph or, more accurately, constructing the line of best fit. A line of best fit is a line that represents the data trend. Several ways to construct best-fit lines can be found online.
   a. Positive: A positive correlation exists when the y-value increases as the x-value increases. The line of best fit has a positive, or upward, slope (see Figure 6.4).
   b. Negative: A scatter plot shows a negative correlation when the y-value decreases as the x-value increases. The line of best fit has a negative, or downward, slope (see Figure 6.5 on page 118).
   c. Strong: A strong correlation exists when a majority of the data lies close to the line of best fit (see Figure 6.6 on page 118).
   d. Weak: A weak correlation exists when a majority of the data lies further away from the line of best fit (Figure 6.7 on page 118).
4. Note to students: Correlations can be weak negative, strong negative, weak positive, or strong positive.
5. Print out real examples of scatter plots (which can easily be found online) and determine what type of correlation the graph depicts.

Figure 6.4 Temperature Graph: Positive Correlation

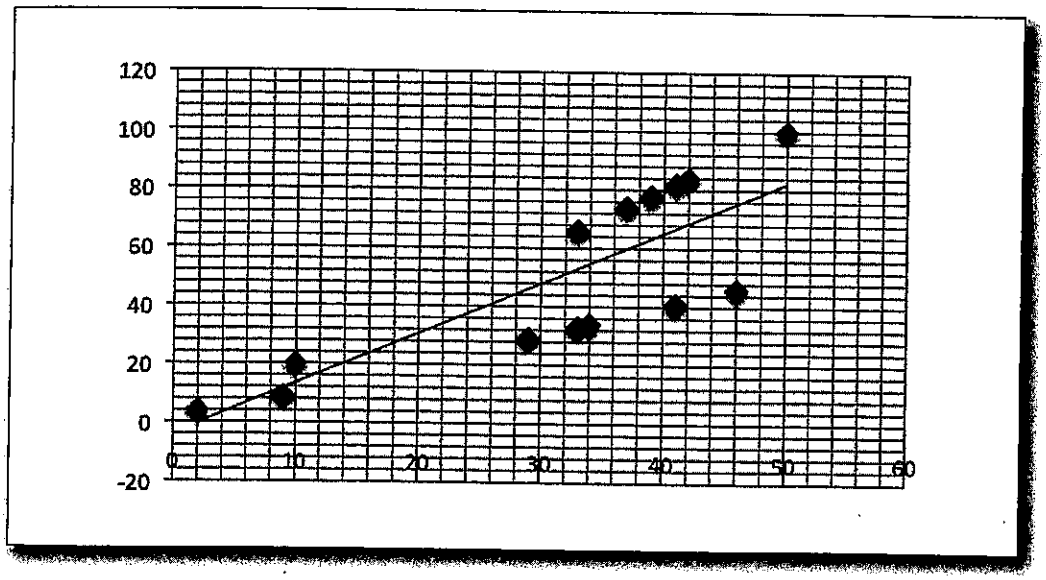


Figure 6.5 Temperature Graph: Negative Correlation

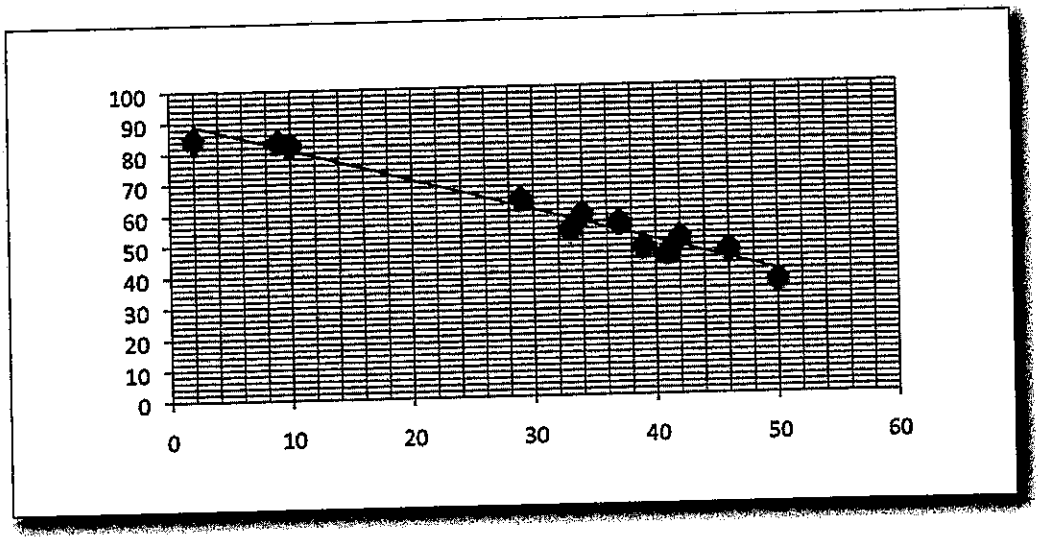


Figure 6.6 Temperature Graph: Strong Correlation

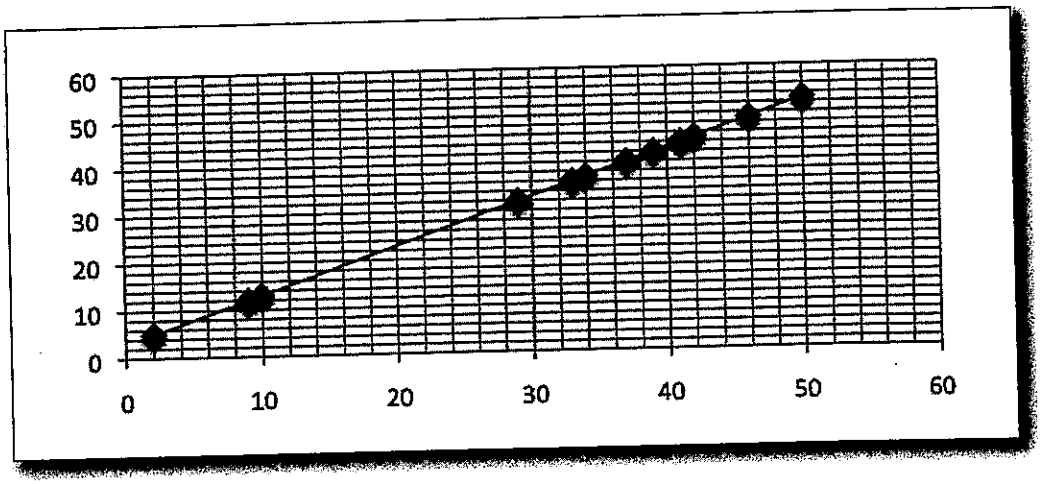
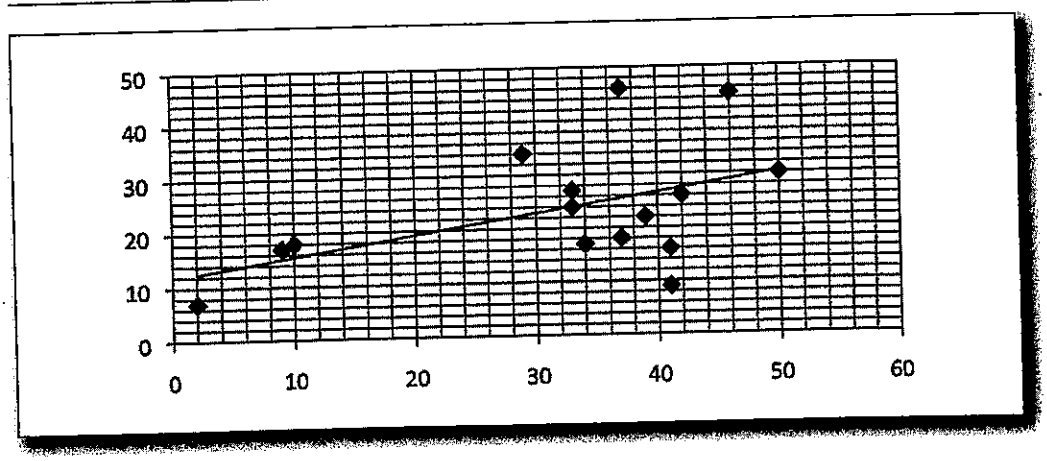


Figure 6.7 Temperature Graph: Weak Correlation



6. Think aloud to explicitly model how you determine the type of correlation for each example.
7. Tell students to analyze the scatter plot they created and determine the type of correlation.
8. Have students provide a written explanation of the correlations. Pair students who are weak in written expression but strong in math understanding with partners who have the skill to model how the explanation should be written.

Tier Two: Partner Activity (May Also Be Used at Tier One)

1. Students work in the same partnerships as for the previous steps and use counters to create a model of the four types of correlations.
   a. Give students time to work in groups to create each model and identify the correlations.
   b. Provide support to groups as necessary.
2. Students use models they just created to determine the type of correlation for the data on their scatter plot.
3. The teacher monitors partners and can provide students with copies of the scatter plots from the lesson for an additional visual aid.

Tier Three: One on One

Students work one on one with the teacher to determine the type of correlation displayed on the scatter plot. Students should have all visual aids and models for reference.

Manipulatives Center

Students work in tiered groups (Tier One is mixed levels, Tier Two is same ability with some peer or teacher support, and Tier Three is one-on-one instruction) to create and analyze scatter plot graphs using a variety of materials. Provide data for students to graph (education levels and income, for example) and a variety of materials such as

- counters;
- card stock (for the graph);
- dry erase boards and markers;
- construction paper;
- buttons;
- cellophane (to make overlays for the graphs);
- index cards for identifying the type of correlation; and
- a pegboard (available at any home supply store) and pegs.

Students work collaboratively to plan and create a scatter plot based on the data provided or student-generated data.

1. Students discuss the type of correlation the data shows.
2. Students write an explanation of their findings.

Extension Activities Center

Students will use their manila folder and graph paper for a variety of other activities, including

- using another type of graph (histogram, line graph, or stem/leaf plot) to analyze the same data from this lesson;
- continuing to record temperature and absences across a longer period of time, then reanalyzing the correlation between the two; and
- asking the school for permission to use two weeks' worth of attendance records from previous years and research the daily temperatures for that time period. Collect data for a two-week period from each season and use a scatter plot to display the correlation between absence rates and the seasons. Students can also make predictions about how or if the correlation between seasons is positive, negative, weak, or strong.

To Differentiate

- Differentiate by number of days in data, manipulatives, support, and grouping.
- Provide small group or individual coaching with a teacher, intervention specialist, or peer tutor.

English as a Second Language and English Language Learners

1. Explicitly teach vocabulary and have words displayed prominently in an organized manner (word wall) in the classroom for easy review. Such vocabulary words include
   a. x- *and* y-*axes;*
   b. *plot;*
   c. *scatter;*
   d. *data;*
   e. *line of best fit;*
   f. *analysis;*
   g. *correlation;*
   h. *positive;*
   i. *negative;*
   j. *weak;* and
   k. *strong.*
2. Include a physical object or picture next to each vocabulary word that represents that word that you are teaching.
3. Students may also want to keep a personal vocabulary list for easy reference.
4. Play a vocabulary game to aid in memorization of words.

Assessment

Students will complete their own scatter plots using a variety of tools such as graph paper, three-dimensional models with manipulatives (magnets, buttons, pegs, or the like), or technology (graphing or spreadsheet software,

graphing websites). Students will provide a written explanation of the correlation between absences and temperature.

Rubric: Creating and Analyzing a Scatter Plot Graph

Category	1	2	3	4
Students will use a variety of tools to create a scatter plot graph to display data collected.	Students need extensive teacher support to create a scatter plot graph.	Students need some teacher support to create a scatter plot graph.	Students need little teacher support in using manipulatives to create a scatter plot chart.	Students independently create a scatter plot graph using manipulatives.
Students will analyze the scatter plot graph to determine the type of correlation between daily temperature and student absences.	Students identify one correlation between temperature and absences with extensive teacher support.	Students make two correlations between temperature and absences with some teacher support.	Students make one correlation between temperature and absences without teacher support.	Students make two correlations between temperature and absences without teacher support.

Across the Curriculum

Whether in social studies, science, or math, teachers can use this approach to help students understand the relationships between

- rates of disease and distance to a source of drinking water;
- body weight and heart disease;
- rate of alcoholism and income; or
- number of calories and grams of fat in their favorite foods.

MATH VOCABULARY ■

The lesson plan samples and strategy examples in the chapter focused on vocabulary provide excellent examples for how to reinforce math vocabulary. Rather than create a separate lesson plan for math vocabulary, I'd like to share an example I saw effectively demonstrated at Permian High School in Odessa, Texas.

Danna McAnnelly and Brandi Pettus, co-teachers at the 10th-grade level, made vocabulary review part of their teaching practice. One of the techniques they used was to choose a state test question and spend five minutes a class period, usually at the end of class, reviewing the vocabulary in that item. They did not spend any time working out the math. They only focused on the vocabulary.

They presented a test question via laptop and projector on a screen. All students had an index card. They were to review the question presented and list any words that they did not understand on that index card. Given that the class had a large bilingual population, this was an especially important exercise. The teachers collected the index cards as the students finished. They

then used the information on the cards to drive vocabulary instruction throughout the semester.

In addition to having students list the words on an index card, they discussed the question with the class as a whole. I was fascinated to learn that the students found the question phrase, "Which of the following best represents . . ." the most challenging part of the test item. We tend to focus on math skills in preparation for state tests in math; however, we also need to concentrate on vocabulary. Many students may do poorly on the test because of a lack of vocabulary understanding rather than a lack of math skill.

It's important to teach math vocabulary to all students. It's critical for non-responders.

Also, teach students to look for clue words in math word problems.

- Clue words for addition: *sum, total, in all, perimeter*
- Clue words for subtraction: *difference, how much more, exceed*
- Clue words for multiplication: *product, total, area, times*
- Clue words for division: *share, distribute, quotient, average*

DECLUTTER THE MATH

From *Memorization and Test Taking Strategies for the Differentiated, Inclusive and RTI Classroom*, Susan Gingras Fitzell, 2010.

Particularly in learning math, disorganized workspaces clutter up working memory because students are too busy trying to make order out of chaos to focus on the actual math problem. Helping students organize their workspace is one of the best ways we can help students with math (Levine, 2003). Following are some simple solutions to organizing math instruction for students.

- Write down the steps to the problem before solving it.
- Avoid mental arithmetic; use a scratch pad or scrap paper.
- Use graph or lined paper to complete math problems:
  - Give your students grid paper or have them turn their lined paper sideways (see Figure 6.8).
  - Fold their lined paper into squares and do one problem in each square.
- Have students work their problems by lining the numbers up in the columns.
- When testing or doing math handouts on plain paper, put a piece of dark lined paper or grid paper under the math page. Students will be able to see the lines through the page and will keep their math organized.
- If they become overwhelmed by looking at the entire test page, have students use blank paper to cover up everything but the problem they are working on so they don't become stressed. When they do not have to look at everything at once, they can focus more productively.

When students are working to organize their workspace or trying to decipher their work, they are using up working memory on organization rather than the math process. These strategies allow them to focus on the math.

Figure 6.8 Grid Paper