MATH IN AFTERSCHOOL

An Instructor's Guide to the

AFTERSCHOOL TRAINING TOOLKIT

A Supplement to the
Online Afterschool
Training Toolkit
for 21st Century
Community Learning Centers
www.sedl.org/afterschool

Produced for the U.S. Department of Education by the National Partnership for Quality Afterschool Learning.

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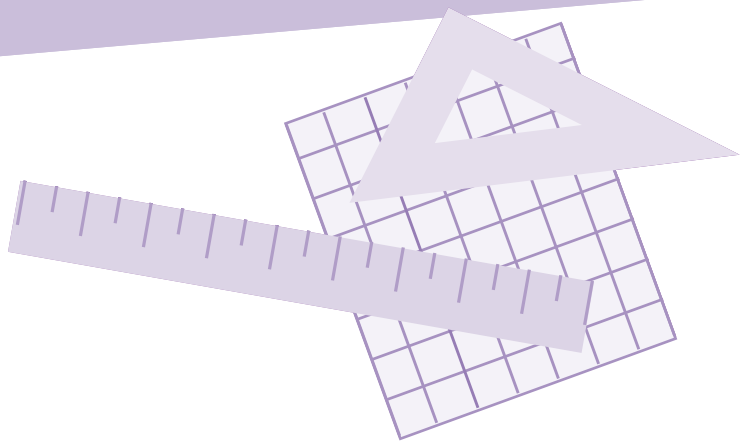


Introduction

The Afterschool Training Toolkit

If you work in afterschool, you most likely know the challenge of offering afterschool academic enrichment that will boost student performance during the regular school day while making sure activities are engaging enough to keep students coming back. Through a contract with the U.S. Department of Education, the National Partnership for Quality Afterschool Learning has developed tools to help you meet this challenge. National Partnership staff visited 53 afterschool programs, nationwide, that had evidence suggesting they had a positive effect on student achievement.

With this research, the National Partnership developed the Afterschool Training Toolkit (www.sedl.org/afterschool/toolkits), an online resource that is available to afterschool professionals to help them offer engaging educational activities that promote student learning. The toolkit is divided into sections that address six content areas: literacy, science, the arts, homework help, technology, and the content area for this guide, math. Like the other content areas in the toolkit, math is taught through promising practices, or teaching techniques with evidence suggesting they help students learn important academic content.

The seven promising practices in afterschool math identified in the Afterschool Training Toolkit are as follows:

- *Finding Math*
- *Math Centers*
- *Math Games*
- *Math Projects*
- *Math Tools*
- *Math Tutoring*
- *Family Connections*

When used with the Afterschool Training Toolkit, the lessons in this instructor's guide will help you master these promising practices. Once you become proficient at these practices, you should be able to use them to develop other math lessons.

This instructor's guide will help you

- understand how to use the math section of the online Afterschool Training Toolkit;
- use math to offer fun lessons that help students learn in afterschool;
- motivate students to participate in afterschool; and
- use the lessons to become a more effective afterschool instructor.

The Role of Math

Before you begin, you should know that this instructor's guide is not a manual for different types of math or for starting an afterschool math program. You do not need to be a math expert to use this guide. In addition to the lessons on promising practices, a planning worksheet is available at the end of this guide. The planning worksheet will help you accommodate your particular afterschool situation and plan for the best possible lesson.

How to Use This Instructor's Guide

This guide will help you master the promising practices in afterschool math through the following steps:

- Watching video clips from the National Partnership's online Afterschool Training Toolkit
- Teaching the lessons included in this instructor's guide to your students
- Reflecting on the student lessons

Video Clips

The Afterschool Training Toolkit (www.sedl.org/afterschool/toolkits) includes video segments showing outstanding afterschool programs across the United States. Watching these video segments allows you to observe afterschool instructors in action as they use promising practices. Take notes on what you see and think of ways that you can use these practices in your afterschool program.

Lessons

After you watch each video that illustrates a practice, you will find several lessons that use the same practice. You can teach as many of these lessons as you think are appropriate to your students, depending on their grade levels and math skills and the time available in your afterschool schedule.

Reflection

After each lesson, you will find a series of questions addressing the preparation, student engagement, academic enrichment, and classroom management of that lesson. The purpose of the reflection is to allow you to be intentional in your instruction—to think about what aspects of a lesson worked well and what changes you might want to make for future lessons. Reflection is an important part of becoming a successful instructor and will help you apply what you learned from one lesson to another.[1]

The following is an example of how a teacher might answer the reflection questions after leading a lesson where students count the number of each color of M&Ms in a bag and make charts to illustrate their findings.

Reflection [Sample]

Preparation

- How well did the lesson planning help you prepare for this activity?
- What can you do to feel more prepared?

Overall, I felt very prepared for this lesson. I read through the lesson several times and had my supplies ready ahead of time. I wish I would have spent more time practicing with the spreadsheet application so that I would have been ready to explain it to the students. We probably should have spent some time reviewing Excel as a class before we began the activity.

Student Engagement

- How did you assess student engagement?
- What did you notice about student engagement in the different parts of the lesson?
- How satisfied were you with the level of student engagement?
- If you were not satisfied, how could you change the lesson to increase student involvement?

I assessed student engagement by observing whether students were on task. If they were talking about something unrelated to the lesson, playing with the candy instead of counting it, or otherwise messing around, I knew they weren't engaged. Most of them were pretty focused. I told them that they could not eat the candy until the lesson was finished, and that kept many of them focused. Some of them were completely distracted by the candy. It was unbelievable, but I didn't know what to do about it. I could switch to something else, but half the fun is using M&Ms.

[1] McEwan, E. K. (2002). *Ten traits of highly effective teachers.* Thousand Oaks, CA: Corwin Press, Inc.

I was pleased with how engaged students were for most of the lesson. Things fell apart a little when we started graphing the results. The range of computer skills varies so much. Some students knew exactly what to do, and others were completely lost. The next time I teach this lesson, I am going to do a mini-lesson on using electronic spreadsheets first so students will be more prepared—and therefore more engaged.

Academic Enrichment

- How did this lesson support other content areas?
- What changes could you make to strengthen academic enrichment and still keep the activity fun?

Aside from the obvious math enrichment, this lesson supports the use of technology in learning. Once students have mastered ratios and graphing results, figuring out the percentage of each color of candy would make a good extension activity.

Classroom Management

- What strategies did you use to make go smoothly?
- What changes would you make if you taught the lesson again?

My advanced preparation really helped the lesson, but overall the lesson did not go as smoothly as I had hoped. Next time, I will definitely spend more time having students practice using Excel, and I will also incorporate additional rewards to keep students engaged and focused.

Practice 1

Finding Math

What Is It?

Finding Math involves using fun problem-solving activities that bring math to life. From cooking to exercise, *Finding Math* lets students use everyday activities to make meaningful discoveries, enhance their understanding of math, and build their enthusiasm for learning.

What Is the Content Goal?

The key goals of *Finding Math* are to engage students in math through everyday activities they already enjoy, build their problem-solving and collaboration skills, increase their desire to learn, and ultimately extend their understanding of math. Specific content goals should be connected to what students are learning during the school day and to grade-level standards.

What Do I Do?

Begin by talking to the day-school teacher to find out what math concepts students are learning, the standards for each grade level, and the kinds of everyday, real-world activities that illustrate math concepts and extend students' learning.

For example, a cooking activity allows students to use math by measuring ingredients, comparing measurements of liquids and solids, converting between standard and metric systems, and reducing or enlarging how much a recipe yields. Next, consider the kinds of activities that your students enjoy and how appropriate math concepts and skills can be incorporated.

Once you have outlined the activities, develop a guiding question or problem to help students discover math in an everyday activity. Figure out the learning goals and outcomes for each activity, secure space, and gather any materials that you might need. As you introduce the activity to students, emphasize a sense of fun and discovery.

Use the planning worksheet at the end of this guide to begin thinking about how you can incorporate math into afterschool activities.

Why Does It Work?

The afterschool setting provides a great opportunity to integrate math learning with activities that students already enjoy. Research suggests that the best activities are based on students' interests, incorporate physical activity, entail social interaction, and provide meaningful learning for students struggling with math. By honoring students' need to learn in a different setting, you can help build their understanding and increase their desire to learn.

Getting Started

video

Go to the *Finding Math* practice found in the math section of the Afterschool Training Toolkit (www.sedl.org/afterschool/toolkits/math/pr_math_find.html). Click on the video "Rhythm and Beats" and watch as fifth- and sixth-grade students at the Champions afterschool program at Independent School No. 125, Woodside, Queens, in New York City, use counting and fractions to compose and perform percussion beats.

Use the before, during, and after writing prompts to write down your ideas on how you might involve your students in math and music.

BEFORE YOU WATCH THE VIDEO, write down what you already know about students using math in music.

DURING THE VIDEO, consider the following:

How does the instructor work with the students to lay the groundwork for the activity and get them started?

How does the instructor interact with the kids? What does he or she do to keep them engaged?

What academic skills, like reading or math are students reinforcing while they participate in the activity? Be sure to give specific examples.

AFTER YOU WATCH THE VIDEO, write what modifications you might need to make to teach this lesson in your own class.

Lesson 1

Three Ms! Making Predictions, Measuring, and Marshmallows

In this lesson, students compare measuring cup sizes. They learn that how much a measuring cup holds is called *volume.* Next, students learn the meaning of the word *prediction,* as they predict how many marshmallows will fit into a cup of orange juice and frozen yogurt.

Grade Level(s):

K–2

Duration:

1 hour

Student Goals:

- Compare and order measuring cups according to volume
- Use tools to measure
- Make comparisons and estimates among different measurements
- Make predictions

Curriculum Connection:

Science

Standards:

These standards and benchmarks are from McREL's online database, Content Knowledge: A Compendium of Content Standards and Benchmarks for K–12 Education (4th edition, 2004; www.mcrel.org/standards-benchmarks). The mathematics portion of the database was developed using National Council of Teachers of Mathematics (NCTM) standards in addition to other nationally recognized standards documents.

Standard 1: Uses a variety of strategies in the problem-solving process

Grades K–2

Benchmark 2: Uses discussions with teachers and other students to understand problems

Standard 4: Understands and applies basic and advanced properties of the concepts of measurement

Grade PreK

Benchmark 4: Orders objects qualitatively by measurable attribute

Benchmark 5: Knows the common language of measurement

Benchmark 6: Knows that different sized containers will hold more or less

Grades K–2

Benchmark 1: Understands the basic measures length, width, height, weight, and temperature

Imagine This!

The room is filled with miniature dessert chefs measuring orange juice into various-sized measuring cups for a new and wonderful snack! As the young chefs ponder and predict how many marshmallows to set aside for the final touch, you fill their cups with tasty vanilla yogurt. Once the chefs have predicted the number of marshmallows necessary to fill up the cup, they add the marshmallows one at a time and keep count until there is no more space in the cup. They compare their predictions to the final count . . . and then eat their creation!

What You Need

- ❒ One set of measuring cups for each small group
- ❒ 50 small marshmallows for each small group
- ❒ One cup of orange juice for each student
- ❒ Frozen yogurt; enough for each student to have a scoop
- ❒ Spoons
- ❒ Plastic cups
- ❒ Paper
- ❒ Pens
- ❒ Pencils
- ❒ Bags for supplies

Getting Ready

- Assemble supply bags with materials needed for each student.
- Be prepared to review the meaning of the word *prediction,* which means to make a reasonable guess about something that hasn't happened yet. You may want to model strategies for forming predictions with marshmallows for younger students.

Vocabulary

Measurement: a comparison to some other known unit (e.g., length, width)

Prediction: a statement of what somebody thinks will happen in the future

Volume: the space or size within a three-dimensional object

What to Do

- Divide students into groups of four or five, based on who will work well together. Give each student a bag of supplies and each small group a set of measuring cups.
- Ask children to line up the measuring cups from smallest to largest.
- Ask students to predict which measuring cup will hold the most orange juice. Try to get students to articulate that the bigger cups will hold more than the smaller cups. Tell them that the amount each cup holds is called volume.
- Ask students how they found their answers and how they know which cup holds more.
- Next, pour orange juice into the 1-cup measuring cups and then have students pour the orange juice from the measuring cups into their plastic cups.
- Ask students to observe any similarities or differences in the juice in each container. What did they notice as they poured the juice? Younger students may think that there are different amounts, based on how the juice fills each container. Ask them how they know. It may help them to clarify the concept of volume by pouring the juice back into the measuring cup to test their predictions.
- Add a scoop of frozen yogurt into each of the plastic cups with juice.
- Next, ask students to predict how many marshmallows will fit into the half-cup measuring cups, write down their predictions, and then describe how they made their predictions.
- Have students test their predictions using the marshmallows and then discuss their answers. Answers will vary depending on how the cup was packed. Finally, students can add marshmallows to their juice and yogurt and eat it!

Teaching Tips

If students haven't used measuring cups or learned about volume and measurement before this lesson, you may want to begin by reviewing each measuring cup; how many halves, thirds, and quarters make a whole; and answer any questions that students have.

Extend

As an extension piece, ask students to describe their process. What did they do first? What did they do second? Number the process on the board. Then ask students to write a how-to piece. Younger students can draw pictures of the process.

Outcomes to Look for

Much of the assessment for this lesson comes from listening to and watching the children. Listen for use of vocabulary, facility with ordering measuring cups, and estimation skills and strategies.

- Student participation and engagement
- Using measuring tools productively
- An understanding of different measurements and how to measure
- Answers that reflect an understanding of size and volume
- Answers that reflect an understanding of comparison and prediction as well as strategies to make and test predictions

Reflection

The questions below are prompts to help you record your ideas, but you can also write additional observations about the lesson that the questions do not cover.

Preparation

- How well did the lesson planning help you prepare for this activity?
- What can you do to feel more prepared?

Student Engagement

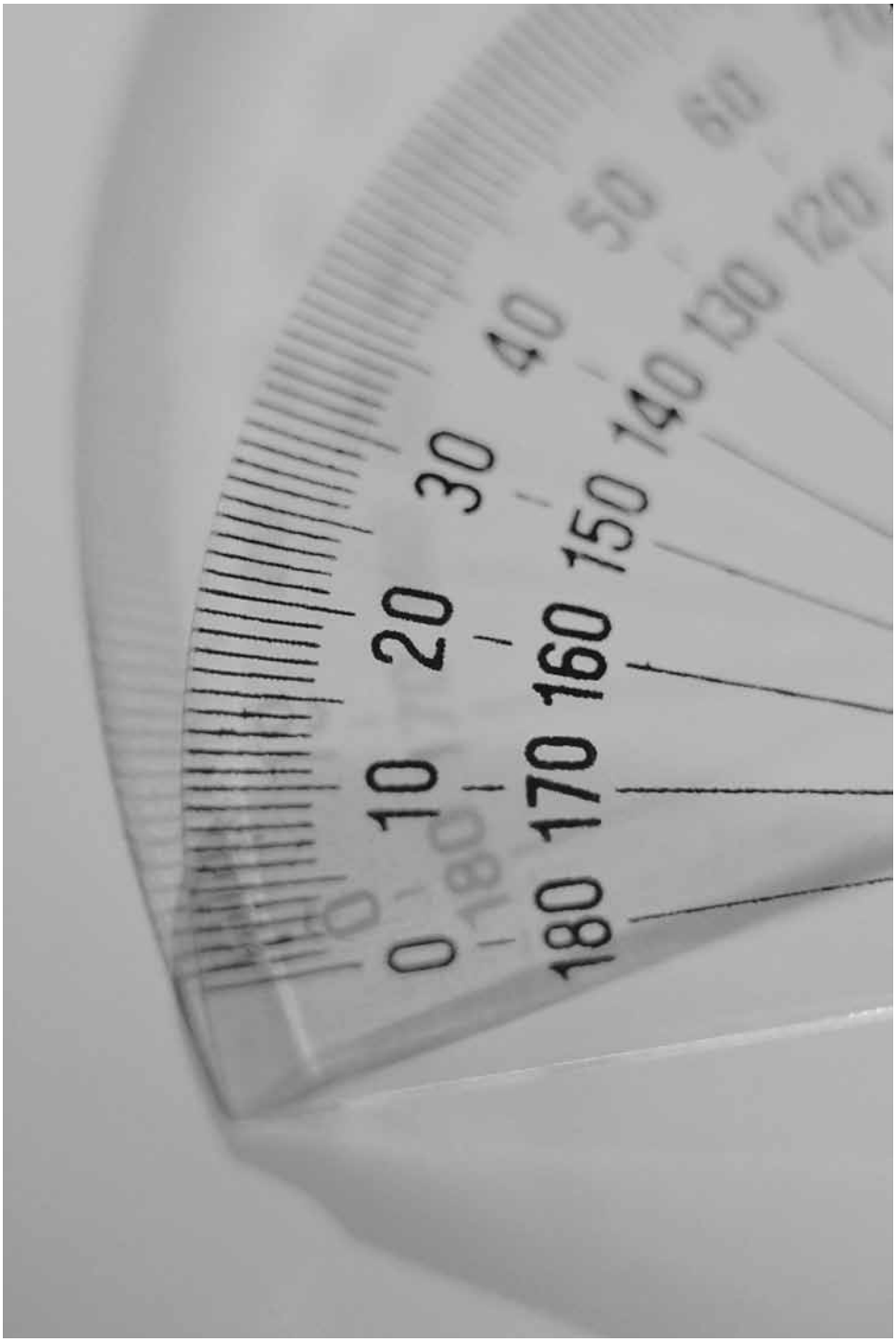
- How did you assess student engagement?
- What did you notice about student engagement in the different parts of the lesson?
- How satisfied were you with the level of student engagement?
- If you were not satisfied, how could you change the lesson to increase student involvement?

Academic Enrichment

- How did this lesson support other content areas?
- What changes could you make to strengthen academic enrichment and still keep the activity fun?

Classroom Management

- What strategies did you use to make this activity go smoothly?
- What changes would you make if you taught the lesson again?


0
10
20
30
40
50
60
180
170
160
150
140
130
120

Lesson 2

Largest Number Race

In this lesson, students design a relay race to compare whole numbers and then compete to create the largest 10-digit number. Teachers will need a large space to set up this activity, which includes kinesthetic activities such as jumping rope, relay races, basketball, and sack races.

Grade Level(s):

3–5

Duration:

30–45 minutes

Student Goals:

- Compare whole numbers
- Understand the place value of digits in a number
- Use specific skills in the context of a variety of physical activities
- Work cooperatively to solve problems

Curriculum Connection:

Physical Education

Standards:

These standards and benchmarks are from McREL's online database, Content Knowledge: A Compendium of Content Standards and Benchmarks for K–12 Education (4th edition, 2004; www.mcrel.org/standards-benchmarks). The mathematics portion of the database was developed using National Council of Teachers of Mathematics (NCTM) standards in addition to other nationally recognized standards documents.

Standard 1: Uses a variety of strategies in the problem-solving process

Grades 3–5

Benchmark 7: Uses explanations of the methods and reasoning behind the problem solution to determine reasonableness of and to verify results with respect to the original problem

Standard 2: Understands and applies basic and advanced properties of the concepts of numbers

Grades 3–5

Benchmark 4: Understands the basic meaning of place value

Benchmark 5: Understands the relative magnitude and relationships among whole numbers, fractions, decimals, and mixed numbers

Imagine This!

Laughing, obstacles courses, and math are all rolled into one lesson! Get ready for some fun with math as students work in teams to complete various obstacle-course races in the shortest amount of time so they can obtain a number. Once they get a number, students must decide where to place it on a 10-digit number line. Beware! Teams must use strategy in deciding where to place the number on the line to create the largest number at the end of the contest. The teams cannot move the numbers once they are placed. This exciting contest repeats nine more times with students placing their numbers on the 10-digit number line after each race. Who will win?!

What You Need

- ❒ Two 10-sided number cubes
- ❒ Masking tape
- ❒ Paper
- ❒ Items for relay race (balls, jump ropes, etc.)

Getting Ready

- For each team, place 10 strips of masking tape on the floor, with each strip representing a placeholder for a 10-digit number, and small pieces of tape for the commas. For example:

  _____, _____ _____ _____, _____ _____ _____, _____ _____ _____

Vocabulary

Billion: one thousand million, written as 1 followed by 9 zeros

Digit: any one of 10 symbols between 0 and 9 that represent numbers

Million: one thousand thousands, written as 1 followed by 6 zeros

Obstacle course: a sporting area where participants have to get past various obstacles or objects to reach a goal

What to Do

- As a class, design an obstacle-course relay that incorporates at least two physical activities—jumping rope and throwing a basketball through a hoop, for example—while moving toward a finish line. The final activity in the relay involves receiving a randomly generated number between 0 and 9, and working together as a team to determine where to stand in a string of 10 digits to make the largest number.
- Divide the students into two teams.
- Choose a person to be the number roller (someone who can't participate in the physical activity or would prefer not to is always a good choice). Each turn, this person will roll the number cube, write the number on two pieces of paper, and hand them to the two competing team members after they finish the other relay tasks. Both teams will receive the same number each turn. The team members should then each write the number somewhere on his or her team's 10-digit number line.
- Tell students that the first team to complete all tasks and make a 10-digit number gets one point. The team that makes the largest number also gets one point. Play can continue as long as time allows. The team with the most points wins.
- Have each team read its number to determine who has won. To read the numbers, you can have students put their numbered pieces of paper on the floor, stand back, and look at the number. You might ask, "How do you know which number is the largest?"
- Once teams have completed their first round, discuss how each team came up with its number, the strategies the students used, and what they learned.
- Begin by reviewing the objective of the game and making sure that the steps are clear to students. The goal of the game is to come up with the largest number. See if students can figure out that larger digits should go at the beginning of the number and smaller digits at the end. However, this is a game of chance and strategy. Students can't move the digits once they have placed them.
- Use guiding questions to encourage students to justify and discuss how each team came up with its number. Use the sample questions below or develop your own.
- What strategy did you use to make the largest number? Was it a good strategy? Why or why not? What strategy would you like to try in the next round?
- This type of questioning should occur several times throughout the relay. Students should refine their strategies once they understand the game better. Give each team time after each round to discuss a strategy for the next round.

Extend

- Try the game with the following:
  - 2-digit multiplication, with the goal being to get the largest product
  - 2-digit subtraction, with the goal being to get the smallest difference
  - 2-digit addition, with the goal being to get the largest sum
  - 2-digit division, with the goal being to get the largest quotient

Outcomes to Look for

- Student participation and engagement
- Students playing together fairly
- Students working together to problem solve
- An understanding of the value of whole numbers
- Answers that reflect an understanding of how base-10 (0–9) numerals can be arranged to make the largest possible number

Teaching Tip

Encourage students to come up with obstacle courses that include activities that are fun, challenging, and accessible to all students. If students are physically challenged and can't participate in the obstacle course, they can be the ones who roll the dice.

Reflection

The questions below are prompts to help you record your ideas, but you can also write additional observations about the lesson that the questions do not cover.

Preparation

- How well did the lesson planning help you prepare for this activity?
- What can you do to feel more prepared?

Student Engagement

- How did you assess student engagement?
- What did you notice about student engagement in the different parts of the lesson?
- How satisfied were you with the level of student engagement?
- If you were not satisfied, how could you change the lesson to increase student involvement?

Academic Enrichment

- How did this lesson support other content areas?
- What changes could you make to strengthen academic enrichment and still keep the activity fun?

Classroom Management

- What strategies did you use to make this activity go smoothly?
- What changes would you make if you taught the lesson again?


1 2 3 4
5 6 7 8
9 10 11 12
4+5=9
4+6=10
4+7=11
10+3=13
4+6=10
4+10=14
4×4=16

Lesson 3

What's the Best Snack?

In this lesson, students use nutritional information to analyze data about different snacks and survey their peers to determine the best snack. To organize their data, students make different charts for displaying the data they collect. In the end, students decide which snack is the healthiest and explain why they think so.

Grade Level(s):

3–5

Duration:

1 hour

Student Goals:

- Predict the best snack, meaning one that is healthy, inexpensive, and tasty. Then test the prediction by collecting data
- Organize data by using a bar graph and a table
- Find the median
- Write and use a survey
- Understand that data represent specific pieces of information
- Draw a conclusion

Curriculum Connection:

Science

Standards:

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Standard 6: Understands and applies basic and advanced concepts of statistics and data analysis

Grades 3–5

Benchmark 1: Understands that data represent specific pieces of information about real-world objects or activities

Benchmark 3: Understands that a summary of data should include where the middle is and how much spread there is around it

Benchmark 6: Understands that data come in many different forms and that collecting, organizing, and displaying data can be done in many ways

Standard 9: Understands the general nature and uses of mathematics

Grades 3–5

Benchmark 2: Understands that mathematical ideas and concepts can be represented concretely, graphically, and symbolically

Imagine This!

Every student in afterschool loves to have a snack, but are snacks good for them? What's in a snack? Are there empty calories or good nutrition? Let students investigate if a snack is healthy before they put that cracker or raisin in their mouths. Students collect data, survey their peers, and draw conclusions about three common snacks . . . and then, of course, they get to eat the snacks!

What You Need

- ❒ Three different snack foods (raisins, pretzels, and peanut-butter crackers), enough for each group of students
- ❒ Nutritional information for each snack
- ❒ Paper
- ❒ Pencils
- ❒ Butcher paper
- ❒ Markers
- ❒ Bags for snacks
- ❒ Copies of the data collection table and sample table (Handout 1)
- ❒ Poster paper, an overhead transparency, or a chalkboard

Getting Ready

- Divide snack food into bags for each group of students.
- Make copies of the nutritional information and price for each snack.

Vocabulary

Calorie: a unit of energy-producing potential in food; if the energy is not used, it is converted to fat

Fat: one of three main components of food, the highest in energy and not water soluble

Mean: a number that is found by dividing the sum of two or more numbers by the number of addends, e.g. an average

Sodium: a soft, silver, metallic element that reacts with other substances and is essential for the body's fluid balance

Sugar: a simple carbohydrate that is sweet tasting, crystalline, and soluble in water

What to Do

- Ask students to pick a partner to work with. You may want to assign partners.
- Provide space and hand out materials (snacks and handouts) to each pair.
- Ask students to think about the snacks they have and to make a prediction about which snack is best.
- Working with students, develop a list of criteria for evaluating the snacks. For example, the best snack might be one that is healthy, inexpensive, and tasty. Ask about factors students might consider in determining quality.
- Take time to talk about nutrition and healthy amounts of calories, fat, and sodium.
- Ask each pair of students to use the nutritional information provided to complete the data collection table and rate each snack. If the two students working together don't agree, they can find the average between the two ratings.

Teaching Tip

Get information ahead of time about calories, fat, sodium, and sugar so you can have a discussion about how they contribute or don't contribute to a healthy snack.

- Post all the ratings on one large table on poster paper, an overhead transparency, or a chalkboard. Refer to the sample table in the handout.
- Ask students to describe how they determined the rating for each snack. For example, if one student rated a snack a 3 and the other student rated it a 4, the mean would be 3.5.
- Next, conduct a survey to find out what the most popular highly rated snack was among all students. Work with students to create a chart of the results.
- Ask each pair to use the data from the survey chart to make a graph of the results.
- Using the data, decide which snack is the best choice. Give students a chance to talk with their partners, and then bring the class back together to share ideas. Each pair explains, using the data, its decision about the best snack, and why the students made that choice. Encourage students to use both sets of data when making a decision. Students can revisit the predictions they made before the data was collected.
- Ask if any of their ideas about what *best* means have changed. Ask, "What is the relationship between the quality rating and your favorite snack?"
- Finally, discuss why the quality rating either matches or doesn't match their favorite snack.

Outcomes to Look for

- Answers that reflect an understanding of information as data
- An ability to collect and organize data in a sensible way (e.g., bar graph, table)
- Answers that reflect an ability to explain reasoning based on the data
- An ability to find a measure of the mean or average
- Students working together to solve problems and discuss strategies and solutions

Handout 1: Data Analysis and Probability: What Is the "Best" Snack?

Data Collection Table

Snack Food	Serving Size	Calories per Serving	Fat per Serving	Protein per Serving	Sodium per Serving	Price per Serving	Quality (1-low, 5-high)
Raisins							
Goldfish® Crackers							
Peanut-Butter Crackers							

Sample Table

Pair	Raisins	Goldfish® Crackers	Peanut-Butter Crackers
1	4	5	4
2	3.5	3	2
3	4	4	3.5
4	3	4.5	4
5	1	5	3

Reflection

The questions below are prompts to help you record your ideas, but you can also write additional observations about the lesson that the questions do not cover.

Preparation

- How well did the lesson planning help you prepare for this activity?
- What can you do to feel more prepared?

Student Engagement

- How did you assess student engagement?
- What did you notice about student engagement in the different parts of the lesson?
- How satisfied were you with the level of student engagement?
- If you were not satisfied, how could you change the lesson to increase student involvement?

Academic Enrichment

- How did this lesson support other content areas?
- What changes could you make to strengthen academic enrichment and still keep the activity fun?

Classroom Management

- What strategies did you use to make this activity go smoothly?
- What changes would you make if you taught the lesson again?

Lesson 4

Musical Notes and Math Fraction Drumming

In this lesson, students learn how whole, half, and quarter fractions link to musical whole, half, and quarter notes and rests. Students decorate drumsticks with the notes and fractions. They then practice drumming various fraction patterns.

Grade Level(s):

3–5

Duration:

90 minutes

Student Goals:

- Learn basic musical notes connected to fractions
- Drum simple fraction patterns
- Perform simple drumming song

Curriculum Connection:

Music

Standards:

These standards and benchmarks are from McREL's online database, Content Knowledge: A Compendium of Content Standards and Benchmarks for K–12 Education (4th edition, 2004; www.mcrel.org/standards-benchmarks). The mathematics portion of the database was developed using National Council of Teachers of Mathematics (NCTM) standards in addition to other nationally recognized standards documents.

Standard 2: Understands and applies basic and advanced properties of the concepts of numbers

Grades 3–5
Benchmark 5: Understands the relative magnitude and relationships among whole numbers, fractions, decimals, and mixed numbers

Standard 9: Understands the general nature and uses of mathematics

Grades 3–5
Benchmark 2: Understands that mathematical ideas and concepts can be represented concretely, graphically, and symbolically

Imagine This!

Students learn about fractions while making music! Your room is filled with children engaged in decorating drumsticks as you introduce each note and the fraction that it represents. You guide the students through drumming the various notes as you introduce the fractions and notes to them. The students are fully engaged in practicing drumming simple fraction patterns in pairs. You pull them back into one group and lead them in drumming the fraction patterns in unison. They drum the fraction patterns enthusiastically.

What You Need

- ❒ Paint stick for each student
- ❒ Paint-stick model for each group
- ❒ Markers for each group
- ❒ Handout 2: Notes, Rests, and Fractions (one copy per table)
- ❒ Handout 3: Simple Drumming Patterns (one copy per table)
- ❒ Poster or overhead transparency showing a simple drumming song

Getting Ready

- Obtain a paint stick for each student (free from a paint store).
- Make a model paint stick decorated with whole, half, and quarter notes and rests for each small group.
- Have a set of markers, paint sticks, a handout with the notes and fractions, and a handout with simple drumming patterns on each table.

Vocabulary

Beat: a rhythmic sound

Drumming pattern: a regular, repetitive arrangement with the drumming

Measure: a unit of time by which a musical work is divided

Notes: musical sound produced by a musical instrument

What to Do

- Divide students into groups of four based on who will work well together.
- Give each student a paint stick, which will serve as a drumstick.
- Give each group a set of markers and the two handouts.
- Introduce the whole and half notes and the fractions 4/4 and 2/4 = 1/2. *See examples at end of lesson.*
- Demonstrate drumming several measures of whole and half notes and rests.
- Have students decorate their drumsticks with the whole and half notes and fractions.
- In small groups, practice drumming the simple drumming patterns of whole and half notes.
- Introduce the quarter note and rest, and the fraction 1/4.
- Demonstrate drumming several measures of quarter notes and rests.
- In small groups, practice drumming the simple patterns of whole, half, and quarter notes and rests.
- In a large group, have students use their drumsticks to drum simple note patterns that they were practicing in small groups.

Extend

- Introduce students to eighth and sixteenth notes, rests, and fractions.
- Increase the complexity of the musical performance by making it a round.
- Get sheet music and have students write the associated fraction under the notes.
- Increase the complexity of the musical performance by having several groups play different beats.
- Have groups of students write and perform their own music.

Outcomes to Look for

- Student participation and engagement
- Understanding of whole numbers, fractions, and decimals

Teaching Tip

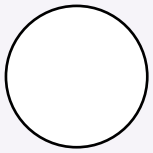
Post and go over the expectations for behavior:

- Drumsticks cannot touch anyone else
- Drum only when requested
- Put down drumstick when not being led in a drumming activity

Handout 2: Notes, Rests, and Fractions: Musical Notes and Math Fraction Drumming

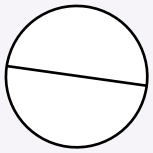
Whole note:

You hold a whole note for 4 beats: 4/4.
You count 4 beats: 1, 2, 3, 4.
Each beat is 4/4 of a whole note.



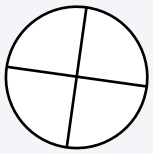
Half note:

You hold a half note for 2 beats: 2/4.
You count 4 beats: 1, 2, 3, 4.
Each beat is 1/2 of a whole note.



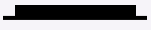
Quarter note:

You hold a quarter note for 1 beat: 1/4.
You count 4 beats: 1, 2, 3, 4.
Each beat is 1/4 of a whole note.



Musical Rests are used to show us when we should not make any noise.

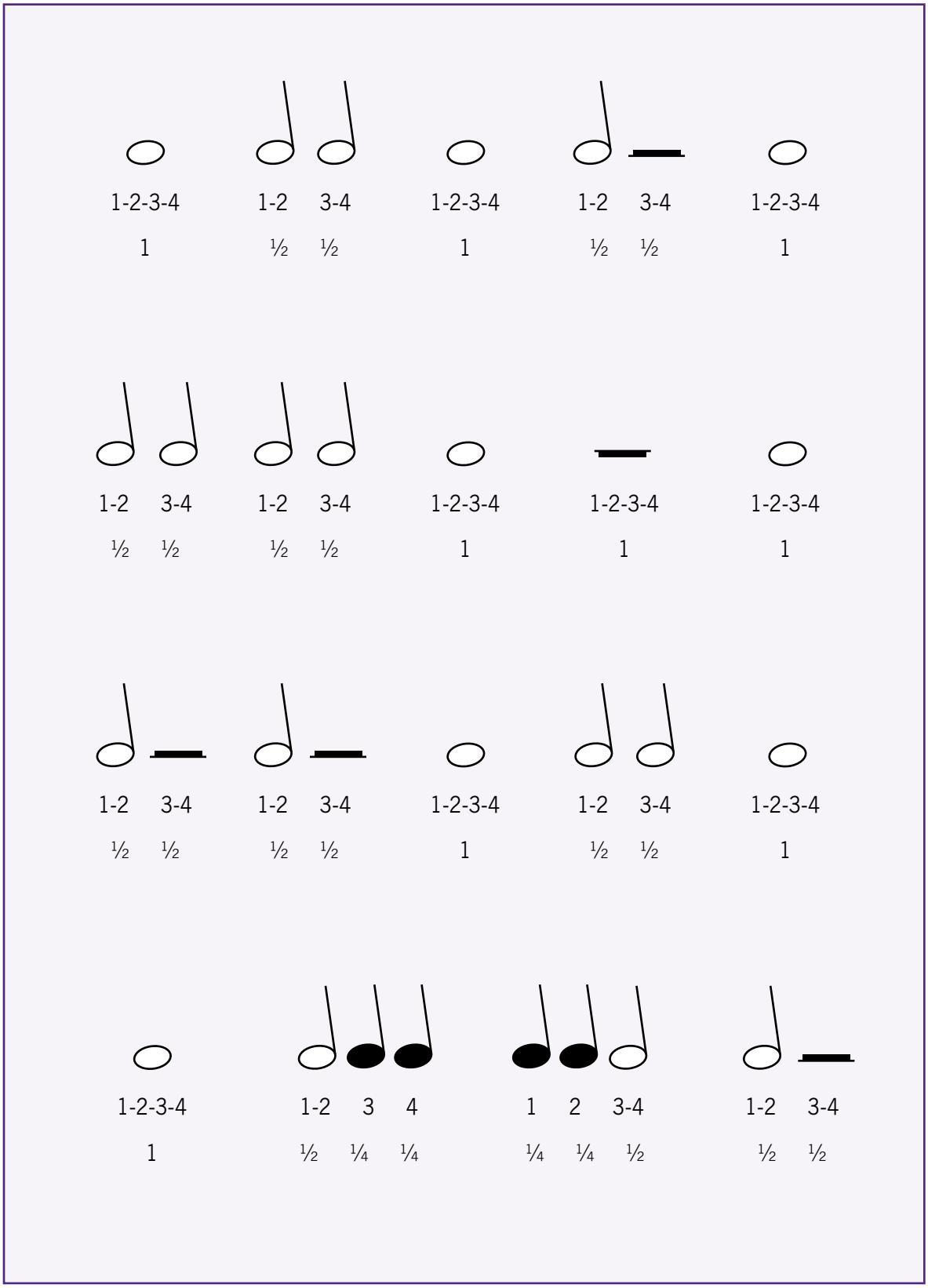
Whole Rest: You do not make any noise for 4 beats: 4/4.



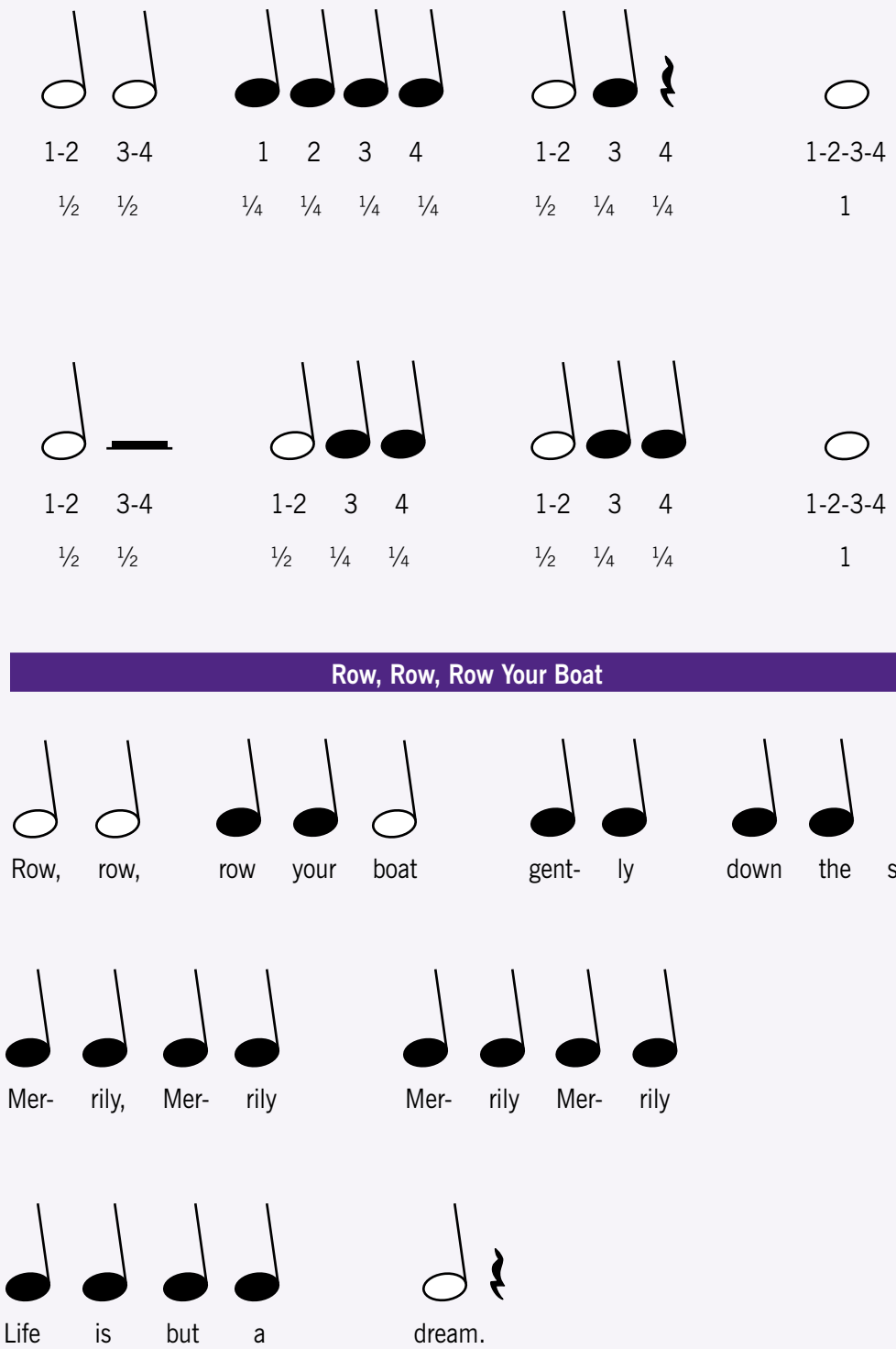
Half Rest: You do not make any noise for 2 beats: 2/4.

Quarter Rest: You do not make any noise for 1 beat: 1/4.

Handout 3: Simple Drumming Patterns: Musical Notes and Math Fraction Drumming



Handout 3, continued



Reflection

The questions below are prompts to help you record your ideas, but you can also write additional observations about the lesson that the questions do not cover.

Preparation

- How well did the lesson planning help you prepare for this activity?
- What can you do to feel more prepared?

Student Engagement

- How did you assess student engagement?
- What did you notice about student engagement in the different parts of the lesson?
- How satisfied were you with the level of student engagement?
- If you were not satisfied, how could you change the lesson to increase student involvement?

Academic Enrichment

- How did this lesson support other content areas?
- What changes could you make to strengthen academic enrichment and still keep the activity fun?

Classroom Management

- What strategies did you use to make this activity go smoothly?
- What changes would you make if you taught the lesson again?

Lesson 5

Paper Airplane Gliders

In this lesson, students explore different paper airplane designs. They build and fly paper airplanes as a way to collect data to determine the best design based on the height and distance traveled.

Grade Level(s):

4–8

Duration:

90 minutes or two class periods

Student Goals:

- Make predictions
- Use tools to measure
- Collect data to prove a hypothesis
- Reinforce averaging, estimation, and rounding skills
- Work with graphs

Curriculum Connection:

Science

Standards:

These standards and benchmarks are from McREL's online database, Content Knowledge: A Compendium of Content Standards and Benchmarks for K–12 Education (4th edition, 2004; www.mcrel.org/standards-benchmarks). The mathematics portion of the database was developed using National Council of Teachers of Mathematics (NCTM) standards in addition to other nationally recognized standards documents.

Standard 3: Uses basic and advanced procedures while performing the processes of computation
Grades 3–5
Benchmark 6: Uses specific strategies to estimate quantities and measurements

Standard 6: Understands and applies basic and advanced concepts of statistics and data analysis
Grades 6–8
Benchmark 5: Uses data and statistical measures for a variety of purposes

Standard 7: Understands and applies basic and advanced concepts of probability
Grades 3–5
Benchmark 3: Understands that when predictions are based on what is known about the past, one must assume that conditions stay the same from the past event to the predicted future event

Benchmark 4: Understands that statistical predictions are better for describing what proportion of a group will experience something rather than which individuals within the group will experience something, and how often events will occur rather than exactly when they will occur

Grades 6–8

Benchmark 3: Understands how predictions are based on data and probabilities

Benchmark 4: Uses specific strategies to estimate computations and to check the reasonableness of computational results

Standard 9: Understands the general nature and uses of mathematics

Grades 3–5

Benchmark 1: Understands that numbers and the operations performed on them can be used to describe things in the real world and predict what might occur

Imagine This!

Can creating paper airplanes have an educational purpose? It may be hard to believe but there's math to be figured and data to be collected in this creative lesson. Your students will love making and flying their very own creations. Whose design will fly the longest distance? Whose design will stay aloft the longest? Does the design affect these numbers? Let's find out!

What You Need

- ❒ Graph paper
- ❒ Unlined paper
- ❒ Tape measures
- ❒ Masking tape or sidewalk chalk
- ❒ Copy of data worksheet (Handout 4) for each student
- ❒ Pencils
- ❒ Stopwatches
- ❒ Markers (optional)

Vocabulary

Aloft: in the air; in flight

Glide: aviation aircraft descent using no engine power

Wingspan: space or expanse between the edges of the wing

Getting Ready

- Prepare copies of the data worksheet for each student. (See Handout 4 at end of lesson.)
- Design the landing strip for the paper airplanes. It should be in a gym, hallway, or other large indoor area to eliminate wind effects. Label each foot and half-foot increment along a line on the landing strip to use for data collection.
- Try this activity before you start it with your students and record your data. Use your data worksheet as a model for your students.

Teaching Tip

Tell students that they should try to duplicate the same launch angle and speed each time.

What to Do

- As an introduction to this activity, ask the students questions similar to the following to help them reach the desired hypothesis for their airplane test. Examples of student responses that will lead to the next questions are in the parentheses.
  - How do we know if a paper airplane is a good or bad paper airplane? *(If it falls to the ground quickly, it is not a good airplane.)*
  - How can we tell if it falls quickly? *(We count.)*
  - What do we count? *(We count the seconds or maybe how high the plane is. We count how far it goes.)*
  - Do we count how far or how long? *(The plane is better if it flies farther. It is better if it flies longer.)*
  - So, is there a difference? *(That depends. In most cases, planes that fly longer will also fly farther. There might be some cases where the plane flies longer but does something like a loop. In that case, it won't fly farther.)*
  - Will the shape of the airplane affect how quickly it falls? *(No, I don't think it matters. I do! I think the shape will help it fly better. Well, maybe, I guess we could test that.)*
- Discuss with students that they now have to come up with a hypothesis to test. The hypothesis should be similar to the following: The shape of the plane affects how quickly it sinks to the ground. The remainder of this activity is designed to help the students explore this hypothesis.
- Look at the data worksheet with your students and explain how to record the data on the worksheet.
- Ask students to design and construct their own paper airplanes out of a single 8½ x 11 inch sheet of paper. Tell them they are going to use their airplanes to test their hypothesis and determine the best design.

Paper Airplane Design Rules

- Students use only regular 8½ x 11 inch paper.
- No tape, clips, or staples can be used.
- No cuts are allowed in the design of the airplane; paper must remain intact.
- Have students choose one partner to work with and to identify themselves as either Partner A or Partner B. Each partner makes his or her own paper airplane. Each student's plane should be different.
- Have all Partner A students fly their planes over the landing strips **five times,** each time trying for **maximum distance.** Then all Partner A students should do **another five** trials, this time trying for **maximum time aloft.** Partner B can help time and measure the flights. Both partners should record the distances and times aloft and average the three longest distances and the three longest times.
- Both partners record the data on each flight on their data worksheet. They should measure the point at which the plane first touches the ground (to the nearest half foot) and not the point at which it comes to rest.
- Then students switch and repeat the exercise with all Partner B students flying their planes **five times** for **distance** and **five times** for **time aloft.**
- Students record the data and average the three longest distances and the three longest times.
- After students have flown their planes, they need to determine their planes' wing area. If students are able, have them unfold their planes and lay out basic geometric shapes to fill the wing area.
  - Older students can calculate the total area from the sum of the areas of the shapes.
  - If students are not able to calculate geometric areas, they could make a duplicate plane, cut off the wings, and lay the wings onto measured grids or pieces of graph paper and count the total squares covered, estimating partial squares.
  - A variation of this technique that eliminates a duplicate plane and cutting wings is to draw or trace a grid on a blank transparency with a marker and then hold the clear grid over the wings to count the squares covered.
- Have students finish their data worksheet and then use their data to create two graphs for the class—one graph comparing time aloft and wing area and the other comparing distance and wing area.
- After they have finished the tests, have students answer the conclusion questions at the bottom of the data worksheet.

Extend

- Repeat the flights with students factoring in their height to see if that makes a difference in the distance and time aloft.
- Students can make a poster of their findings or conclusions.

Outcomes to Look for

- Student participation and engagement
- Using measuring tools productively
- An understanding of different measurements and how to measure
- Answers that reflect an understanding of ratio
- Answers that reflect an understanding of comparison and prediction as well as strategies to make and test predictions

Handout 4: Paper Airplanes Data Worksheet

Name_____ **I am Partner** (circle one) **A** **B**

My Hypothesis:

Partner A's Plane

Area of Partner A's Wings=_____

Average Time Aloft (add the three best times together and divide by 3)=_____

Average Distance Glided (add the three best distances together and divide by 3)=_____

Partner A	1st flight	2nd flight	3rd flight	4th flight	5th flight
Time aloft in seconds					
Partner A	**1st flight**	**2nd flight**	**3rd flight**	**4th flight**	**5th flight**
Distance the plane glided					

Partner B's Plane

Area of Partner B's Wings=_____

Average Time Aloft (add the three best times together and divide by 3)=_____

Average Distance Glided (add the three best distances together and divide by 3)=_____

Partner B	1st flight	2nd flight	3rd flight	4th flight	5th flight
Time aloft in seconds					
Partner B	**1st flight**	**2nd flight**	**3rd flight**	**4th flight**	**5th flight**
Distance the plane glided					

Conclusion Questions

What did you learn about your hypothesis?

How do you think you can improve your airplane's distance and time aloft without changing the size of the plane?

How do you think your height may have affected the loft and distance?

How would you test to see if you are right?

Reflection

The questions below are prompts to help you record your ideas, but you can also write additional observations about the lesson that the questions do not cover.

Preparation

- How well did the lesson planning help you prepare for this activity?
- What can you do to feel more prepared?

Student Engagement

- How did you assess student engagement?
- What did you notice about student engagement in the different parts of the lesson?
- How satisfied were you with the level of student engagement?
- If you were not satisfied, how could you change the lesson to increase student involvement?

Academic Enrichment

- How did this lesson support other content areas?
- What changes could you make to strengthen academic enrichment and still keep the activity fun?

Classroom Management

- What strategies did you use to make this activity go smoothly?
- What changes would you make if you taught the lesson again?


5/40
5/10
3/9
4/48
3/6
5/30

Practice 2

Math Centers

What Is It?

The practice *Math Centers* features small-group stations that let students work together on fun math activities such as puzzles, problems using manipulatives, and brainteasers. Math centers give students opportunities to problem solve a variety of activities, pace themselves, and work independently or with their peers.

What Is the Content Goal?

The key goals of *Math Centers* are to engage students in different math-related activities, build their problem-solving and collaboration skills, increase their desire to learn, and ultimately extend their understanding of math. Specific content goals should be connected to what students are learning during the school day and to grade-level standards.

What Do I Do?

Begin by talking to the day-school teacher to find out what math concepts students are learning, the standards for each grade level, and the kinds of activities that extend students' learning. For example, an activity involving money could help build students' understanding of number and operation, an important math standard. Next, consider activities that your students already enjoy and how appropriate math concepts and skills can be incorporated.

Once you've outlined the activities, create space for small groups to work and secure any materials or tools that will help them problem solve. Introduce the activity to the students, with an emphasis on making it a fun challenge. Math centers work best when students have some choice in their activity, when they can approach an activity or problem from different angles, and when students work independently or with their peers to solve a problem. Instructors act as facilitators. Circulate among the math centers, asking questions that guide students toward a solution and providing feedback that encourages students' understanding of the math involved and their desire to learn.

Why Does It Work?

Research suggests that *Math Centers* encourage students' independence and increase their enthusiasm for learning by giving students opportunities to make choices, work together, and talk about math. When students work in small groups, they are more likely and willing to explore different approaches to problem solving as well as to question, take risks, explain things, and have their ideas challenged. Finally, centers help bring math content to life through fun activities.

Getting Started

video

Go to the *Math Centers* practice found in the math section of the Afterschool Training Toolkit (www.sedl.org/afterschool/toolkits/math/pr_math_centers.html). Click on the video "Math Centers: Choices and Challenges" and watch as students at Purple Sage Elementary School in Houston, Texas, choose a variety of center-based math games in small groups that help them better understand and practice mathematical thinking.

Use the before, during, and after writing prompts to write down your ideas on how you might involve your students in math and centers.

BEFORE YOU WATCH THE VIDEO, write down what you already know about students using math in centers.

DURING THE VIDEO, consider the following:

How does the instructor work with the students to lay the groundwork for the activity and get them started?

How does the instructor interact with the kids? What does he or she do to keep them engaged?

What academic skills, like reading or math, are students reinforcing while they participate in the activity? Be sure to give specific examples.

AFTER YOU WATCH THE VIDEO, write what modifications you might need to make to teach this lesson in your own class.

Lesson 1

Measuring Hands and Feet

In this lesson, students predict if their hand or their foot is larger. They will use a variety of measurement skills, tools, and strategies to find the area of their handprints and footprints.

Grade Level(s):

2–5

Duration:

30–45 minutes

Student Goals:

- Understand length, width, height, and area, and how they connect
- Use specific strategies to estimate measurements
- Select and use appropriate standard (e.g., inches) and nonstandard (e.g., arbitrary lengths of string) units and tools of measurement
- Test predictions and communicate mathematical reasoning

Curriculum Connection:

Science

Standards:

These standards and benchmarks are from McREL's online database, Content Knowledge: A Compendium of Content Standards and Benchmarks for K–12 Education (4th edition, 2004; www.mcrel.org/standards-benchmarks). The mathematics portion of the database was developed using National Council of Teachers of Mathematics (NCTM) standards in addition to other nationally recognized standards documents.

Standard 1: Uses a variety of strategies in the problem-solving process

Grades K–2

Benchmark 2: Uses discussions with teachers and other students to understand problems

Benchmark 3: Explains to others how she or he went about solving a numerical problem

Grades 3–5

Benchmark 1: Uses a variety of strategies to understand problem situations

Benchmark 2: Represents problems situations in a variety of forms

Benchmark 3: Understands that some ways of representing a problem are more helpful than others

Benchmark 4: Understands and applies basic and advanced properties of the concepts of measurement

Standard 4: Understands and applies basic and advanced properties of the concepts of measurement

Grades K–2

Benchmark 1: Understands the basic measures length, width, height, weight, and temperature

Grades 3–5

Benchmark 1: Understands the basic measures perimeter, area, volume, capacity, mass, angle, and circumference

Benchmark 2: Selects and uses appropriate tools for given measurement situations
Benchmark 4: Understands relationships between measures
Benchmark 5: Understands that measurement is not exact
Benchmark 6: Uses specific strategies to estimate quantities and measurements

Imagine This!

Wiggle out of those socks and shoes! Get ready for bare feet and giggles as students make predictions about the size of their own hands and feet. After predicting, they have to get down to business and gather data! Hmm, how might they do this? Let them ponder this with each other for a few minutes as they look at the supplies at their centers. Watch them figure out that tracing their hands and feet and measuring their drawings will lead them to a conclusion!

What You Need

- ❒ Graph paper
- ❒ Unlined paper
- ❒ Pencils or colored pencils
- ❒ Rulers
- ❒ Protractors (optional)
- ❒ Geoboards (optional)
- ❒ Directions for each center
- ❒ Handout 5: Measurement and Geometry: Hands and Feet

Vocabulary

Area: the space of the inside of a two-dimensional figure

Length: distance from end to end

Prediction: a statement of what somebody thinks will happen in the future

Width: distance from side to side

Getting Ready

- Prepare directions and materials to create inviting centers.
- Print a sample hands-and-feet measurement image (Handout 5).
- Use the materials provided to trace one hand and one foot on separate pieces of paper.
- Predict whether your hand or your foot takes up more space.
- Find out if your prediction is correct.
- Be ready to model what you have done for your students.

What to Do

- Use the sample hands-and-feet measurement image to review length, width, and area with students.
- Ask students to trace one hand and one foot on graph paper, and then to predict which is bigger in total area. Students may count the squares on the graph paper as a strategy for making predictions.
- Next, ask students to measure the length and width of their handprints and footprints.
- When students have measured length and width, ask them to calculate the area of each one to test their predictions.
- Circulate and pose questions as students are working.

Using Guiding Questions

As students work together, the instructor should facilitate learning by asking questions that encourage students to use what they know about math to solve the problem, as opposed to simply giving them the answers. Use the sample guiding questions below or develop your own.

- I notice that you are counting spaces, represented by boxes on your graph paper, inside your handprints and footprints. Why might this method be useful in finding out which takes up more space?
- What method do you plan on using to solve the problem? What is your strategy?
- Can you restate this question in your own words?
- How are you keeping track of your calculations?
- Did you answer the question?

- Encourage students to work together to problem solve.
- Finally, ask students to report on which was bigger, how they came to their answers, if their predictions were correct, and what they learned.

Outcomes to Look for

- Student participation and engagement
- Students working together and using tools to problem solve
- Understanding of nonstandard units of measurement (guessing size in terms of a specific student's handprint or footprint, e.g.) as well as standard units of measurement (measuring inches and centimeters, calculating the area)
- Answers that reflect an understanding of length, width, and area
- Ability to make and test predictions
- Students working together to problem solve

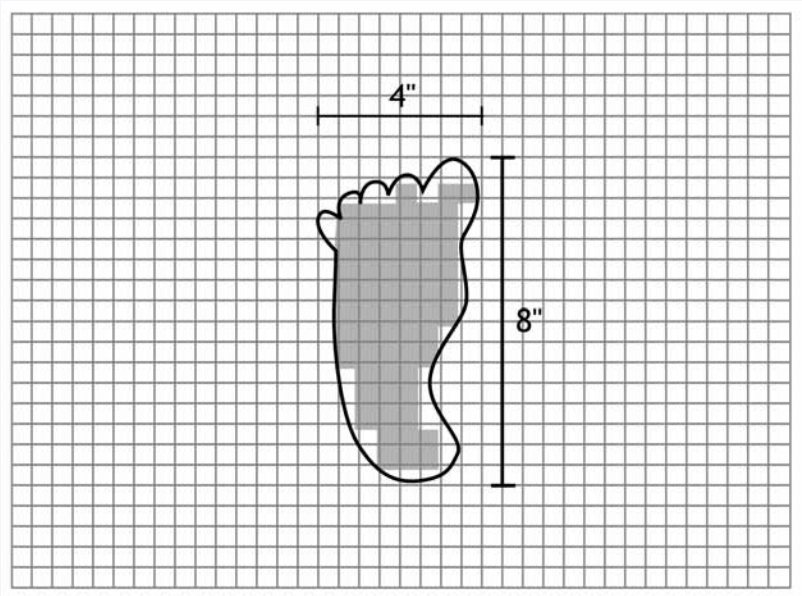
Teaching Tip

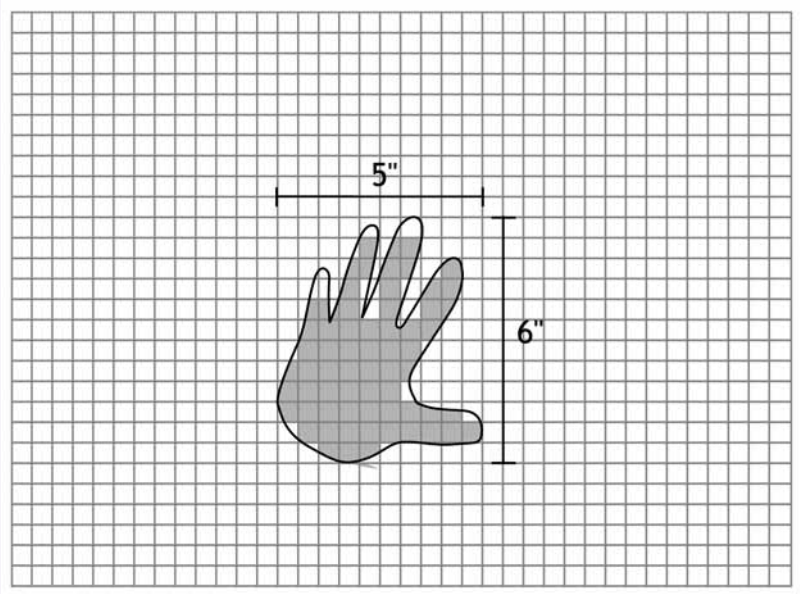
Standard and Nonstandard Units of Measurement

Some students will understand length, width, and area quicker than others and may not need guidance on the use of a ruler or protractor. Be sure that students maintain the proper units of measurement as they proceed (centimeters, inches) and that all measurements for one object are taken using the same units. Students who are measuring will also need to use the formula for calculating area, or the space an object takes up (area = length x width). Allow them to either come up with the formula on their own or have a conversation about what they might do with their measurements before providing them with the formula.

Students who are just learning these concepts may use nonstandard units of measurement, such as counting the squares on the graph paper or simply guessing by comparing the size of their hands and feet. These students will need to estimate some squares in portions (halves, quarters) and will also need to track what has been counted in some way. Coloring or marking counted spaces in some way will be helpful. However students decide to tackle the problem, allow them to explore on their own before offering a suggestion.

Handout 5: Measurement and Geometry: Hands and Feet





Reflection

The questions below are prompts to help you record your ideas, but you can also write additional observations about the lesson that the questions do not cover.

Preparation

- How well did the lesson planning help you prepare for this activity?
- What can you do to feel more prepared?

Student Engagement

- How did you assess student engagement?
- What did you notice about student engagement in the different parts of the lesson?
- How satisfied were you with the level of student engagement?
- If you were not satisfied, how could you change the lesson to increase student involvement?

Academic Enrichment

- How did this lesson support other content areas?
- What changes could you make to strengthen academic enrichment and still keep the activity fun?

Classroom Management

- What strategies did you use to make this activity go smoothly?
- What changes would you make if you taught the lesson again?

Lesson 2

Finding Pentominoes

Students explore geometric relationships by arranging squares to form pentominoes, figures that are made up of five squares. Students work in cooperative groups arranging shapes to form 12 geometrical shapes. As a group, they will then reflect on their mathematical reasoning.

Grade Level(s):

3–5

Duration:

45 minutes

Student Goals:

- Understand basic features of shapes, such as sides and angles
- Explore geometric relationships by arranging objects
- Understand what a pentomino is and how it is formed
- Work together to find different pentominoes and problem solve
- Reflect on and communicate mathematical reasoning

Curriculum Connection:

The Arts

Standards:

These standards and benchmarks are from McREL's online database, Content Knowledge: A Compendium of Content Standards and Benchmarks for K–12 Education (4th edition, 2004; www.mcrel.org/standards-benchmarks). The mathematics portion of the database was developed using National Council of Teachers of Mathematics (NCTM) standards in addition to other nationally recognized standards documents.

Standard 1: Uses a variety of strategies in the problem-solving process

Grades 3–5

Benchmark 1: Uses a variety of strategies to understand problem situations

Standard 5: Understands and applies basic and advanced properties of the concepts of geometry

Grades 3–5

Benchmark 2: Understands basic properties of figures

Benchmark 4: Understands that shapes can be congruent or similar

Benchmark 5: Uses motion geometry to understand geometric relationships

Imagine This!

How can playing with squares and drawing the results be considered math? As early as 3000 B.C. in Mesopotamia, people were studying shapes and their relationships to each other in surveying, architecture, measurements, areas, and volumes. Drawing and building shapes—the visual, hands-on nature of geometry—makes geometry very accessible for all students!

What You Need

- ❒ Graph paper
- ❒ Unlined paper
- ❒ Pencils
- ❒ Pentomino blocks (optional)
- ❒ Dominoes (optional)

Getting Ready

- Small blocks or tiles work well for this activity, but if you don't have them, students can draw pentominoes on graph paper.
- Use the materials you have to create inviting centers where students have access to all the materials they may need.
- Review the possible shapes students can make with up to five squares (see the examples on page 56). The bottom row shows you the 12 possible shapes students can make with pentominoes. You can share this information with students after they have completed the lesson.

Vocabulary

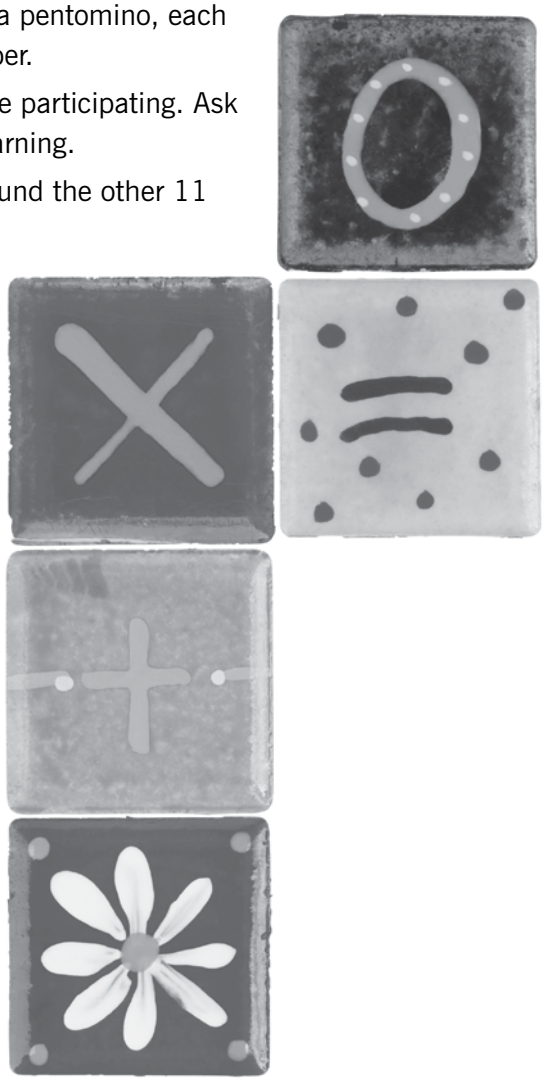
Domino: a small rectangular tile marked with one to six dots; used in various games

Pentomino: a shape made up of five squares connected on at least one side

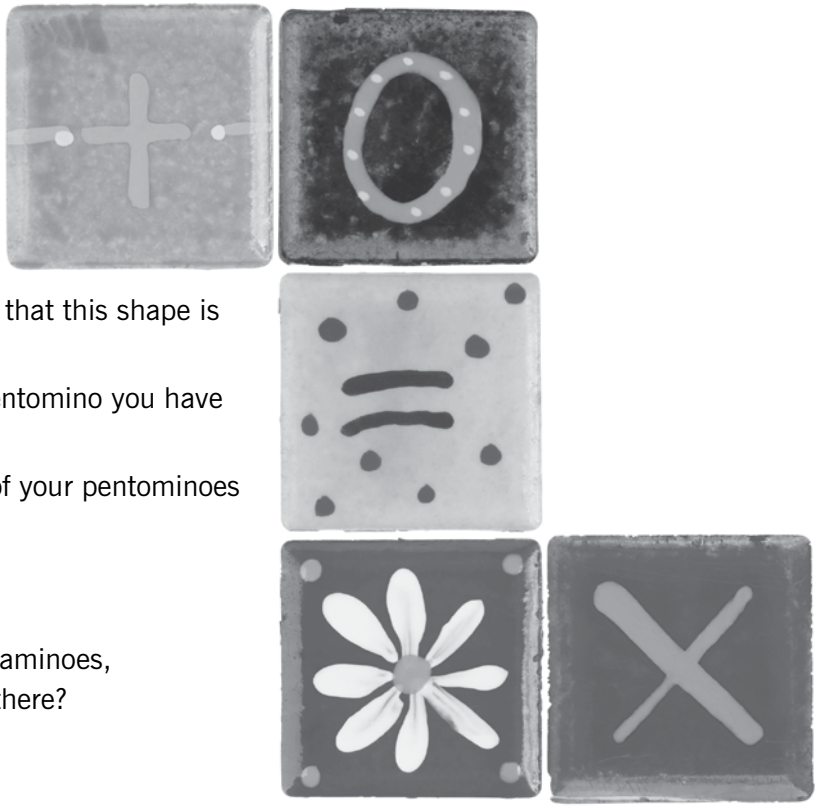
Triomino: a shape with three squares connected on at least one side

What to Do

- Create groups of four to five students for each center. You may want to assign students to groups based on their needs and abilities or ask students to count off for random groups.
- Draw or configure a pentomino using one of the images from the handout. Introduce the word to students and ask guiding questions about how many squares there are in this new shape to create a group definition. (A pentomino is a shape made up of five squares connected on at least one side.)
- Using the pentomino you created, turn it so that the squares are still in the same arrangement but are facing a different direction. Explain that this is not a different pentomino because the combination of squares is the same.
- Explain that there are 12 possible pentominoes, or 12 possible shapes that can be created by combining five squares. You have already created one pentomino. Working in groups, the students are to find the other 11.
- Now, ask students to work together in groups, with members taking turns, to find as many different pentominoes as they can. As the group creates a pentomino, each student should draw it on his or her individual graph paper.
- Circulate among the centers to make sure all students are participating. Ask questions and provide positive feedback to encourage learning.
- As each group finishes, check in to see if the students found the other 11 pentominoes.
- Share the examples of pentominoes on page 56 at this time. Have students compare their drawings with the examples.
- Discuss the activity with the whole group. Which pentominoes were the easiest to find? Which were the hardest? What did you learn?



Assessing Pentominoes



As students work in centers to find all 12 pentominoes, use the following guiding questions to assess students' progress and encourage them to think for themselves:

- Can you tell me how you know that this shape is a pentomino?
- How do you know that each pentomino you have created is different?
- How can you figure out if one of your pentominoes is the same as another?

Extend

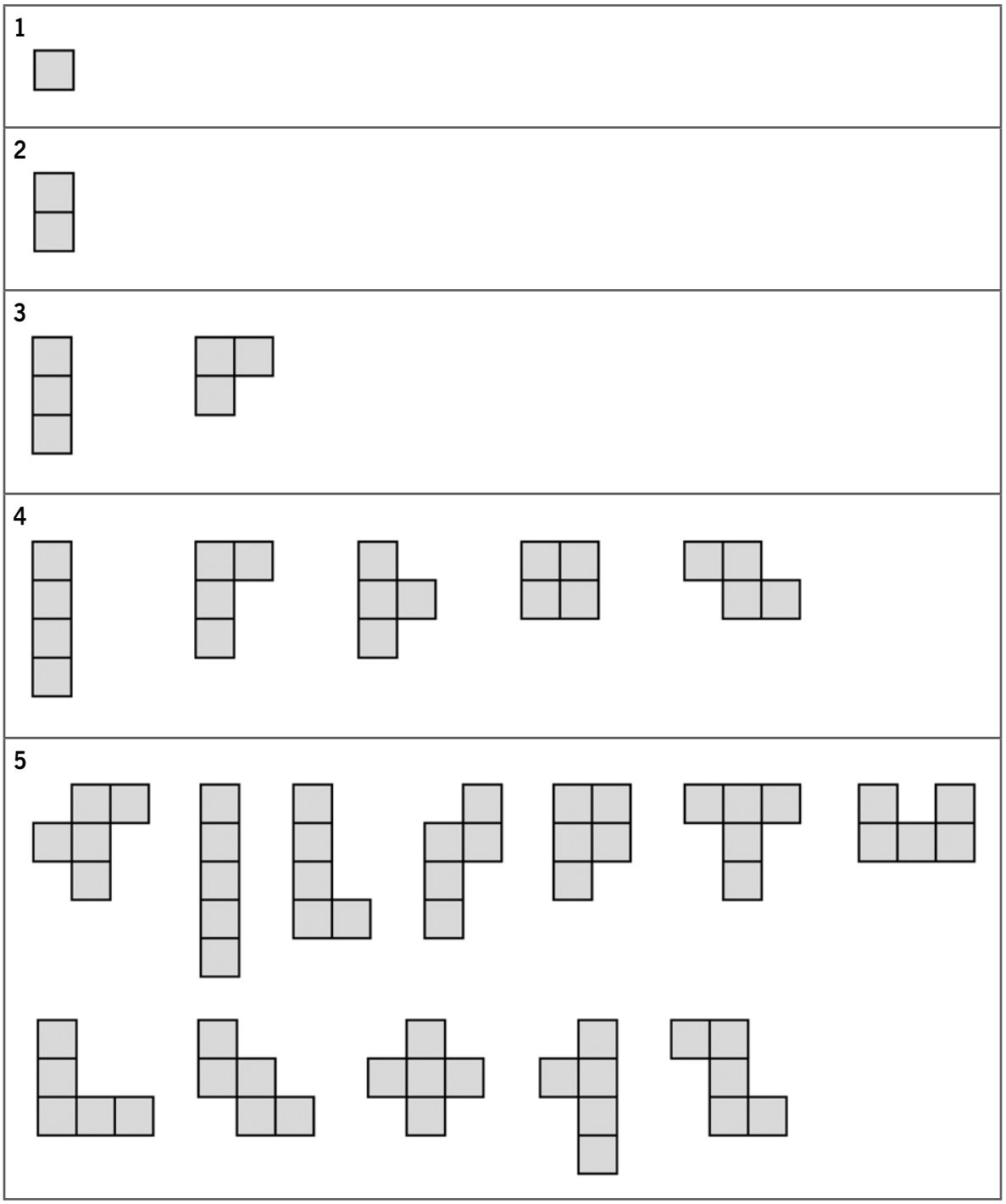
How many combinations of quadraminoes, hextominoes, and triominoes are there?

Outcomes to Look for

- Student participation and interest in the activity
- Students working and talking together to problem solve and find pentominoes
- Answers that reflect an understanding of geometric relationships
- Answers and configurations that reflect an understanding of what a pentomino is
- Students using different strategies to find other pentominoes
- Students' ability to explain different shapes and how they found their answers

Geometry: Finding Pentominoes

Pentominoes are composed of five squares, just as dominoes are made up of two squares. If you are introducing pentominoes to students for the first time, it may be helpful to begin by reviewing dominoes or other simpler cases. Here are the "-ominoes" for one through five.



Reflection

The questions below are prompts to help you record your ideas, but you can also write additional observations about the lesson that the questions do not cover.

Preparation

- How well did the lesson planning help you prepare for this activity?
- What can you do to feel more prepared?

Student Engagement

- How did you assess student engagement?
- What did you notice about student engagement in the different parts of the lesson?
- How satisfied were you with the level of student engagement?
- If you were not satisfied, how could you change the lesson to increase student involvement?

Academic Enrichment

- How did this lesson support other content areas?
- What changes could you make to strengthen academic enrichment and still keep the activity fun?

Classroom Management

- What strategies did you use to make this activity go smoothly?
- What changes would you make if you taught the lesson again?

Lesson 3

Using Gift Certificates

In this lesson, students use number and operation skills to figure out how best to spend a gift certificate at their favorite restaurant. They can spend their money in many combinations, but they have to include all members of their group.

Vocabulary

Strategy: a plan of action to get the answer

Grade Level(s):

4–5

Duration:

45–60 minutes

Student Goals:

- Solve real-world problems involving number and operations
- Use mathematical tools effectively to solve problems
- Compute (add, subtract, multiply, and divide) decimals
- Use specific strategies such as estimation and rounding to make predictions
- Understand and apply a variety of strategies to solve problems
- Reflect on and communicate mathematical reasoning

Curriculum Connection:

Life Skills

Standards:

These standards and benchmarks are from McREL's online database, Content Knowledge: A Compendium of Content Standards and Benchmarks for K–12 Education (4th edition, 2004; www.mcrel.org/standards-benchmarks). The mathematics portion of the database was developed using National Council of Teachers of Mathematics (NCTM) standards in addition to other nationally recognized standards documents.

Standard 1: Uses a variety of strategies in the problem-solving process

Grades 3–5

Benchmark 1: Uses a variety of strategies to understand problem situations

Benchmark 3: Understands that some ways of representing a problem are more helpful than others

Benchmark 4: Uses trial and error and the process of elimination to solve problems

Standard 3: Uses basic and advanced procedures while performing the process of computation

Grades 3–5

Benchmark 1: Multiplies and divides whole numbers

Benchmark 2: Adds, subtracts, multiplies, and divides decimals

Benchmark 4: Uses specific strategies to estimate computations and to check the reasonableness of computational results

Benchmark 5: Performs basic mental computations

Benchmark 8: Solves real-world problems involving number operations

Standard 9: Understands the general nature and uses of mathematics

Grades 3–5

Benchmark 1: Understands that numbers and the operations performed on them can be used to describe things in the real world and predict what might occur.

Imagine This!

Gifts certificates are cool gifts if you know how to use them. You could spend them entirely on yourself or entirely on someone else, but in this class a $65 certificate is being shared with each group—now that's cooperation at its best! Get out the base-10 blocks or paper money and have some fun figuring out what people can eat. Maybe after all those mouth-watering choices, some real snacks might be available?!

What You Need

- ❒ Unlined paper
- ❒ Graph paper
- ❒ Calculators (optional)
- ❒ Pencils with erasers
- ❒ Base-10 blocks or play money
- ❒ Materials to set up a restaurant table (optional)
- ❒ A copy of the mission and menu for each center (Handout 6)

Getting Ready

- Gather materials and arrange centers to give students access to materials.
- Make copies of the mission description, menu, and guiding questions.

What to Do

- Create groups of four to five students for each center. You may want to assign students to groups based on their needs and abilities or ask students to count off for random groups.
- Students may work independently with group support or together as a group. If they work independently, have them compare and discuss their answers with each other when they are finished. For group work, ask each group to delegate one student to read the mission description and guiding questions, and other students to be in charge of different materials and tasks to ensure that everyone participates.
- Explain to students that they will have 30 minutes to complete the activity.
- Circulate among the centers to listen to students' conversations and facilitate discussion by asking guiding questions that guide students toward a solution. (See the questions on the next page.)

Teaching Tip

Using Base-10 Blocks

Base-10 blocks are wooden or plastic blocks that represent units of 1, 10, or 100. In this lesson, students can use them, as they would play money, to represent quantities as they calculate how to spend their gift certificate. Base-10 blocks are an example of a manipulative, a concrete object that helps some students calculate amounts.

Using Guiding Questions

Guiding questions offer problem-solving prompts that encourage students to think for themselves and use what they know to figure out the answer. For example, students may present an answer and ask you if it is right. Instead of simply saying yes or no, you might want to ask them how they got their answer, if it makes sense to them, and if they know how to check their math to see if their answer is right. In this way, students are using what they know to answer their own question and learning how to justify their thinking.

Use the following guiding questions or add your own.

- Can you restate the problem in your own words?
- What do you know about the problem? For example, how much can you spend? How many people are using the gift certificate? What does that tell you about how much each person can spend?
- What method do you plan on using to solve the problem? What is your strategy? How are you keeping track of your thinking, and which strategies have you tried?
- What materials could help you solve the problem?
- How did you find your answer? Does it make sense?
- Did you answer the question? Go back and check.
- What did you learn from other students that helped you solve the problem?
- Finally, how can you show that your answer is correct?
- Be ready to model problem solving with base-10 blocks or other materials. Provide positive feedback to encourage students' success.
- When students have completed the activity, ask each group to present its solutions (there may be more than one) as well as the steps and mathematical reasoning involved. Allow time for questions and answers.

Extend

- Change the dollar amount of the gift certificate and redo the center.
- Change the number of courses people will eat.

Outcomes to Look for

- Student participation and interest in problem solving
- Students using a variety of approaches and strategies to problem solve
- Answers that reflect reasonable predictions and effective use of tools
- Adding, subtracting, multiplying, and dividing decimals accurately
- Students' ability to communicate how they arrived at the solution

Handout 6: Number and Operation: Using Gift Certificates

Mission Description

You received a gift certificate to your favorite restaurant. The gift certificate is worth $65. You invite four of your closest friends to dinner. Each member of the group orders at least one entree and at least one drink. Describe what each member of the group will order and how much it totals. Good luck!

Menu

ENTREES

Spaghetti $8.00
Hamburger and fries $7.25
Fish fillet $8.50
Soup and sandwich $6.50
Soup and salad $6.00

SIDES

Salad $2.99
French fries $1.99
Baked potato $.99
Steamed vegetables $1.50
Applesauce $.75

DESSERTS

Brownie sundae $3.50
Ice cream sundae $2.50
Chocolate layer cake $2.50
Cherry pie $3.00
Lemon square $2.75

DRINKS

Milk $1.25
Juice $1.50
Soda $1.00
Lemonade $1.00
Iced tea $.75

Reflection

The questions below are prompts to help you record your ideas, but you can also write additional observations about the lesson that the questions do not cover.

Preparation

- How well did the lesson planning help you prepare for this activity?
- What can you do to feel more prepared?

Student Engagement

- How did you assess student engagement?
- What did you notice about student engagement in the different parts of the lesson?
- How satisfied were you with the level of student engagement?
- If you were not satisfied, how could you change the lesson to increase student involvement?

Academic Enrichment

- How did this lesson support other content areas?
- What changes could you make to strengthen academic enrichment and still keep the activity fun?

Classroom Management

- What strategies did you use to make this activity go smoothly?
- What changes would you make if you taught the lesson again?

Lesson 4

What's the Chance?

This lesson focuses on developing students' understanding of data and probability, while they determine if the game they are playing is fair. Students are encouraged to engage in rich mathematical discussions while testing their hypotheses.

Vocabulary

Probability: the extent that something is likely to happen

Grade Level(s):

6–8

Duration:

1 hour

Student Goals:

- Communicate about mathematics (e.g., use mathematical language, compare their thinking with other students' thinking, construct logical arguments to support their thinking)
- Use strategies to understand new math content
- Select and use the best method of representing and describing a set of data
- Use experimental methods to determine theoretical probability

Curriculum Connection:

Science

Standards:

These standards and benchmarks are from McREL's online database, Content Knowledge: A Compendium of Content Standards and Benchmarks for K–12 Education (4th edition, 2004; www.mcrel.org/standards-benchmarks). The mathematics portion of the database was developed using National Council of Teachers of Mathematics (NCTM) standards in addition to other nationally recognized standards documents.

Standard 1: Uses a variety of strategies in the problem-solving process

Grades 6–8

Benchmark 1: Uses a variety of strategies to understand new mathematical content and to develop more efficient solution methods or problem extensions

Benchmark 4: Constructs logical verifications or counter examples to test conjectures and to justify algorithms and solutions to problems

Standard 6: Understands and applies basic and advanced concepts of statistics and data analysis

Grades 6–8

Benchmark 1: Understands and applies basic and advanced concepts of probability

Benchmark 3: Uses experimental and simulation methods to determine probabilities

Benchmark 4: Understands the differences among experimental, simulation, and theoretical probability techniques and the advantages and disadvantages of each

Standard 7: Understands and applies basic and advanced concepts of probability

Grades 6–8

Benchmark 1: Understands and applies basic and advanced concepts of probability

Benchmark 3: Uses experimental and simulation methods to determine probabilities

Benchmark 4: Understands the differences among experimental, simulation, and theoretical probability techniques and the advantages and disadvantages of each

Standard 9: Understands the general nature and uses of mathematics

Grades 6–8

Benchmark 7: Understands that mathematics provides a precise system to describe objects, events, and relationships and to construct logical arguments

Benchmark 10: Understands that mathematicians commonly operate by choosing an interesting set of rules and then playing according to those rules; the only limit to those rules is that they should not contradict each other

Imagine This!

Have you ever wondered how likely you are to roll a pair of dice and get a seven? The study of probability can help you figure out the likelihood of that happening. In math, we call the thing that is likely to happen an *event.* The word *probability* is used to mean the chance that a particular event (or set of events) will occur expressed on a linear scale from 0 (impossibility) to 1 (certainty). As you roll the dice, keep a record of the impossibility and certainty scores in the game What's the Chance? to see if you can determine a pattern—the probability!

What You Need

- ❒ What's the Chance teacher's guide (see pp. 71–75)
- ❒ What's the Chance student worksheet (Handout 7)
- ❒ Pencils
- ❒ Graph paper (and other paper as needed)
- ❒ Calculators
- ❒ Game board markers (e.g., coins, counters) for each team
- ❒ A number cube (die) with an even number of sides

Getting Ready

- Review the What's the Chance teacher's guide.
- Copy the What's the Chance? student worksheet (Handout 7) and familiarize yourself with the scenarios students will be involved with. If necessary, make time to share the lesson with a day-school mathematics instructor to converse about the standards and mathematics involved.
- Decide how you will organize students into pairs (allowing choice or assigning partners).
- Make sure all materials are available for all students.
- Prepare a brief introduction of the game and the students' mission during the game. Students have probably had experiences playing dice games as well as games of chance.

What to Do

- Ask students if they think board games, card games, and games with dice are fair. Encourage them to share some experiences and to think about whether they felt the games were set up fairly. Clarifying the task and piquing students' interest in the lesson are the goals of this discussion.
- Ask students to familiarize themselves with the instructions and to get started as soon as their twosome is ready. Before playing, students are asked to predict which player will have the most wins. You can collect the predictions by putting tally marks on the board for Player 1 or Player 2. Be sure to ask students to talk about the reasoning behind their predictions.
- Circulate and stay involved while students play and answer the questions on the worksheet. While talking with students, try to generate student thinking without giving away answers or leading students down a particular line of thinking.
- For example, you can ask students, "How did you arrive at this answer?" or "What happened when you modified the game board?"
- Ask, "Are you surprised by the results? Why? Why not? What is surprising to you?"
- Once students realize that Player 2 wins most of the time, ask, "Why does Player 2 win more often than Player 1?"
- To get students ready to answer the questions on the theoretical probability of the game, you can ask, "With what you know about probability, how often do you think Player 2 *should* win? All the time? Half the time? One fifth of the time? How could you figure this out?"

- As students play the game, encourage them to bounce ideas around about who is winning and why. Student dialogue will enhance the richness of the game and the learning experiences associated with playing it.
- Be prepared for some students to move forward to the extensions or to save the extensions for another day. You may decide that some students can take the extensions home to work on (and play with a family member) if they have a desire to do so.
- After students have played the game and answered the questions, lead a class discussion on fairness in games and what it means. This will allow students to affirm their learning by thinking through and comparing what they discovered (e.g., their thinking, their discoveries, their theories, their ideas) while they played.

Extend

The teacher's guide has extension activities at the end.

Outcomes to Look for

- All students engaged and actively seeking answers
- Students using strategies effectively
- Students effectively representing and describing data
- Students using experimental methods and determining theoretical probability

Handout 7: What's the Chance?

STUDENT WORKSHEET

Have you ever wondered if games are fair? Here is a chance to play a game based on probability and learn how to determine your chances of winning the game.

What's the Chance? is a game based on probability. Play this game with a partner. In order to play, you will need to use a game board that looks like the one below, a marker, and an even-sided number cube or die:

1	1	2	1 Start Here	2	1	1

How to Play:

- Begin by placing the marker on the center box, labeled 1—Start Here.
- Player 1 begins by rolling the die. If an even number is rolled, the marker is moved one space to the right; if an odd number is rolled, the marker is moved one space to the left.
- Each player's turn consist of three rolls of the die and the corresponding marker moves.
- At the end of a turn (three rolls of the die), a point is scored by one of the players. If the marker ends on a white box, Player 1 receives a point. If the marker ends on a purple box, Player 2 receives a point.
- At the end of each turn, return the marker to the 1—Start Here box.
- Players alternate turns.

A game consists of five turns per player. The player with the most points is the winner.

Before you begin, think about whether the game appears to be fair. Why do you think so? Who do you predict will win?

You might want to use a table like the one below and tally marks to keep track of points. Play at least 10 games to see if any patterns emerge. Your Game 1 row might look something like this, where Player 1 is the winner:

	Player 1	Player 2
Game 1	~~IIII~~ I	IIII

	Player 1	Player 2
Game 1		
Game 2		
Game 3		
Game 4		
Game 5		
Game 6		
Game 7		
Game 8		
Game 9		
Game 10		

Questions:

1. Based on your experimental data, do you think the game is fair? Why or why not? If you think the game is unfair, how could you modify the game to make it a fair game?
2. Create a list of all the different possible outcomes for Players 1 and 2. For example, EVEN, EVEN, ODD is one possible outcome, and Player 2 would win.
3. What is the theoretical probability of Player 1 winning a game? How about Player 2 winning a game? Use a list or tree diagram to help you decide.
4. How does the theoretical probability compare to the experimental probability (your results from actually playing the game)? Explain why the experimental results might be different than the theoretical probability.

Handout 7, continued

Extension Activities

Part 1. Add one square on either end of the game board, so that it looks like this:

2	1	1	2	1 Start Here	2	1	1	2

Play the game as described above. However, each turn consists of four rolls of the die. A game is still 10 turns—5 turns for each player. Players alternate turns. If the marker lands on a white box, Player 1 scores a point. If the marker lands on a purple box, Player 2 scores a point. At the end of 10 turns, the player with the most points is the game winner.

Before you play the game, predict who you think will win the most games. Why do you think so?

Play 10 games and record your results.

Questions:

1. Based on your experimental data, do you think the game is fair? Why or why not? If you think the game is unfair, how could you modify the game to make it a fair game?
2. Create a list of all the different possible outcomes for Players 1 and 2. For example, EVEN, EVEN, ODD, EVEN is one possible outcome, and Player 1 would win.
3. What is the theoretical probability of Player 1 winning a game? How about Player 2 winning a game? Use a list or tree diagram to help you decide.
4. How does the theoretical probability compare to the experimental probability (your results from actually playing the game)? Explain why the experimental results might be different than the theoretical probability.

Part 2. Create your own game, based on ideas similar to What's the Chance?

What's the Chance?

TEACHER'S GUIDE

This Teacher's Guide is like the student version (Handout 7), but it includes answers. Have you ever wondered if games are fair? Here is a chance to play a game based on probability and learn how to determine your chances of winning the game.

What's the Chance? is a game based on probability. Play this game with a partner. In order to play, you will need to use a game board that looks like the one below, a marker, and an even-sided number cube or die:

1	1	2	1 Start Here	2	1	1

How to Play:

- Begin by placing the marker on the center box, labeled 1—Start Here.
- Player 1 begins by rolling the die. If an even number is rolled, the marker is moved one space to the right; if an odd number is rolled, the marker is moved one space to the left.
- Each player's turn consist of three rolls of the die and the corresponding marker moves.
- At the end of a turn (three rolls of the die), a point is scored by one of the players. If the marker ends on a white box, Player 1 receives a point. If the marker ends on a purple box, Player 2 receives a point.
- At the end of each turn, return the marker to the 1—Start Here box.
- Players alternate turns.

A game consists of five turns per player. The player with the most points is the winner.

Before you begin, think about whether the game appears to be fair. Why do you think so? Who do you predict will win?

You might want to use a table like the one below and tally marks to keep track of points. Play at least 10 games to see if any patterns emerge. Your Game 1 row might look something like this, where Player 1 is the winner:

	Player 1	Player 2
Game 1	~~IIII~~ I	IIII

Teacher's Guide, continued

	Player 1	Player 2
Game 1		
Game 2		
Game 3		
Game 4		
Game 5		
Game 6		
Game 7		
Game 8		
Game 9		
Game 10		

Questions:

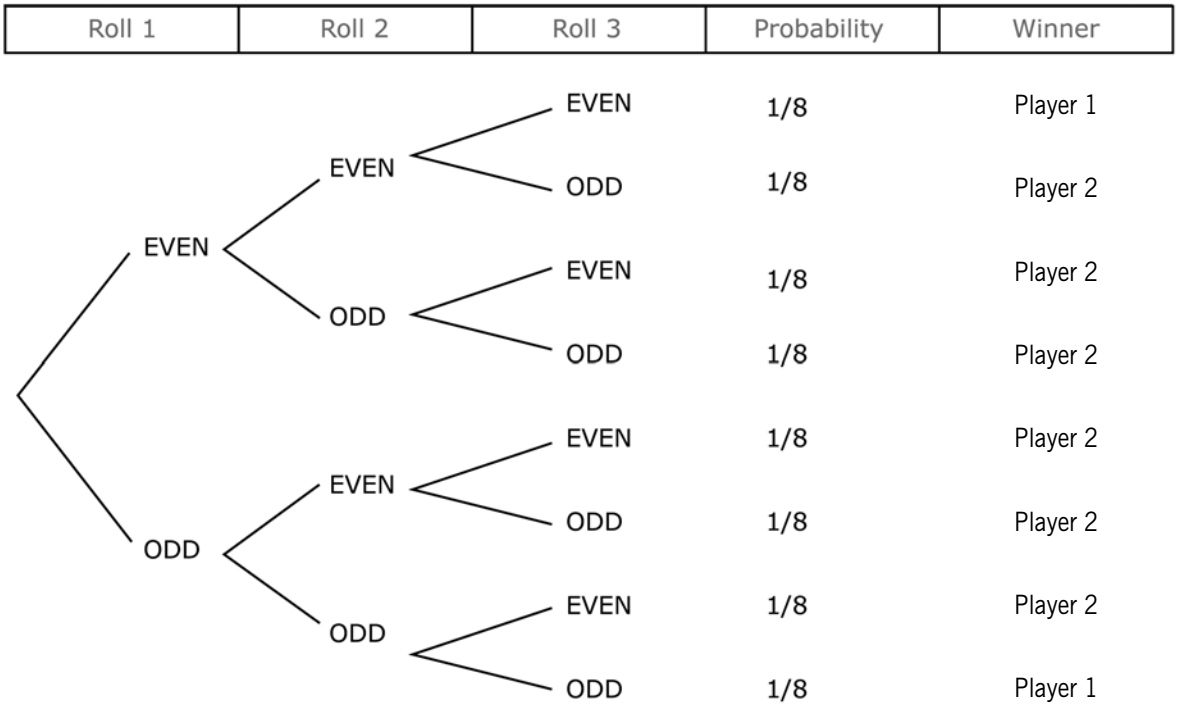
1. Based on your experimental data, do you think the game is fair? Why or why not? If you think the game is unfair, how could you modify the game to make it a fair game?

   The game is not a fair game, although experimental results will vary. Player 2 has a 75% chance of winning, while Player 1 has only a 25% chance of winning.

   Students will create various fair games. The idea is to find a game where each player has an equal chance of winning.

2. Create a list of all the different possible outcomes for Players 1 and 2. For example, EVEN, EVEN, ODD is one possible outcome, and Player 2 would win.

Outcome	Winner
EVEN, EVEN, EVEN	Player 1
EVEN, EVEN, ODD	Player 2
EVEN, ODD, EVEN	Player 2
EVEN, ODD, ODD	Player 2
ODD, EVEN, EVEN	Player 2
ODD, EVEN, ODD	Player 2
ODD, ODD, EVEN	Player 2
ODD, ODD, ODD	Player 1



3. What is the theoretical probability of Player 1 winning a game? How about Player 2 winning a game? Use a list or tree diagram to help you decide.

   The list created in Question 3 can be used for students to explain that, out of eight possible outcomes, Player 2 will win six of the games, and Player 1 will win two of the games (theoretically). The tree diagram above shows the theoretical probability.

   Each event is equally likely, with a probability of 1/8. Out of the eight events, Player 2 wins six times, and Player 1 wins two times. This leads to our theoretical probabilities: the probability of Player 1 winning is 2/8, or 1/4. The probability of Player 2 winning is 6/8, or 3/4.

4. How does the theoretical probability compare to the experimental probability (your results from actually playing the game)? Explain why the experimental results might be different than the theoretical probability.

   Answers will vary with on the results of the experiments.

Teacher's Guide, continued

Extension Activities

Part 1. Add one square on either end of the game board, so that it looks like this:

2	1	1	2	1 Start Here	2	1	1	2

Play the game as described above. However, each turn consists of four rolls of the die. A game is still 10 turns—5 turns for each player. Players alternate turns. If the marker lands on a white box, Player 1 scores a point. If the marker lands on a purple box, Player 2 scores a point. At the end of 10 turns, the player with the most points is the game winner.

Before you play the game, predict who you think will win the most games. Why do you think so?

Play 10 games and record your results.

Questions:

1. Based on your experimental data, do you think the game is fair? Why or why not? If you think the game is unfair, how could you modify the game to make it a fair game?

   The game is not a fair game, although experimental results will vary. Player 1 has an 87.5% chance of winning, while Player 2 has only a 12.5% chance of winning.

   Students will create various fair games. The idea is to find a game where each player has an equal chance of winning.

2. Create a list of all the different possible outcomes for Players 1 and 2. For example, EVEN, EVEN, ODD, EVEN is one possible outcome; and Player 1 would win.

Outcome	Winner
EVEN, EVEN, EVEN, EVEN	Player 2
EVEN, EVEN, EVEN, ODD	Player 1
EVEN, EVEN, ODD, EVEN	Player 1
EVEN, EVEN, ODD, ODD	Player 1
EVEN, ODD, EVEN, EVEN	Player 1
EVEN, ODD, EVEN, ODD	Player 1
EVEN, ODD, ODD, EVEN	Player 1
EVEN, ODD, ODD, ODD	Player 1
ODD, EVEN, EVEN, EVEN	Player 1
ODD, EVEN, EVEN, ODD	Player 1
ODD, EVEN, ODD, EVEN	Player 1
ODD, EVEN, ODD, ODD	Player 1
ODD, ODD, EVEN, EVEN	Player 1
ODD, ODD, EVEN, ODD	Player 1
ODD, ODD, ODD, EVEN	Player 1
ODD, ODD, ODD, ODD	Player 2

There are 16 equally likely outcomes.

3. What is the theoretical probability of Player 1 winning a game? How about Player 2 winning a game? Use a list or tree diagram to help you decide.
   The list created in Question 3 can be used for students to explain that, out of 16 possible outcomes, Player 2 will win 2 of the games, and Player 1 will win 14 of the games (theoretically).

   Each event is equally likely, with a probability of 1/16. Out of the 16 events, Player 2 wins 2 times, and Player 1 wins 14 times. This leads to our theoretical probabilities: the probability of Player 1 winning is 14/16, or 7/8. The probability of Player 2 winning is 2/16, or 1/8.
4. How does the theoretical probability compare to the experimental probability (your results from actually playing the game)? Explain why the experimental results might be different than the theoretical probability.
   Answers will vary with the results of the experiments.

Part 2. Create your own game, based on ideas similar to What's the Chance?

Reflection

The questions below are prompts to help you record your ideas, but you can also write additional observations about the lesson that the questions do not cover.

Preparation

- How well did the lesson planning help you prepare for this activity?
- What can you do to feel more prepared?

Student Engagement

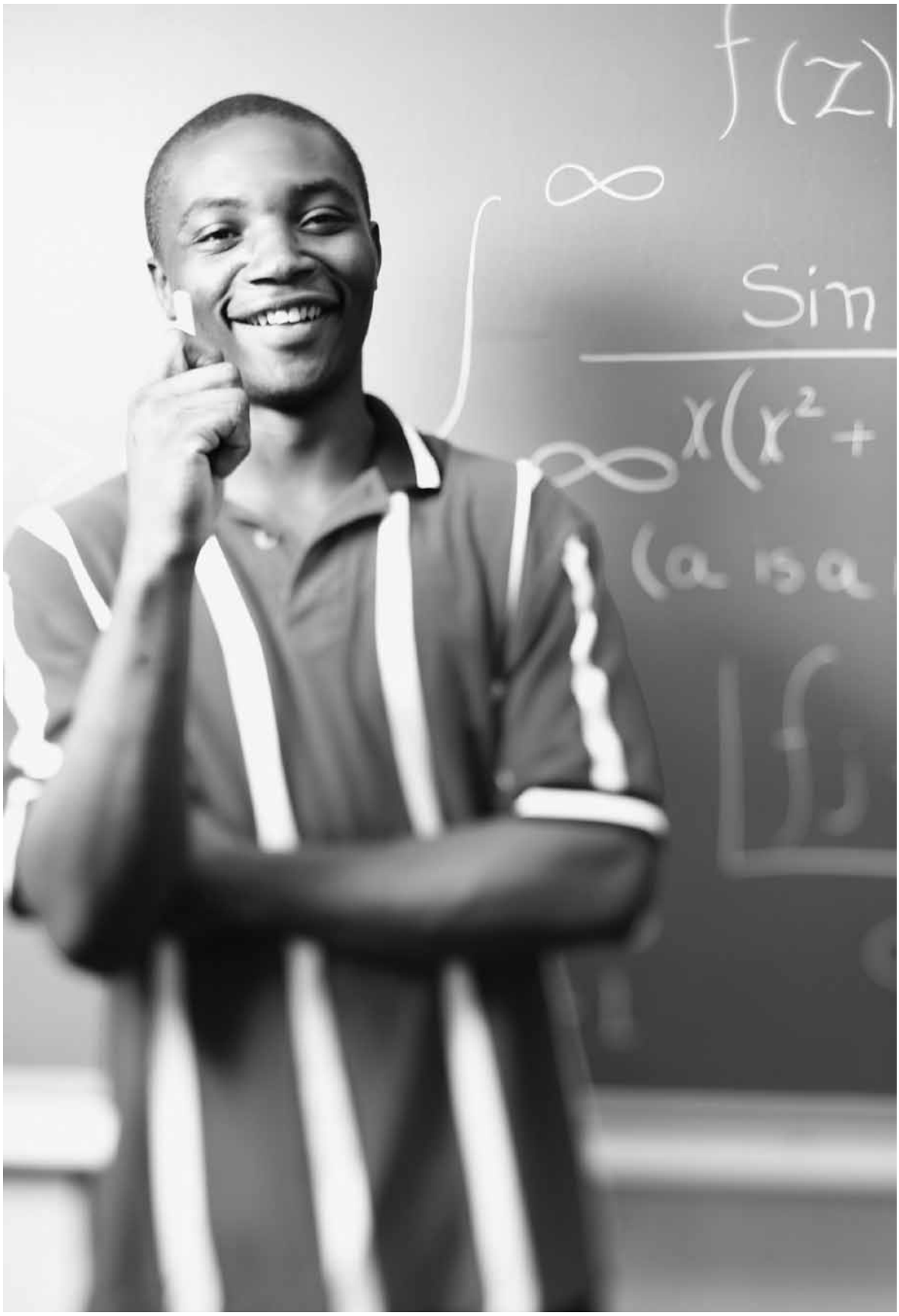
- How did you assess student engagement?
- What did you notice about student engagement in the different parts of the lesson?
- How satisfied were you with the level of student engagement?
- If you were not satisfied, how could you change the lesson to increase student involvement?

Academic Enrichment

- How did this lesson support other content areas?
- What changes could you make to strengthen academic enrichment and still keep the activity fun?

Classroom Management

- What strategies did you use to make this activity go smoothly?
- What changes would you make if you taught the lesson again?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Lesson 5

Pattern Block Percentages

In this lesson, students use pattern blocks to learn about percentages and represent percentages pictorially.

Grade Level(s):

5–6

Duration:

30 minutes

Student Goals:

- Compare shapes to discover relationships between different percentages
- Use tools to explore and represent relationships
- Deepen understanding of the relationship between percentages and ratios
- Work cooperatively with peers

Curriculum Connection:

The Arts

Standards:

These standards and benchmarks are from McREL's online database, Content Knowledge: A Compendium of Content Standards and Benchmarks for K–12 Education (4th edition, 2004; www.mcrel.org/standards-benchmarks). The mathematics portion of the database was developed using National Council of Teachers of Mathematics (NCTM) standards in addition to other nationally recognized standards documents.

Standard 2: Understands and applies basic and advanced properties of the concepts of numbers

Grades 3–5

Benchmark 2: Understands equivalent forms of basic percents, fractions, and decimal and when one form of a number might be more useful than another

Grades: 6–8

Benchmark 1: Understands the relationships among equivalent number representations and the advantages and disadvantages of each type of representation

Benchmark 7: Understands the concepts of ratio, proportion, and percent and the relationships among them

Standard 5: Understands and applies basic and advanced properties of the concepts of geometry

Grades 3–5

Benchmark 1: Knows basic geometric language for describing and naming shapes

Benchmark 2: Understands and applies basic and advanced properties of the concepts of numbers

Imagine This!

The room is filled with multiple locations for students to explore their mathematical thinking and to reinforce skills learned during the school day. A group of students sitting around a table scattered with pattern blocks is discussing how to best solve the problem at hand. Your students can demonstrate their artistic side in this center.

What You Need

❒ One set of guiding questions per pair of students at the center

❒ One set of pattern blocks per pair of students at the center

❒ Unlined paper

❒ Colored pencils in the following colors: blue, green, orange, red, tan, and yellow

Getting Ready

- Assemble the center by providing enough pattern blocks for each pair of students. Students will also need access to unlined paper and colored pencils.
- Prepare sheets for each pair at the center with the following guiding questions:
  - Use the pattern blocks to make two-color designs in which one color takes up 20% of the whole. Illustrate these designs on the paper provided.
    - > Explain your strategy for creating a design that shows 20%.
    - > How can different designs all show 20%?
    - > Label the fractional part for each piece used in your design.
  - Use the pattern blocks to create a design that is 20% one color, 30% a second color, and 50% another color.
    - > How many different designs can you come up with that fit this description?
    - > How can different designs all illustrate this description?
    - > Label the fractional part for each piece used in your design.
  - What would a design showing colors with the ratio of 3:1 look like? How about the ratio of 2:3? Sketch and justify your answers.

What to Do

- Create groups of four to five students for each center. You may want to assign students to groups based on their needs and abilities or ask students to count off for random groups.
- Students may work independently with group support or together as a pair.
- Explain to students that they will have 30 minutes to complete the activity.
- Circulate among the centers to listen to students' conversations and facilitate discussion by asking questions that guide students toward a solution. Provide positive feedback to encourage students' success.
- When students have completed the activity, ask each group to present their solutions (there may be more than one) as well as the steps and mathematical reasoning involved. Allow time for questions and answers.

Extend

- Ask students to sketch several possible designs of a circle, 25% of which is one color.
- Ask how the process of sketching the circle compares to constructing a design with the pattern blocks.

Outcomes to Look for

Much of the assessment for this lesson comes from listening to and watching the students. Listen for use of vocabulary, understanding of percentages, and students' ability to illustrate their discoveries.

- Student participation and engagement
- Using tools productively
- Answers that reflect an understanding of percentages
- Answers that reflect an understanding of the relationships between ratios and percentages

Teaching Tip

Setting Expectations

Prior to having students work in centers, be sure to establish norms for working with their peers. Explain to students that centers are designed for them to spend as little or as much time as necessary to complete the activity and gain an understanding of the materials covered before moving onto the next center.

Vocabulary

Hexagon: a two-dimensional figure with six sides

Parallelograms: a two-dimensional geometric figure with four sides in which both pairs of opposite sides are parallel and of equal length, and the opposite angles are equal

Percentage: a proportion stated in terms of one-hundredths

Ratio: a proportional relationship between two different numbers or quantities

Rhombus: a parallelogram that has four equal sides

Square: a geometric figure with four right angles and four equal sides

Trapezoid: a quadrilateral shape that has one pair of parallel sides and one pair of sides that are not parallel

Triangle: a two-dimensional geometric figure formed of three sides and three angles

Reflection

The questions below are prompts to help you record your ideas, but you can also write additional observations about the lesson that the questions do not cover.

Preparation

- How well did the lesson planning help you prepare for this activity?
- What can you do to feel more prepared?

Student Engagement

- How did you assess student engagement?
- What did you notice about student engagement in the different parts of the lesson?
- How satisfied were you with the level of student engagement?
- If you were not satisfied, how could you change the lesson to increase student involvement?

Academic Enrichment

- How did this lesson support other content areas?
- What changes could you make to strengthen academic enrichment and still keep the activity fun?

Classroom Management

- What strategies did you use to make this activity go smoothly?
- What changes would you make if you taught the lesson again?


4
+4
3
+2

Practice 3

Math Games

What Is It?

The practice *Math Games* features fun activities that develop targeted math strategies and skills. They can be competitive, cooperative, whole group, small group, or solitary. *Math Games* can provide for structured play, in which students are highly motivated to engage in mathematical thinking, have mathematical conversations, remember numerical combinations, and develop problem-solving strategies.

What Is the Content Goal?

The goal of *Math Games* is to engage students in meaningful mathematical problem-solving experiences, build math knowledge and skills, and increase students' desire to learn through fun activities. Specific content knowledge will vary according to the game students play and the connection to day-school learning and standards.

What Do I Do?

Begin by talking to the day-school teacher to find out what math concepts and skills students are learning, and what kinds of games can extend their knowledge. For example, if students are learning to multiply and divide, a fun game that lets students compete for solutions can extend their learning. Select appropriate math games that target particular strategies and skills, and tap students' interests. Allow students to work together in small groups or as a larger group. Facilitate learning during the games by asking questions that encourage students to use what they know about math to find the answer. Guide student thinking and highlight important mathematical concepts through modeling, asking questions, and facilitating conversations with and between students.

Why Does It Work?

In addition to tapping children's natural motivation to play, *Math Games* offer several other instructional advantages, including opportunities for choice, high concentration, and informal instruction. Choice promotes engagement while providing students with opportunities to increase their understanding and application of math skills and concepts, gain computational fluency, and utilize communication skills to justify their moves. Games also encourage social interaction and immediate feedback

Getting Started

video

Go to the *Math Games* practice found in the math section of the Afterschool Training Toolkit (www.sedl.org/afterschool/toolkits/math/pr_math_games .html). Click on Video 2, which shows from Purple Sage Elementary School in Houston. In this video, third-, fourth-, and fifth-grade students engage in a competitive physical game of bacon and egg that integrates math skill building.

Use the before, during, and after writing prompts to write down your ideas on how you might involve your students in math games.

BEFORE YOU WATCH THE VIDEO, write down what you already know about students using math games.

DURING THE VIDEO, consider the following:

How does the instructor work with the students to lay the groundwork for the activity and get them started?

How does the instructor interact with the kids? What does he or she do to keep them engaged?

What academic skills, like reading or math, are students reinforcing while they participate in the activity? Be sure to give specific examples.

AFTER YOU WATCH THE VIDEO, write what modifications you might need to make to teach this lesson in your own class.

Lesson 1

Race to the Finish

In this game, students roll number cubes to move a bicyclist toward the finish line. Each time they roll the number cubes, students record on a data chart the frequency of the numbers rolled. At the end of the game, students analyze the frequency of numbers to see which number they will choose in the next game.

Grade Level(s):

K–2

Duration:

At least 10 minutes per round

Student Goals:

- Count with understanding and recognize how many in sets of objects
- Develop a sense of whole numbers and represent and use them in flexible ways
- Understand data and how data can be represented in bar graphs
- Connect number words and numerals to the quantities they represent by using physical models and representations on number cubes
- Develop fluency with basic number combinations for addition

Standards:

These standards and benchmarks are from McREL's online database, Content Knowledge: A Compendium of Content Standards and Benchmarks for K–12 Education (4th edition, 2004; www.mcrel.org/standards-benchmarks). The mathematics portion of the database was developed using National Council of Teachers of Mathematics (NCTM) standards in addition to other nationally recognized standards documents.

Standard 2: Understands and applies basic and advanced properties of the concepts of numbers
Grades K–2
Benchmark 4: Understands basic whole number relationships

Standard 3: Uses basic and advanced procedures while performing the processes of computation
Grades K–2
Benchmark 1: Adds and subtracts whole numbers

Standard 6: Understands and applies basic and advanced concepts of statistics and data analysis
Grades K–2
Benchmark 1: Collects and represents information about objects or events in simple graphs

Standard 7: Understands and applies basic and advanced concepts of probability
Grades K–2
Benchmark 1: Understands that some events are more likely to happen than others
Benchmark 2: Understands that some events can be predicted fairly well but others cannot because we do not always know everything that may affect an event

Imagine This!

People predicting winners! People cheering for their favorite number! Addition, probability, and data all rolled into one. Students will be engaged as they play this probability game and keep track of their data. Will they choose the same numbers to cheer for in the next game? Let's see—what does the data say?

What You Need

- ❒ Copies of the Race to the Finish game board (Handout 8; laminated if possible) for each group
- ❒ Markers (watercolor, dry erase, or overhead) for writing on laminated game boards
- ❒ Pair of dice for each small group

Getting Ready

- Copy the game board (Handout 8). Laminate or cover the copy with clear contact paper.
- If you plan to introduce the game to the whole group, make an overhead transparency of the game board.

Vocabulary

Data: information, numbers used for making calculations and drawing conclusions

Prediction: a statement of what somebody thinks will happen in the future

What to Do

- Set the game up, making sure that all students can see the game board (an overhead projector might prove useful).
- Have students choose a number between 1 and 12 that they will cheer for; each number represents a cyclist on the game board.
- Ask students to predict who will win and why.
- Provide two dice and have students take turns rolling them.
- After each roll, students add the two numbers rolled and place an x in the empty space above the bicyclist whose number corresponds with the sum of the two numbers rolled.
- Each x represents the bicyclist moving closer toward the finish line.
- Students continue taking turns rolling the cubes and charting the outcome until one of the bicyclists reaches the finish line.
- As students play, encourage them to predict who they think will win, who is ahead, and why. Ask guiding questions throughout and after the game. See **Guiding Questions** below for sample questions.

Guiding Questions

During Play

- Who is ahead? Which bicyclist is in first place right now? Who is in second place? How far behind is the second-place bicyclist? How do you know?
- How far from the finish line is Bicyclist 5?
- Which bicyclist moves ahead this roll? How do you know?
- How many times have you rolled a 5? How do you know?

After Play

- For whom did you cheer in this game? If you play the game again, are you going to pick this bicyclist to cheer on again?
- Which bicyclists are more or less likely to win? Why?
- Will Bicyclist 1 ever win? How do you know?

Outcomes to Look for

- Student engagement and participation
- Comments and answers that reflect that students can use their charts to discuss the bicyclists' standings in the race
- Comments, answers, and choices that reflect an understanding of impossible and more or less likely outcomes
- Students counting with understanding and recognizing how many in sets of objects
- Comments and answers that reflect a developing understanding of and fluency in addition

Handout 8: Data Analysis and Probability: Race to the Finish

1	2	3	4	5	6	7	8	9	10	11	12

Finish Line

Reflection

The questions below are prompts to help you record your ideas, but you can also write additional observations about the lesson that the questions do not cover.

Preparation

- How well did the lesson planning help you prepare for this activity?
- What can you do to feel more prepared?

Student Engagement

- How did you assess student engagement?
- What did you notice about student engagement in the different parts of the lesson?
- How satisfied were you with the level of student engagement?
- If you were not satisfied, how could you change the lesson to increase student involvement?

Academic Enrichment

- How did this lesson support other content areas?
- What changes could you make to strengthen academic enrichment and still keep the activity fun?

Classroom Management

- What strategies did you use to make this activity go smoothly?
- What changes would you make if you taught the lesson again?

Lesson 2

Math Football

In this game, students work as teams to solve mathematics problems and gain yardage on the Math Football game board. Students compete to determine which team can solve the problems more swiftly and score the most touchdowns.

Grade Level(s):

5–10 (depending on difficulty level of questions)

Duration:

10–15 minutes per game

Student Goals:

- Reinforce mathematical vocabulary and skills
- Encourage teamwork and collaboration

Curriculum Connection:

Physical Education

Standards:

These standards and benchmarks are from McREL's online database, Content Knowledge: A Compendium of Content Standards and Benchmarks for K–12 Education (4th edition, 2004; www.mcrel.org/standards-benchmarks). The mathematics portion of the database was developed using National Council of Teachers of Mathematics (NCTM) standards in addition to other nationally recognized standards documents.

The standards addressed depend on the questions the teacher writes and the grade level of the students. Below are the categories of math standards that could be addressed.

Number and Operations (includes Arithmetic and Number Sense)

Patterns, Relationships, and Algebraic Thinking

Geometry and Spatial Visualization

Measurement

Probability and Statistics

Problem Solving

Reasoning and Proof

Communication

Connections

Imagine This!

The afterschool instructor plays the music from *Monday Night Football* and asks, "Are you ready for some football?" Students are eager to form teams and put on their game faces. Game boards, question cards, and marker pieces are distributed; and students wait anxiously for the instructor to signal the start of the game. Students work in teams to solve problems quickly and to see which team can score the most touchdowns.

What You Need

- ❒ A copy of the math football playing board (Handout 9)
- ❒ Question-and-answer cards prepared for the level of the learner (the cards can be prepared on index cards)
- ❒ Game board markers (e.g., coins, counters) for each team
- ❒ Stopwatch
- ❒ Paper
- ❒ Pencils

Getting Ready

- Duplicate a math football playing board (Handout 9) for each pair of teams.
- Prepare question-and-answer cards for the level of the learners (See page 99 for examples.)
- Collect one game board marker for each team.
- Collect markers of various colors, one per team.

What to Do

- Divide students into teams. Teams may be composed of one to three players.
- Determine which teams will compete against each other. Students of similar grade level or mathematics experience should compete with each other.
- Provide each team with a marker and each pair of competing teams with one math football playing board.
- Explain the rules to players.
  - Each team places its team marker on the 50-yard line.
  - A set of question cards is distributed to competing teams.
  - Teams may not start until the instructor calls for play to begin.
  - When play begins, both teams try to solve the problem as quickly as possible. The first team to solve the problem accurately moves the team marker 10 yards on the playing board. The answers for the problems can be found on the reverse side of the question card so that players may self-check.
  - When a team reaches the end zone, it scores 7 points. Players record the points and return team markers to the 50-yard line to begin another round.
  - At the end of 10 minutes of play, the team with the most points wins the math football game.
- When students understand the rules and are ready to play, the instructor signals for play to begin and the action starts.

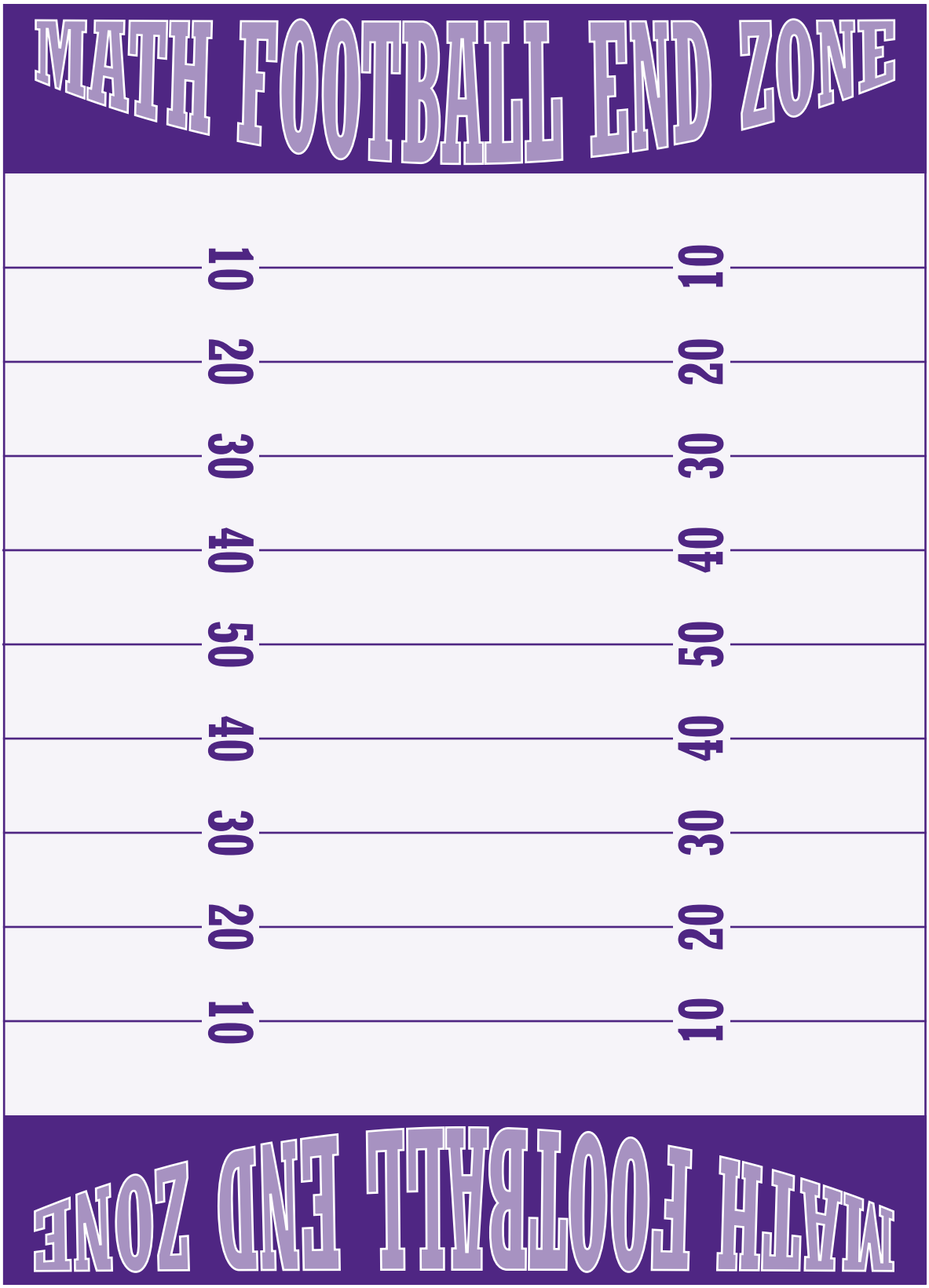
Outcomes to Look for

- Increased fluency with grade-appropriate math skills
- Teamwork and collaboration

Teaching Tip

To keep play fair for each team, remember to place a blank question card on top of the stack. The time for each game (10 minutes) may be extended if doing so works best for the students.

Handout 9: Math Football Playing Board



Sample Question Cards

Math Football Question Cards	Compute $5 + 6(15 \div 3) - 4$
The Harrison's dinner bill at a restaurant is $63. How much money should be left as a tip if the family plans to leave a 15% tip?	A tree casts a shadow 9 meters long. At the same time, a building that is 54 meters tall casts a shadow that is 27 meters long. How tall is the tree?
A store advertisement reads, "Going Out of Business—Everything $\frac{5}{8}$ off." What percent is this?	What value of *d* makes the following number sentence true? $\frac{d}{3} = -27$
Susan is $\frac{1}{4}$ John's age. If Susan is 2 years old, how old is John?	$\frac{10 + 30 \div 5}{28 \div 7 \bullet 2} =$
A circular plate has a radius of 7 inches. What is the area of the plate to the nearest whole inch?	Which measurement below represents the greatest volume? 17 pints, 2 gallons, 35 cups, 9 quarts
green apples—$1.48 per lb. red apples—$1.02 per lb. If Jean buys $3\frac{1}{2}$ pounds of each, how much does she pay for the apples?	Which represents the greater value, $\frac{2}{11}$ or $\frac{1}{9}$?
During basketball practice, Jena attempted 52 free throws and made 16 of them. What is the probability that she will make the next free throw that she attempts?	The ages of students in Martin's karate class are as follows: 8, 9, 7, 10, 9, 11, 6 Which age represents the mode?

Sample Question Cards, continued (Answers)

Answer: 31 Use order of operations $5 + 6(5) - 4$ $5 + 30 - 4 = 31$	**Math Football Question Cards**
Answer: 18 meters $t/9 = 54/27 \quad t = 18$	Answer: \$9.45 10% of \$63.00 is \$6.30 5% of \$63.00 is \$3.15 \$6.30 + \$3.15 = \$9.45
Answer: –81 Use inverse operation $-27 \bullet 3 = -81$	Answer: 62.5% $5/8 = 5 \div 8 = 0.625 \bullet 100 = 62.5\%$
Answer: 2 Use order of operations $\frac{10 + 6}{4 \bullet 2} = \frac{16}{8} = 2$	Answer: 8 $4 \times 2 = 8$
Answer: 9 quarts Convert all to cups 17 pints = 34 cups, 2 gallons = 32 cups 35 cups, 9 quarts = 36 cups	Answer: 154 sq in. Area = $\pi(r2)$ $\pi(72) = 3.14 \times 49 = 153.86 = 154$
Answer: $2/11$ $2/11 = 18/99$ and $1/9 = 11/99$ so $2/11$ is greater	Answer: \$8.75 $\$1.48 \times 3.5 = \$5.18$ $\$1.02 \times 3.5 = \$3.57$
Answer: 9 The mode is the value represented most often in a set of data.	Answer: $4/13$ $16/52 = 4/13$

Reflection

The questions below are prompts to help you record your ideas, but you can also write additional observations about the lesson that the questions do not cover.

Preparation

- How well did the lesson planning help you prepare for this activity?
- What can you do to feel more prepared?

Student Engagement

- How did you assess student engagement?
- What did you notice about student engagement in the different parts of the lesson?
- How satisfied were you with the level of student engagement?
- If you were not satisfied, how could you change the lesson to increase student involvement?

Academic Enrichment

- How did this lesson support other content areas?
- What changes could you make to strengthen academic enrichment and still keep the activity fun?

Classroom Management

- What strategies did you use to make this activity go smoothly?
- What changes would you make if you taught the lesson again?

Lesson 3

Number Concentration

In this game, students match Arabic numerals with their picture representation. The students will use the classic game of concentration to match the numbers they are learning during the school day to the geometric representation of the same number.

Grade Level(s):

K–2

Duration:

30 minutes

Student Goals:

- Recognize the Arabic numerals (0, 1, 2, 3, 4, 5, 6, 7, 8, 9)
- Recall the value of the Arabic numerals as represented through pictures
- Name the geometric shapes used

Curriculum Connection:

Life Skills (thinking and reasoning)

Standards:

These standards and benchmarks are from McREL's online database, Content Knowledge: A Compendium of Content Standards and Benchmarks for K–12 Education (4th edition, 2004; www.mcrel.org/standards-benchmarks). The mathematics portion of the database was developed using National Council of Teachers of Mathematics (NCTM) standards in addition to other nationally recognized standards documents.

Standard 2: Understands and applies basic and advanced properties of the concepts of numbers

Grades K–2

Benchmark 1: Understands that numerals are symbols used to represent quantities or attributes of real-world objects

Benchmark 3: Understands symbolic, concrete, and pictorial representations of numbers

Standard 5: Understands and applies basic and advanced properties of the concepts of geometry

Grades K–2

Benchmark 1: Understands basic properties of and similarities and differences between simple geometric shapes

Imagine This!

The room is filled with students working excitedly in small groups playing games. Who could have imagined students would be so excited about math! Students are using the math vocabulary of geometric shapes to explain why they are winning. As the students finish their games, they beg you to let them play again and again.

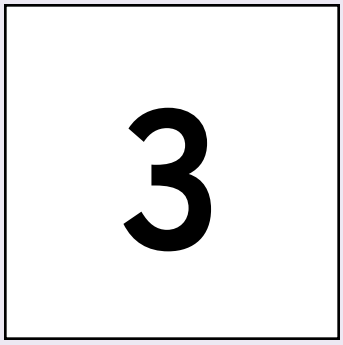
What You Need

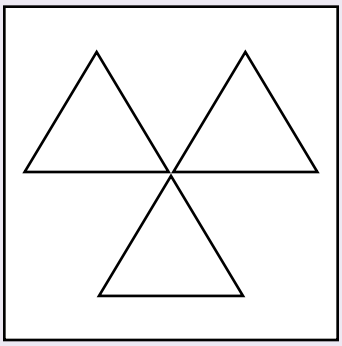
❒ Several sets of 22 concentration cards

Getting Ready

- Prepare the concentration cards so that each of the numerals 0, 1, 2, 3, 4, 5, 6, 7, 8, 9 is represented numerically on a card and pictorially on a separate card. (See example below.)
- Use geometric shapes to represent each number in pictures. Name the shapes as you model the game.
- Have the students say the name of the shapes after you.

Card Example





What to Do

- Divide students into groups of two or three, based on who will work well together. Give each student group a deck of concentration cards.
- Ask students to place each of the cards print side down on the table.
- Explain to the students the basic rules of the game of concentration.
  - Each player will take turns picking a card and flipping it over.
  - Then the same player will pick a second card trying to make a match. A match is made when the player picks a card that has an Arabic numeral that matches the picture illustrated on the other card selected.
  - If the player makes a match, he or she gets to keep both cards and go again.
  - If the player does not make a match, he or she turns both cards over; and the turn goes to the next player.
  - The game is over when all of the cards have been matched. The winner is the player who has the most matched cards at the end of the game.

Extend

- Ask students to create their own set of concentration cards that they can take home to play with.

Outcomes to Look for

Much of the assessment for this lesson comes from listening to and watching the children.

- Student participation and engagement
- An understanding of numerals and their corresponding geometric picture representation

Teaching Tip

Modeling

If students haven't played concentration before, the teacher might model the directions for the large group with some sample cards. When modeling how to play, make sure to ask the large group for feedback as to whether the two cards turned over are a match.

Reflection

The questions below are prompts to help you record your ideas, but you can also write additional observations about the lesson that the questions do not cover.

Preparation

- How well did the lesson planning help you prepare for this activity?
- What can you do to feel more prepared?

Student Engagement

- How did you assess student engagement?
- What did you notice about student engagement in the different parts of the lesson?
- How satisfied were you with the level of student engagement?
- If you were not satisfied, how could you change the lesson to increase student involvement?

Academic Enrichment

- How did this lesson support other content areas?
- What changes could you make to strengthen academic enrichment and still keep the activity fun?

Classroom Management

- What strategies did you use to make this activity go smoothly?
- What changes would you make if you taught the lesson again?

Lesson 4

Rational Number Bingo

Teachers continually point to fractions as a stumbling block for students. This game is a fun way to provide practice with this important topic. While playing this game, students gain fluency reducing fractions to their lowest terms and converting common percents and decimals into fraction form. The game is played like a typical bingo game, but participants must make mental conversions of rational numbers before locating the numerical value on their bingo card.

Grade Level(s):

4–8

Duration:

5–10 minutes for one game

Student Goals:

- Reinforce skills with reducing fractions to lowest terms
- Promote fluency with conversion of common decimals and percents to fractions
- Promote strategies for mental mathematics

Curriculum Connection:

Life Skills (thinking and reasoning)

Standards:

These standards and benchmarks are from McREL's online database, Content Knowledge: A Compendium of Content Standards and Benchmarks for K–12 Education (4th edition, 2004; www.mcrel.org/standards-benchmarks). The mathematics portion of the database was developed using National Council of Teachers of Mathematics (NCTM) standards in addition to other nationally recognized standards documents.

Standard 2: Understands and applies basic and advanced properties of the concepts of numbers

Grades 3–5

Benchmark 2: Understands equivalent forms of basic percents, fractions, and decimals and when one form of a number might be more useful than another

Benchmark 5: Understands the relative magnitude and relationships among whole numbers, fractions, decimals, and mixed numbers

Grades 5–8

Benchmark 1: Understands the relationships among equivalent number representations and the advantages and disadvantages of each type of representation

Imagine This!

The afterschool instructor holds up a bingo card and says, "Who wants to play bingo?" Students naturally gravitate toward this fun approach to learning and are eager to join the fun. Students prepare their own bingo cards and listen attentively as the instructor randomly selects the first number card from the container. Students convert the number to its equivalent fraction and race to find the amount on their card. As more cards are selected, the tension builds. Who will be the first to call "Bingo!"?

What You Need

- ❒ A copy of the rational number bingo card for each player (See example from pages 109–110)
- ❒ Equivalent rational number cards individually cut and placed in a container

Getting Ready

- Duplicate a rational number bingo card for each player.
- Cut the equivalent rational number cards into individual pieces and place them in a container.
- Mix the numbers cards well before beginning the game.

Vocabulary

Decimal: relating to the number 10 as a base

Fraction: a part of a whole, formed by dividing one quantity into another

Percent: one part in 100

Rational number: a whole number or the quotient of any whole numbers, excluding zero as a denominator

What to Do

- Tell students that they will be playing a game of bingo.
- Direct students to prepare their own bingo playing card.
- Direct students to prepare something to use as a marker for their bingo card. Since the card will be used multiple times, it is best for students to use bits of paper or manipulative pieces (cubes, counters, etc.) to identify the equivalent fractions on their cards.
- When play begins, select an equivalent rational number card from the container. Read aloud what is on the card and repeat it 2–3 times. Try to maintain a brisk pace to keep students focused as they play the game.
- Explain to players that they must convert the numerical value to its fraction in lowest terms and then find that fraction on their bingo card. If the lowest-term fraction is on the bingo card, the player should cover it with a marker such as a bit of paper. The first person to complete a bingo (vertically, horizontally, or diagonally) wins the round.
- Make sure the cards selected from the container are kept in a separate pile. These cards will be needed to check for accuracy of the bingo.
- When a student calls out "bingo," make sure that all other students maintain their playing cards until accuracy is checked.
- If a player gets a true bingo, that player wins the round. Players should then remove the markers on their cards and prepare for another game of rational number bingo. Small rewards may be provided to winners of each round as appropriate.

Teaching Tip

Players should use mental math strategies to play this game, but if some players have difficulty with the mental math, they can opt to use paper and pencil. Keep players focused by maintaining a brisk pace as the equivalent cards are read. The pace should be appropriate for the level of the learners.

Extend

Use different math concepts for the bingo cards and questions.

Outcomes to Look for

- Increased fluency and confidence with converting fractions to lowest terms
- Increased fluency and confidence with converting common decimals and percents to the equivalent fraction
- Active listening skills

Rational Number Bingo Card

Directions

Each player will make his or her own bingo card by choosing a fraction from the list below and placing it in one square on the bingo card. A fraction may be used only once per card.

$\frac{1}{2}$ $\frac{1}{3}$ $\frac{1}{4}$ $\frac{1}{5}$ $\frac{1}{6}$ $\frac{1}{7}$ $\frac{1}{8}$ $\frac{1}{9}$ $\frac{1}{10}$ $\frac{2}{3}$ $\frac{3}{4}$ $\frac{2}{5}$ $\frac{3}{5}$ $\frac{4}{5}$ $\frac{5}{6}$

$\frac{2}{7}$ $\frac{3}{7}$ $\frac{4}{7}$ $\frac{5}{7}$ $\frac{6}{7}$ $\frac{3}{8}$ $\frac{5}{8}$ $\frac{7}{8}$ $\frac{2}{9}$ $\frac{4}{9}$ $\frac{5}{9}$ $\frac{7}{9}$ $\frac{8}{9}$ $\frac{3}{10}$ $\frac{7}{10}$ $\frac{9}{10}$

Equivalent Rational Number Cards for Bingo

50%	$\frac{4}{12}$	0.25	20%	$\frac{3}{18}$	$\frac{5}{35}$
0.125	$\frac{3}{27}$	10%	$\frac{8}{12}$	75%	0.4
60%	$\frac{12}{15}$	$\frac{10}{12}$	$\frac{8}{28}$	$\frac{9}{21}$	$\frac{8}{14}$
$\frac{25}{35}$	$\frac{18}{21}$	$\frac{27}{72}$	$\frac{10}{16}$	$\frac{28}{32}$	$\frac{6}{27}$
$\frac{12}{27}$	$\frac{15}{27}$	$\frac{28}{36}$	$\frac{16}{18}$	0.3	70%
0.9					

Reflection

The questions below are prompts to help you record your ideas, but you can also write additional observations about the lesson that the questions do not cover.

Preparation

- How well did the lesson planning help you prepare for this activity?
- What can you do to feel more prepared?

Student Engagement

- How did you assess student engagement?
- What did you notice about student engagement in the different parts of the lesson?
- How satisfied were you with the level of student engagement?
- If you were not satisfied, how could you change the lesson to increase student involvement?

Academic Enrichment

- How did this lesson support other content areas?
- What changes could you make to strengthen academic enrichment and still keep the activity fun?

Classroom Management

- What strategies did you use to make this activity go smoothly?
- What changes would you make if you taught the lesson again?

Lesson 5

Who Has?

This game is a fun way to reinforce essential mathematics vocabulary and skills. Students are provided clue cards that make a statement and ask a question. As students answer correctly, the game proceeds in a loop until all clues are read and answered orally. This game moves quickly and can be used whenever a few minutes are available. It is recommended to record the time it takes the group to complete the loop of clues. Students enjoy playing this game over and over and are motivated to beat their previous times.

Grade Level(s):

4–8

Duration:

5–10 minutes

Student Goals:

- Reinforce mathematics vocabulary and skills
- Increase mathematical fluency
- Promote listening skills

Curriculum Connection:

Language Arts

Standards:

These standards and benchmarks are from McREL's online database, Content Knowledge: A Compendium of Content Standards and Benchmarks for K–12 Education (4th edition, 2004; www.mcrel.org/standards-benchmarks). The mathematics portion of the database was developed using National Council of Teachers of Mathematics (NCTM) standards in addition to other nationally recognized standards documents.

The standards addressed would depend on the questions the teacher writes and the grade level of the students. Below are the categories of math standards that could be addressed.

Number and Operations (includes Arithmetic and Number Sense)

Patterns, Relationships, and Algebraic Thinking

Geometry and Spatial Visualization

Measurement

Probability and Statistics

Problem Solving

Reasoning and Proof

Communication

Connections

Imagine This!

The afterschool instructor holds the stopwatch, selects a student to begin, and says, "Go!" The student begins to read his clue, as all other students listen carefully. Students quickly review their clue solutions for the correct response, and the student with that card reads the answer and the next question. Students are eager to keep the pace brisk and work hard to beat their best completion time. When the game is over, you can hear students say, "Can we do this again?" The afterschool instructor smiles and says, "Certainly."

What You Need

- ❒ Clue cards for each student; students can be given multiple cards if needed
- ❒ Stopwatch or clock with a second hand

Getting Ready

Prepare the clue cards before the session. Clue cards should correspond to content that the students are either currently studying in class or have previously studied. Duplicating the clues on cardstock will make them last longer.

Example clues are given below.

I have an acute angle. Who has a triangle with two congruent sides?	**I have an isosceles triangle. Who has a polygon with four sides?**
I have a quadrilateral. Who has an angle that measures more than 90°?	**I have an obtuse angle. Who has a triangle with no congruent sides?**

What to Do

- Explain the rules of the game to students. Distribute one or more clue cards to each student. (Make sure *all* clue cards are distributed.)
- Encourage students to listen carefully as the clues are read so that the group can complete the list of clues as quickly as possible. A stopwatch or analog clock with a secondhand should be used to record the time it takes for students to read and respond to all clues. The rules are as follows:
  - Each player receives one or more clue cards.
  - Players should not review their clue cards until all students receive clues.
  - The instructor designates one student to read his or her clue to begin the game. The instructor begins the stopwatch as the first player begins reading.
  - No player may speak except the one person reading the clue and the person who responds to the clue. Players should not call out hints or the solution to help a student who doesn't realize he or she holds the correct response.
  - Play continues until all clues have been read and answered. When the first player rereads the final response, the instructor should stop the watch and record the group's time.
  - Play may be repeated with students using the same clue cards, or students may exchange cards before playing again.

Teaching Tip

New Vocabulary Terms

If some students are unfamiliar with the vocabulary terms, allow them to work with the clue cards between timed sessions. The students could work to arrange the cards to show clues and correct responses. After students understand this game, you might consider having them make clue cards with new questions (see samples at end of lesson).

Extend

- Different math content can be used for this game.

Outcomes to Look for

- Active listening skills
- Increased use of mathematical vocabulary
- Ability to visualize
- Solving mental math problems

Who Has? Clue Cards

To develop a set of clue cards for the *Who Has* game, it is helpful to list the clues in order as shown below. Clues can be developed for any topic or at any level as long as the student can read and understand the clues.

1. I have perpendicular lines. Who has a six-sided polygon?
2. I have a hexagon. Who has an angle that measures less than 90°?
3. I have an acute angle. Who has a triangle with two congruent sides?
4. I have an isosceles triangle. Who has a polygon with four sides?
5. I have a quadrilateral. Who has an angle that measures more than 90°?
6. I have an obtuse angle. Who has a triangle with no congruent sides?
7. I have a scalene triangle. Who has the product of 20 and 4?
8. I have 80. Who has an eight-sided polygon?
9. I have an octagon. Who has the quotient of 100 and 5?
10. I have 20. Who has a triangle with all sides congruent?
11. I have an equilateral triangle. Who has a polygon with five sides?
12. I have a pentagon. Who has the sum of 55 and 45?
13. I have 100. Who has a pair of lines that do not intersect?
14. I have parallel lines. Who has a pair of lines that intersect at a 90° angle?

Reflection

The questions below are prompts to help you record your ideas, but you can also write additional observations about the lesson that the questions do not cover.

Preparation

- How well did the lesson planning help you prepare for this activity?
- What can you do to feel more prepared?

Student Engagement

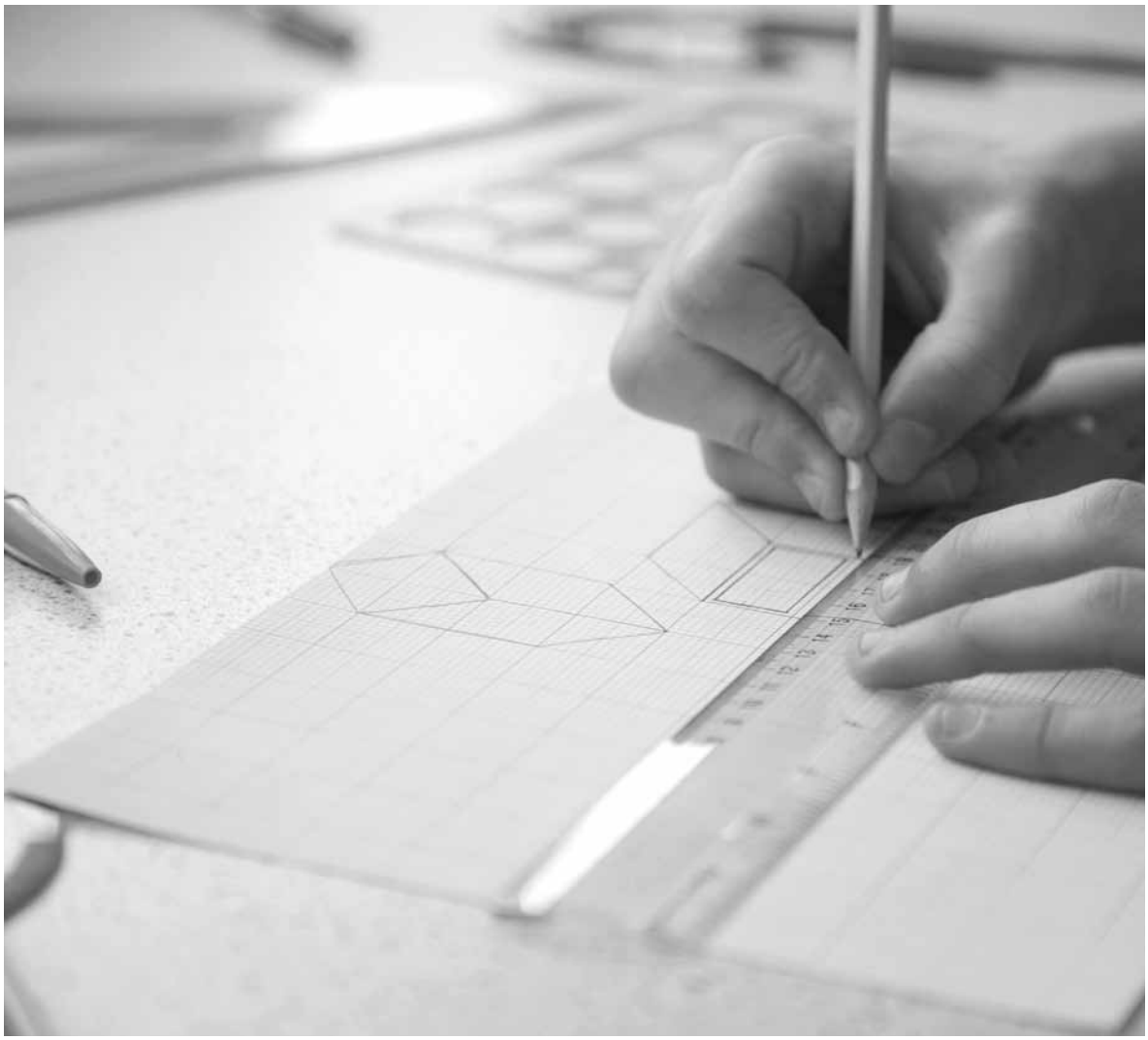
- How did you assess student engagement?
- What did you notice about student engagement in the different parts of the lesson?
- How satisfied were you with the level of student engagement?
- If you were not satisfied, how could you change the lesson to increase student involvement?

Academic Enrichment

- How did this lesson support other content areas?
- What changes could you make to strengthen academic enrichment and still keep the activity fun?

Classroom Management

- What strategies did you use to make this activity go smoothly?
- What changes would you make if you taught the lesson again?



Practice 4

Math Projects

What Is It?

The practice *Math Projects* features experiences that connect mathematical concepts and procedures to engaging real-world activities that extend for more than one lesson. Key to the projects concept is that the mathematics—content and process—emerge from the students' own investigation of an authentic situation, rather than a classroom exercise. This helps students see ties between mathematics and real-life experiences.

What Is the Content Goal?

The specific content goals of *Math Projects* will vary depending on the math involved in the project; but all projects engage students in a given topic, develop problem-solving skills, and increase students' understanding of how to use math in real-world situations.

What Do I Do?

Begin by connecting with the day-school teacher to find out what math concepts, skills, and standards students are studying; and what kinds of activities might lend themselves to math projects. For example, building and racing model cars can extend what students are learning about measurement, geometry, and algebra. Or, combine math and science activities by working on an interdisciplinary project that requires data collection and analysis related to the environment.

Work with students to choose an idea or project that interests them. Then, discuss the project, identify what students will do, make a project plan and time line, identify resources you will need, and finally conduct the project. Projects work best when students can work on them in a regular, ongoing way as some projects can take several days. You will also want to determine how your students will present and evaluate their projects. A culminating activity, such as a final product or presentation, is a typical way to wrap up a math project.

Why Does It Work?

Project-based learning in math works because students are directly involved in their own learning as they develop problem-solving skills, learn new math content, and apply what they learn in authentic, real-world situations. Through project work, students develop a need to learn new mathematical content and applications. They also experience the connections between the math they have learned in school and real-world situations, and gain skill in transferring and applying this knowledge.

Getting Started

video

Go to the *Investigating Science Through Inquiry* practice found in the science section of the Afterschool Training Toolkit (www.sedl.org/afterschool/toolkits/science/pr_investigating.html). Click on the "Exploring Trebuchets" video and watch as first- through sixth-graders at the Brighton-Allston Afterschool Enrichment Program (BASE) in Boston, Massachusetts, work on a project creating trebuchets (catapults). You will see math skills being used throughout the project.

Use the before, during, and after writing prompts to write down your ideas on how you might involve your students in math projects.

BEFORE YOU WATCH THE VIDEO, write down what you already know about students using math projects.

DURING THE VIDEO, consider the following:

How does the instructor work with the students to lay the groundwork for the activity and get them started?

How does the instructor interact with the kids? What does he or she do to keep them engaged?

What academic skills, like reading or math, are students reinforcing while they participate in the activity? Be sure to give specific examples.

AFTER YOU WATCH THE VIDEO, write what modifications you might need to make to teach this lesson in your own class.

Lesson 1

Digital Math Storytelling

In this project, students create original math stories that include text, drawings, photos, animation, audio, and video. They use math and technology tools, such as digital cameras, computers, and manipulatives, to bring their math stories to life.

Grade Level(s):

3–8

Duration:

Several sessions over 2 to 3 weeks

Student Goals:

- Enhance communication skills by asking questions, expressing opinions, constructing math narratives, and writing for an audience
- Increase collaboration skills in a group project
- Use math to tell a story
- Apply existing math knowledge to generate new ideas, products, or processes

Curriculum Connection:

Technology, Language Arts

Standards:

These standards and benchmarks are from McREL's online database, Content Knowledge: A Compendium of Content Standards and Benchmarks for K–12 Education (4th edition, 2004; www.mcrel.org/standards-benchmarks). The mathematics portion of the database was developed using National Council of Teachers of Mathematics (NCTM) standards in addition to other nationally recognized standards documents.

The standards addressed would depend on the questions the teacher writes and the grade level of the students. Below are the categories of math standards that could be addressed.

Number and Operations (includes Arithmetic and Number Sense)

Patterns, Relationships, and Algebraic Thinking

Geometry and Spatial Visualization

Measurement

Probability and Statistics

Problem Solving

Reasoning and Proof

Communication

Connections

Imagine This!

An afterschool instructor gathers a class of 20 students to work on a digital math project, called "The Story of Math." Students get to work in small groups finding, creating, and digitizing the stories of math in their everyday lives. They take photographs with digital cameras, learn to use scanners to incorporate original math artwork, or even add music, narration, and video to their stories.

What You Need

Choose the technology tools that are appropriate for the skill level of your students. The supplies are the same for each session. Following are some basic recommendations:

- ❒ One computer for every 2–3 students
- ❒ Word processing software and presentation software such as PowerPoint
- ❒ Digital cameras
- ❒ Tool for voice recording (most computers have this feature)
- ❒ Sticky notes or index cards and poster paper to use for creating the storyboards
- ❒ Internet access for instructor and student computers (optional)
- ❒ Electronic projector for instructor computer (optional)
- ❒ Microphones (optional)
- ❒ Scanners (optional)

Getting Ready

Instructors should determine students' computer skill levels and select appropriate technology tools. Instructors should also have familiarity with multimedia software applications and equipment or enlist the help of a volunteer who does.

- Become familiar with the digital storytelling process by completing an online tutorial. Visit the *Developing Self-Expression and Creativity* practice of the technology section of the Afterschool Training Toolkit, and click on the Resources tab (www.sedl.org/afterschool/toolkits/technology/pr_developing.html).
- Consult with day-school teachers to see if digital math storytelling might enrich learning with a math concept being studied currently in class.
- Arrange for volunteers to assist students.

What to Do

Suggestions for breaking this lesson into sessions are provided, but feel free to change the sessions as needed.

Session 1

- Introduce students to digital storytelling by showing them some of the digital stories from the Resources section by projecting them on a screen for all to see and discuss. Note that stories have a beginning, middle, and end. At this point you can begin to develop a rubric with the students for their projects.
- Brainstorm some math story ideas.
  Examples:
  - Take a geometry walk around the classroom and show and tell what you found.
  - Math is all around the school. Where? Split up in groups and find out.
  - Explain to others a concept like adding fractions using real-life examples.
  - Portray math problems using various strategies.
  - When do you use math in your personal life?
- After completing this brainstorming session, discuss what story the group wants to tell. Constructing a story as a group about a math topic will help students learn both the math process and the software needed to develop a digital story. This activity can be completed as a whole-class group or small, three-person group. If this is the first time your class has created a story, a whole-class group effort may be easier to manage.

Sessions 2 and 3

- Draft a story (on paper) based on the chosen idea. (This can happen either in a whole-class group or in small, three-person groups.)
- Remind the class that they may make changes to the draft at any time. For younger students in particular, review basic storytelling concepts, such as a story has a beginning, middle, and end; or a story has a title and authors.
- As you guide your students through the storytelling process, use the seven main elements of digital storytelling, created by Joe Lambert, cofounder of the Center for Digital Storytelling.
- Remember that the math story—not the technology—should drive this project. Although audio and visual media may enhance certain aspects of a story, students should focus on how best to communicate what's at the core of their math story.
- With the whole-class group or the three-person groups, different students can develop different parts of the story. Also, if this project is your students' first experience with digital storytelling, keep the story short—no more than 3 minutes in length.
- This would be a good time to look at the rubric again and revise it if necessary.

Session 4

- Introduce students to storyboarding.
- Hand out small, colored sticky notes and sheets of paper with blank story boards, which are rows of empty boxes resembling an empty cartoon strip. Show students how to tell their math story frame by frame by discussing the pictures through which—and the sequence in which—they will tell their math story.
- After students have determined the text and picture sequence, discuss transitions, visual effects (if any), and soundtracks. Always keep in mind the skill level of your students when planning ways to represent their ideas.

Sessions 5–9

- Help students prepare their final draft.
  - For a whole-class group project, break students into small groups, based on their ages and skill levels. Ask each small group to develop one or two pieces of the storyboard. One group will be in charge of assembling the pieces into one story using PowerPoint or another software application. For the three-person group projects, students can assign each other different tasks within their group project.
  - If the group wishes to record narration, ask them to divide the story so that everyone gets to read. Before recording, demonstrate how to narrate effectively. Discuss differences between using emotion and no emotion in your speech, and what effect quick or slow speech has on the story. Students need to practice narration before recording.
  - With the three-person groups, view their stories and use the rubric to help them assess how they did.
- Have each group share its project with other students.
- You might consider having the groups assess each other's project using the rubric.
- These would be excellent projects to share at a family math night.

Session 10

- For the whole-class project, use the rubric to assess the project help students understand what they need to do next time in small-group projects. They will want to do this again!
- Discuss the value of collaboration in creating a digital math story.
- Have each student relate to a partner the special contribution he or she made to the project and why it was important. Discuss as a group what students learned about digital math storytelling.

Outcomes to Look for

- Student participation and engagement
- An understanding that media can help make math learning far more than just problems in a book
- Demonstration of math knowledge

Reflection

The questions below are prompts to help you record your ideas, but you can also write additional observations about the lesson that the questions do not cover.

Preparation

- How well did the lesson planning help you prepare for this activity?
- What can you do to feel more prepared?

Student Engagement

- How did you assess student engagement?
- What did you notice about student engagement in the different parts of the lesson?
- How satisfied were you with the level of student engagement?
- If you were not satisfied, how could you change the lesson to increase student involvement?

Academic Enrichment

- How did this lesson support other content areas?
- What changes could you make to strengthen academic enrichment and still keep the activity fun?

Classroom Management

- What strategies did you use to make this activity go smoothly?
- What changes would you make if you taught the lesson again?

Lesson 2

Stock Market Game

Students conduct research to determine stocks that they would like to include in a financial portfolio. Using a hypothetical budget of $100,000, students track stocks over 4 weeks and devise a financial report to share with the other class investors.

Grade Level(s):

6–8

Duration:

4 weeks

Student Goals:

- Understand the basics of how stocks are bought and sold
- Use mathematical skills to track and compute changes in the value of stocks over a 4-week period of time
- Devise a financial report and present findings to other class investors

Curriculum Connection:

Social Studies

Standards:

These standards and benchmarks are from McREL's online database, Content Knowledge: A Compendium of Content Standards and Benchmarks for K–12 Education (4th edition, 2004; www.mcrel.org/standards-benchmarks). The mathematics portion of the database was developed using National Council of Teachers of Mathematics (NCTM) standards in addition to other nationally recognized standards documents.

Standard 3: Uses basic and advanced procedures while performing the processes of computation

Grades 6–8

Benchmark 6: Uses proportional reasoning to solve mathematical and real-world problems

Standard 9: Understands the general nature and uses of mathematics

Grades 6–8

Benchmark 2: Understands that mathematicians often represent real things using abstract ideas like numbers or lines; they then work with these abstractions to learn about the things they represent

Imagine This!

An afterschool instructor engages a group of secondary students by posing the following scenario. Suppose you had $100,000 to invest in the stock market. Do you think that your decisions would cause your financial portfolio to increase in value? Or would your decisions result in financial losses? During the next 4 weeks you will have the opportunity to invest a hypothetical $100,000 in the stocks of your choice. During the investing time frame, you will keep weekly records indicating the percent of change (positive or negative) in the value of each of your stocks. At the end of the time period, you will share your financial portfolio with the other investors in this class and reflect on the decisions that you made.

What You Need

- ❒ Information to help students research stocks—newspapers, periodicals, company research reports, access to the Internet (if available)
- ❒ Financial portfolio worksheet
- ❒ Graph Paper
- ❒ Pencils
- ❒ Calculators (optional)

Getting Ready

- Collect newspapers, periodicals, and company financial reports to help students research companies and stocks.
- Gain access to the Internet, if possible, for student research.
- Make arrangements to have copies of a current newspaper available each day during the 4-week game.
- Review the history of stocks and general information about how stock markets function. Teacher support can be found at the official Stock Market Game Web site under Teacher Support Center (http://smgww.org/).
- Make copies of the financial portfolio worksheet.

What to Do

- Introduce the stock market game to students by using the questions described in the "Imagine This!" part of the lesson. Tell students that they will be tracking the stocks from companies of their choosing to see which student-investor team has the greatest gain in stock value during the next 4 weeks.
- Group students in teams of 2 to 3.
- Start with an introduction to the basics of the stock market.
- Help students understand how to locate a stock in the newspaper and report its value.
- Provide time for students to research stocks and decide which ones to track. Students may purchase stocks from 5 to 10 companies. Students should identify why they decided to select a certain stock. (For example, I will track the Tasty Ice Cream Company because it's getting warm and more people will be buying ice cream.)
- At the end of each week, have a group discussion about gains and losses and other observations related to the stock market. Students should complete the financial portfolio worksheet and graph the percent of change each week.
- At the end of the 4 weeks students should report their results to the larger group. Results will show which teams had the greatest gains and losses.
- Ask students to reflect on the stock market game experience. Did they have surprises along the way? What did they learn from this experience?

Teaching Tip

Stock Information

It's important for students to know why companies issue stock. Companies issue shares of stock to raise money (financial capital) for starting or expanding business operations. The Web site, Wally's Stock Ticker (www.prongo.com/stock/index.pl), gives daily stock information in student-friendly terms.

Outcomes to Look for

- A better understanding about how the skills learned in math class can be used beyond the classroom
- A better understanding of how companies gain the funds needed to grow and do business
- Decision-making
- Teamwork

Vocabulary

Bear market: a nickname for a market where stocks fall consistently over a period of time

Bull market: a nickname for a market where stocks rise consistently over a period of time

Earnings: net income for a company during a certain time frame

Portfolio: a collection of investments

Shares: units (certificates or book entries) representing ownership in a corporation

Stock: ownership in a company as issued in shares

Stock market: an organized marketplace where shares of stock are bought and sold; an example is the New York Stock Exchange

Reflection

The questions below are prompts to help you record your ideas, but you can also write additional observations about the lesson that the questions do not cover.

Preparation

- How well did the lesson planning help you prepare for this activity?
- What can you do to feel more prepared?

Student Engagement

- How did you assess student engagement?
- What did you notice about student engagement in the different parts of the lesson?
- How satisfied were you with the level of student engagement?
- If you were not satisfied, how could you change the lesson to increase student involvement?

Academic Enrichment

- How did this lesson support other content areas?
- What changes could you make to strengthen academic enrichment and still keep the activity fun?

Classroom Management

- What strategies did you use to make this activity go smoothly?
- What changes would you make if you taught the lesson again?

Lesson 3

Learning Math and Art With Quilts

In this project, students will learn about geometric shapes, patterns, and measurement by making paper quilts. Each small group will create square, rectangle, triangle, and circle quilt blocks by using measuring, color combinations, and piecing skills. Students will conclude the project by putting all the blocks together to make a large paper quilt.

Grade Level(s):

K–2

Duration:

Seven 45-minute sessions

Student Goals:

- Learn the concept of patterns
- Learn basic geometric patterns
- Learn what shapes are formed when divided (for example, a square becomes two triangles or two rectangles)
- Learn basic measuring skills
- Increase fine-motor cutting skills
- Increase collaboration and decision-making skills
- Learn colors and color combinations

Curriculum Connection:

The Arts, Language Arts

Standards:

These standards and benchmarks are from McREL's online database, Content Knowledge: A Compendium of Content Standards and Benchmarks for K–12 Education (4th edition, 2004; www.mcrel.org/standards-benchmarks). The mathematics portion of the database was developed using National Council of Teachers of Mathematics (NCTM) standards in addition to other nationally recognized standards documents.

Standard 4: Understands and applies basic and advanced properties of the concepts of measurement

Grades K–2

Benchmark 1: Understands the basic measures length, width, height, weight, and temperature

Standard 5: Understands and applies basic and advanced properties of the concepts of geometry

Grades K–2

Benchmark 1: Understands basic properties of and similarities and differences between simple geometric shapes

Benchmark 2: Understands the common language of spatial sense

Benchmark 3: Understands that geometric shapes are useful for representing and describing real-world situations

Benchmark 4: Understands that patterns can be made by putting different shapes together or taking them apart

Standard 9: Understands and applies basic and advanced properties of functions and algebra

Grades K–2

Benchmark 1. Recognizes regularities in a variety of contexts (e.g., events, designs, shapes, sets of numbers)

Benchmark 2. Extends simple patterns (e.g., of numbers, physical objects, geometric shapes)

Imagine This!

Your room is filled with children making square shapes of paper quilt blocks. The small groups of students are fully engaged in measuring, cutting, and piecing their colorful shapes into their own individual quilt blocks to contribute to the final culminating product—one large group quilt! Excitement permeates the room on the big day when they make their group quilt! The groups of students take their group quilts on a quilt march to the other afterschool classes to show them their beautiful products. The group quilts are displayed in the building later that day. Families attend a family night where the quilts are on display.

What You Need

See individual sessions for other supplies needed.

❒ Quilting patterns from the Internet

❒ Children's books:

- *The Patchwork Quilt* by Valerie Flournoy. Pictures by Jerry Pinkney. (New York: Dial Books for Young Readers, 1985)
- *Amina's Blanket* by Helen Dunmore. Illustrated by Paul Dainton. (New York: Crabtree Publishers, 2003)
- *The Keeping Quilt* by Patricia Polacco. (New York: Simon & Schuster Books for Young Readers, 1998)
- *The Quilt Story* by Tony Johnston. Pictures by Tomie dePaola. (New York: Putnam, 1985)
- *The Boy and the Quilt* by Shirley Kurtz. Illustrated by Cheryl Benner. (Intercourse, PA: Good Books, 1991)
- *The Mountains of Quilt* by Nancy Willard and Tomie dePaola. Pictures by Tomie dePaola. (San Diego: Harcourt Brace Jovanovich, 1987)
- *The Quiltmaker's Gift* by Jeff Brumbeau. Pictures by Gail de Marcken. (Duluth, MN: Pfeifer-Hamilton Publishers, 2000)
- *Sweet Clara and the Freedom Quilt* by Deborah Hopkinson. Illustrated by James Ransome. (New York: Knopf, 1993)

Vocabulary

Circle: a two-dimensional geometric figure formed of a curved line surrounding a center point, every point of the line being an equal distance from the center point

Circumference: the distance around a circle

Diagonal: a line that joins two points on a polygon but is not a side

Diameter: a line or chord through the center of a circle

Equal: the same amount

Line segment: part of a line; has a beginning and an end

Measure: the size or extent of something

Pattern: a repeated design

Quilt: a bedcover made of two layers of fabric stitched together with padding held in place by decorative intersecting seams

Radius: a line segment extending from the center of a circle to its edge

Rectangle: figure with four sides and four right angles

Reverse pattern: opposite pattern

Square: a geometric figure with four right angles and four equal sides

Symmetry: correspondence in size and shape of parts on opposite sides of dividing lines

Triangle: a two-dimensional geometric figure formed of three sides and three angles

Session 1: Using Square Patterns

What You Need

- ❒ Ruler for each student
- ❒ Scissors for each student
- ❒ Enough dark blue and light blue sheets of paper so that each student can have five 3 x 3 inch squares of each color
- ❒ Sample of pattern designs with two colors of 3 x 3 inch squares
- ❒ One sheet of white paper for each student
- ❒ Glue for each student

Getting Ready

- Have materials (ruler, scissors, paper, and glue) ready for each student.
- Cut 3 x 3 inch dark and light blue squares so each student has five of both colors.
- Cut a 36 x 36 inch square for each group.
- Have 9 x 9 samples of various square pattern combinations.
- Engage another adult or older student to assist you.

What to Do

- Read a book about quilts to the students. (See the list in "What You Need.")
- Talk to students about quilts. Show quilt samples or pictures of quilts.
- Talk to students about squares and patterns. Show them sample square patterns.
- Discuss the properties of a square.
- Divide students into groups of four based on who will work well together.
- Go over directions and behavior expectations for use of glue, scissors, collaboration, etc.
- Review how to measure objects. Have students measure one of the small squares to ensure they know how to measure 3 x 3 inches.
- Demonstrate how to measure a piece of paper to create a 9 x 9 inch square. Show students how to mark the 9 inches at the top and bottom and use their rulers to draw a line across their paper to create a 9-inch square. Have students measure and cut their paper into a 9 x 9 inch square. Rotate among students as they measure and cut their square. (Accuracy is important.)
- Have each student select five dark blue and five light blue, precut, 3 x 3 inch squares. (The students will not use one of the squares.)
- Have students design their own 9 x 9 inch square patterns and glue their patterns onto their 9 x 9 inch squares.
- Have each group combine its square patterns to make a 36 x 36 inch quilt square.
- Ask groups to share and talk about their quilt squares with the other groups.
- Mark the names of each group member on the back of the large square and collect the quilt squares to save for the culminating event.

Session 2: Using Triangle Patterns

What You Need

- ❒ Ruler for each student
- ❒ Scissors for each student
- ❒ Enough dark green and light green sheets of paper so that each student can make five 3 x 3 inch squares of each color
- ❒ Sample of triangle symmetry designs with two colors in a 9 x 9 inch quilt squares
- ❒ One sheet of white paper for each student
- ❒ Glue for each student

Getting Ready

- Have materials (ruler, scissors, paper, and glue) ready for each student.
- Cut 3 x 3 inch dark green and light green squares so each student has five of both colors. (Make extras in case students mess up when cutting the triangles).
- Cut a 36 x 36 inch square for each group.
- Have 9 x 9 inch samples of various symmetrical triangle combinations.

What to Do

- Read another book about quilts (optional).
- Discuss what students learned about making their square quilts in the previous session. Review the vocabulary from the beginning of the lesson.
- Model for the students how to make two triangles from a square. Show them sample triangle patterns.
- Discuss the properties of a triangle.
- Divide students into the same groups of four from the previous session.
- Go over directions and review behavior expectations for use of glue, scissors, and collaboration.
- Review how to measure objects. Have students measure one of the small squares to ensure they know how to measure 3 x 3 inches.
- Demonstrate and review how to measure a paper to create a 9 x 9 inch square. (Accuracy is important.)
- Have each child select five dark green and five light green 3 x 3 inch squares. (They will not use one of the squares.)
- Demonstrate for the students how to draw a diagonal line on a square to make two triangles. Circulate among the students as they draw and cut their squares into triangles. (Accuracy is important.)
- Have students design their own 9 x 9 inch symmetrical triangle patterns and glue their patterns onto their 9 x 9 inch squares.
- Have each group combine its triangle patterns to make a 36 x 36 inch quilt square.
- Ask groups to share and talk about their quilt squares with the other groups.
- Mark the names of each group member on the back of the large square and collect the quilt squares to save for the culminating event.

Session 3: Using Rectangle Patterns

What You Need

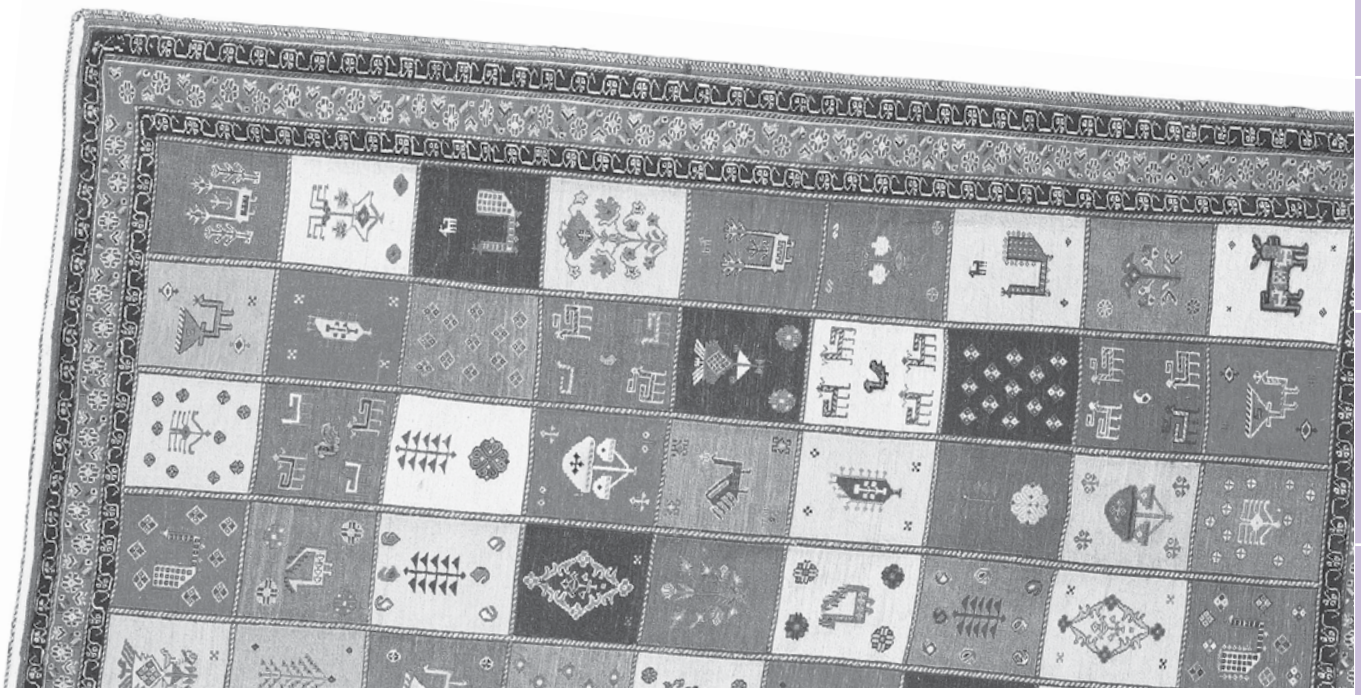
- ❒ Ruler for each student
- ❒ Scissors for each student
- ❒ Enough dark purple and light violet sheets of paper so that each student can make five 3 x 3 inch squares of each color
- ❒ Sample of rectangle designs with two colors in a 9 x 9 inch quilt square
- ❒ One sheet of white paper for each student
- ❒ Glue for each student

Getting Ready

- Have materials (ruler, scissors, paper, and glue) ready for each student.
- Cut 3 x 3 inch dark purple and light violet squares so each student has five of both colors.
- Cut a 36 x 36 inch square for each group.
- Have 9 x 9 inch samples of various equal rectangle pattern combinations.

What to Do

- Read another book about quilts (optional).
- Discuss what students learned about making their triangle quilts in the previous session.
- Review the vocabulary from the previous session.
- Model for students how to make two rectangles from a square. Show them sample rectangle patterns.
- Discuss the properties of a rectangle.
- Divide students into the same groups of four from the previous session.



- Go over directions and review behavior expectations for collaboration.
- Review how to measure objects. Have students measure one of the small squares to ensure it measures 3 x 3 inches.
- Demonstrate and review how to measure a paper to create a 9 x 9 inch square. (Accuracy is important.)
- Have each child select five dark purple and five light violet 3 x 3 inch squares. (They will not use one of the squares.)
- Demonstrate how to fold the square to make two equal rectangles. Circulate among students as they draw and cut their squares into equal rectangles. (Accuracy is important.)
- Have students design their own 9 x 9 inch rectangle pattern and glue their patterns onto their 9 x 9 inch squares.
- Have each group combine its triangle patterns to make a 36 x 36 inch quilt square.
- Ask groups to share and talk about their quilt squares with the other groups.
- Mark the names of each group member on the back of the large square and collect the quilt squares to save for the culminating event.

Session 4: Using Circle Patterns

What You Need

❒ Ruler for each student

❒ Scissors for each student

❒ Enough yellow and orange sheets of paper so that each student can have five 3 x 3 inch squares of each color

❒ Enough yellow and orange sheets of paper so that each student can have five circles with a 3-inch diameter

❒ Sample of circle designs with two colors in a 9 x 9 inch quilt square alternating the color of background and circle

❒ One sheet of white paper for each student

❒ Glue for each student

Getting Ready

- Have materials (ruler, scissors, paper, and glue) ready for each student.
- Cut yellow and orange squares and circles so each student has five yellow and orange squares and five yellow and orange circles.
- Cut a 36 x 36 inch square for each group.
- Have 9 x 9 inch samples of circle pattern combinations that reverse the yellow and orange background and circles.

What to Do

- Read another book about quilts (optional).
- Discuss what the students learned about making their rectangle quilts in the previous session.
- Review the vocabulary from the previous session.
- Discuss the vocabulary words for a circle.
- Model for students how to make a pattern by reversing the background and circle. Show them sample reversed circle background patterns.
- Divide students into the same groups from the previous session.
- Go over directions and review behavior expectations for collaboration.
- Review how to measure objects. Have students measure one of the small squares to ensure it measures 3 x 3 inches.
- Demonstrate and review how to measure a paper to create a 9 x 9 inch square. (Accuracy is important.)
- Have each student select five orange and five yellow circles. (They will not use one of the circles.)
- Have each student select five orange and five yellow squares. (They will not use one of the squares.)
- Have students design their own 9 x 9 inch reversed circle pattern and glue their pattern onto their 9 x 9 inch square.
- Have each group combine its circle patterns to make a 36 x 36 inch quilt square.
- Ask groups to share and talk about their quilt squares with the other groups.
- Mark the names of each group member on the back of the large square and collect the quilt squares to save for the culminating event.

Teaching Tip

Session Preparation

Review directions and behavior expectations before having groups start their work. Have materials on the tables and posted when the students enter the room. Post a chart of the vocabulary words with a picture depicting each word. Explicitly demonstrate each step in each session. Review with students how they will conduct themselves on the quilt march.

Session 5: Going on a Quilt March

What You Need

❒ The quilt pieces that each group has made

❒ A paper (card stock or cardboard) that is 4-feet square for each group

❒ Glue for each group

❒ Various small cracker snacks

❒ Glue

Getting Ready

- Have materials (paper, glue, quilt pieces) ready for each group
- Cut a 4-foot square for each group

What to Do

- Read a culminating book about quilts to the students.
- Review the vocabulary words from the previous sessions and the properties of all the shapes.
- Divide students into the groups from the previous sessions.
- Go over directions and behavior expectations for collaboration.
- Hand out each group's quilt pieces and the 4-foot-square paper.
- Have each group collaboratively arrange its group square, triangle, rectangle, and circle patterns to make its final 4-foot-square quilt.
- Ask groups to share and talk about their quilt with the other groups.
- Lead groups on a quilt march, during which students share their quilts with the older students in other classes.
- Display the quilts throughout the building.

Extend

- Develop combined quilting designs.
- Use tiles to make patterns.
- Use grid paper to design patterns.
- Introduce tessellations.

Outcomes to Look for

- Students discussing and making geometric patterns with colors
- Students knowing how to make different smaller shapes from one large shape
- Students measuring lengths and widths properly
- Students using scissors properly
- Collaboration among students

Reflection

The questions below are prompts to help you record your ideas, but you can also write additional observations about the lesson that the questions do not cover.

Preparation

- How well did the lesson planning help you prepare for this activity?
- What can you do to feel more prepared?

Student Engagement

- How did you assess student engagement?
- What did you notice about student engagement in the different parts of the lesson?
- How satisfied were you with the level of student engagement?
- If you were not satisfied, how could you change the lesson to increase student involvement?

Academic Enrichment

- How did this lesson support other content areas?
- What changes could you make to strengthen academic enrichment and still keep the activity fun?

Classroom Management

- What strategies did you use to make this activity go smoothly?
- What changes would you make if you taught the lesson again?

Lesson 4

Scale

In this lesson students learn to draw to scale a perimeter of a room. They will use various measuring tools, including an architect's scale or ruler. To draw a room to scale, students will have to use fractions and ratios to reduce large space measurements down to a drawing that can be put on a piece of paper.

Grade Level(s):

6–8

Duration:

1–2 weeks (ten sessions of 45–60 minutes)

Student Goals:

- Understand the basic elements of measuring the perimeter of a space
- Learn how to use an architect's scale or ruler
- Convert large measurements into scaled measurements
- Work cooperatively
- Understand scale drawing

Curriculum Connection:

The Arts

Standards:

These standards and benchmarks are from McREL's online database, Content Knowledge: A Compendium of Content Standards and Benchmarks for K–12 Education (4th edition, 2004; www.mcrel.org/standards-benchmarks). The mathematics portion of the database was developed using National Council of Teachers of Mathematics (NCTM) standards in addition to other nationally recognized standards documents.

Standard 4: Understands and applies basic and advanced properties of the concepts of measurement

Grades 6–8

Benchmark 4: Solves problems involving units of measurement and converts answers to a larger or smaller unit within the same system

Imagine This!

The rooms in your school are covered with beautiful scale drawings! Students sketch your classroom—all of the doors, windows, closets, and even the furniture along the walls. Then you bring out tape measures as students work in pairs to measure the actual things in their drawings. On their sketches students write the exact measurements of each item. Now, how do they convert those measurements into much smaller ones and stay accurate to scale? They use a new tool—the architect's scale—to create scale drawings of their classroom. Once students understand how to make scale drawings, they're ready to make a drawing completely on their own of another room in the school—the library, the cafeteria, the office, and so on. The students can choose the room.

What You Need

The supplies are the same for each session.

❒ Pencils with erasers

❒ Colored pencils (optional)

❒ Tape measures

❒ Rulers

❒ Architects' scales (a three-sided ruler)

❒ Graph paper

❒ 11 x 17 inch paper

Getting Ready

- Purchase architects' scales for your classroom.
- Sketch the room on plain paper so you can use it as a model. Don't put measurements on this sketch.
- Copy your sketch and now measure the room and put your measurements on the copied sketch for later use.
- Practice using the architects' scale to convert a large measurement to a smaller, scaled measurement. Convert one of your actual room measurements into a scaled measurement.
- Once you get the hang of it, sketch your final drawing using the scaled measurements.
- Ryerson University has a good example for you to look at before you begin doing your own (http://www.ryerson.ca/arch/Gallery%202007/gallery.html)

Session 1: Sketching Shapes

What to Do

- Have students notice the perimeter of the room. Where are the windows, doors, closets, and furniture against the wall? Where are the outlets?
- Where is north, south, east, and west?
- As a group, have students guesstimate the room's dimensions.
- Have each student sketch on plain paper the room with all the items mentioned above. Have students check each other's sketches to see if they have included everything. Some students may have to start again to be sure to include all the items mentioned.

Session 2: Creating Scaled Measurements

What to Do

- Have students work in pairs to measure the perimeter of the room—the walls, windows, closets, bookshelves, and so on. As they obtain a dimension, they should write it on their sketch of that item.
- Have the students begin converting their large measurements into scaled measurements.
- Check students' math before they move on to making their final drawing.

3/32" = 1' (1:128 scale)
3/16" = 1' (1:64 scale)
1/8" = 1' (1:96 scale)
1/4" = 1' (1:48 scale)
1/2" = 1' (1:24 scale)
3/4" = 1' (1:16 scale)
1" = 1' (1:12 scale)
1 3/8" = 1' (1:8.7 scale)
1 1/2" = 1' (1:8 scale)
and 3" = 1' (1:4 scale)

Session 3: Drawing to Scale

What to Do

- Have students finish their math calculations.
- Have students work independently and begin their scale drawings of the classroom. They can use graph paper or plain paper. They should use pencil first; and, later, when they are sure they have everything correct, they can use colored pencils or pens to go over the drawing.

Session 4: Sharing Sketches

What to Do

- Have students finish their drawings. Remind them to include north, south, east, west, and outlets.
- Post all the sketches and have students walk around comparing the drawings. If you want to use a rubric and have students assess each other, a sample is at the end of the lesson.
- Ask students to reflect on what they learned in this first scale drawing. Students may discuss their observations in groups or write them down individually.

Session 5: Expanding the Design

What to Do

- Lead students on a walk around the school to look at rooms—with scale drawings in mind! Ask students to look for interesting challenges and what things might make a drawing easy or difficult.
- Have each student choose a room at the end of the walk.

Sessions 6–9: Moving Beyond the Classroom

What to Do

- Before students work independently sketching a room in the school, be sure to get approval from other adults and be sure to go over behavior expectations for independent work. Set a time for all students to be back in your classroom.
- Have students sketch their chosen room.
- Have students measure their room, calculate the scaled dimensions, and create their scale drawing.

Session 10: Examining the Sketches

What to Do

- Lead a gallery walk of the students' first sketch with measurements, their math calculations, and their final scale drawings.
- Have students use the rubric to assess each other's drawings. You can designate who will assess which drawings so that there is time for all the drawings to be assessed by someone.

Extend

- Show off the scaled drawings project at a family night.
- Go a step further with the measurements and have students measure a complete wall and figure out how much paint they would need to paint it.

Outcomes to Look for

- Cooperative and independent learning
- Students' abilities to convert large measurements into smaller measurements
- Finished products
- Peer review of finished products

Sample Rubric for Scale Drawing

4	3	2	1
The drawing is nearly perfect to scale.	The drawing is close to scale.	The drawing considers scale.	The drawing shows little use of scale.
The labels meet professional standards.	The labels are near professional.	The labels show minimum standards.	The labels do not meet standards.

Checklist

❒ Measurements on the scale chart are accurate and complete.

❒ Scale is included on right-hand lower corner of the finished drawing.

❒ All dimensions are labeled.

Reflection

The questions below are prompts to help you record your ideas, but you can also write additional observations about the lesson that the questions do not cover.

Preparation

- How well did the lesson planning help you prepare for this activity?
- What can you do to feel more prepared?

Student Engagement

- How did you assess student engagement?
- What did you notice about student engagement in the different parts of the lesson?
- How satisfied were you with the level of student engagement?
- If you were not satisfied, how could you change the lesson to increase student involvement?

Academic Enrichment

- How did this lesson support other content areas?
- What changes could you make to strengthen academic enrichment and still keep the activity fun?

Classroom Management

- What strategies did you use to make this activity go smoothly?
- What changes would you make if you taught the lesson again?

Practice 5

Math Tools

What Is It?

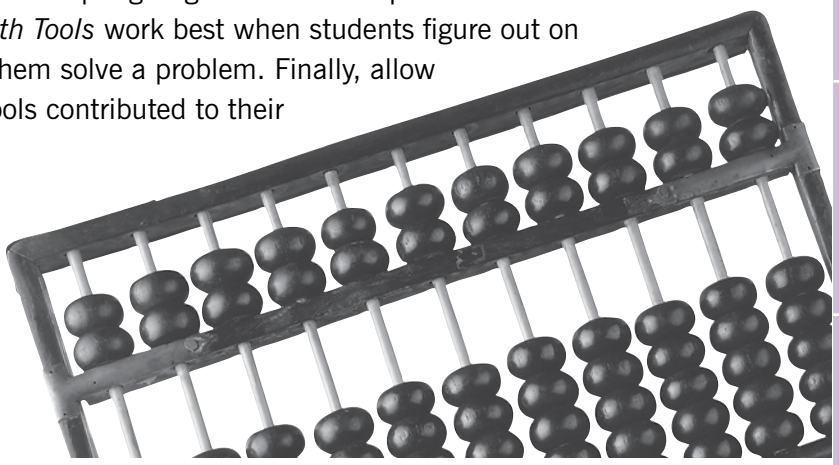
The practice *Math Tools* includes pictures, rulers, symbols, technology, and concrete materials such as beans, blocks, or other manipulatives that allow students to problem solve. *Math Tools* can help students measure, count, sort, and evaluate math problems.

What Is the Content Goal?

A central goal of *Math Tools* is to help students learn to use tools and objects to problem solve and enhance their understanding of targeted math concepts and skills. Specific content will vary depending on the lesson, learning goals, and connection to the day-school learning.

What Do I Do?

Begin by talking to the day-school teacher. Find out what concepts and skills students are learning, and how tools can enhance their learning. Develop activities that students will enjoy, where they can play with different objects and learn to use tools to problem solve. Provide an assortment of tools to tap students' interest and help them see a variety of approaches to problem solving. Make connections between the tools and the corresponding mathematical idea you want students to learn. It is tempting to get out the manipulatives and show students how to use them, but *Math Tools* work best when students figure out on their own how the tools can help them solve a problem. Finally, allow students to discuss how specific tools contributed to their thinking about mathematics.



Why Does It Work?

When tools are used productively to teach and learn mathematics, students see connections among objects, symbols, language, and ideas. Students who are provided with mathematical tools use them to explore concepts and to build mathematical understanding.

Additionally, tools help students think flexibly about mathematics, use creativity to solve new mathematics problems, and explore mathematics with less anxiety. Because the nature of afterschool is active and social, afterschool settings are ideal for allowing students to explore, test, build, think, talk, connect, and reason with mathematical tools.

Getting Started

video

Go to the *Finding and Solving Problems* practice found in the technology section of the Afterschool Training Toolkit (www.sedl.org/afterschool/toolkits/technology/pr_finding_solving.html). Click on the "Hide and Seek with Geocaching" video. Middle school students are working with a new tool that will help them with longitude and latitude measurements.

Use the before, during, and after writing prompts to write down your ideas on how you might involve your students in using math tools.

BEFORE YOU WATCH THE VIDEO, write down what you already know about students using math tools.

DURING THE VIDEO, consider the following:

How does the instructor work with the students to lay the groundwork for the activity and get them started?

How does the instructor interact with the kids? What does he or she do to keep them engaged?

What academic skills, like reading or math, are students reinforcing while they participate in the activity? Be sure to give specific examples.

AFTER YOU WATCH THE VIDEO, write what modifications you might need to make to teach this lesson in your own class.

Lesson 1

Tangrams

In this lesson, students study geometric shapes. The shapes are puzzle pieces for one large square. Students cut out the pieces and move them around to figure out how they go together to make a square. Once they have figured it out, students can color and paste their pieces together on construction paper.

Grade Level(s):

K–2

Duration:

45–60 minutes

Student Goals:

- Understanding of how geometric shapes fit together
- Improved skills at cutting and pasting
- Understanding of the word *tangram*

Curriculum Connection:

The Arts

Standards:

These standards and benchmarks are from McREL's online database, Content Knowledge: A Compendium of Content Standards and Benchmarks for K–12 Education (4th edition, 2004; www.mcrel.org/standards-benchmarks). The mathematics portion of the database was developed using National Council of Teachers of Mathematics (NCTM) standards in addition to other nationally recognized standards documents.

Standard 5: Understands and applies basic and advanced properties of the concepts of geometry

Grades K–2

Benchmark 2: Understands the common language of spatial sense

Benchmark 4: Understands that patterns can be made by putting different shapes together or taking them apart

Imagine This!

Mixing arts and crafts with math in afterschool will make learning geometry fun! After students cut out their geometric shapes, watch their minds puzzle through the shapes as they visualize how to make them into one square. And then students get the opportunity to beautify their final product and take it home!

What You Need

- ❒ Scissors
- ❒ Glue
- ❒ Markers or paint
- ❒ Construction paper
- ❒ Tangram shapes (Handout 10)

What to Do

- Have students cut out the shapes.
- Then have students move the shapes around in several configurations to figure out how they fit together as a square.
- Have the students color (or paint) the pieces and paste the completed square onto construction paper.
- Have the students label their finished product "Tangram Puzzle."
- Have the students write (or talk) about the process they went through to figure out the puzzle.

Outcomes to Look for

- Student recognition of geometric patterns
- Enhanced cutting and pasting skills

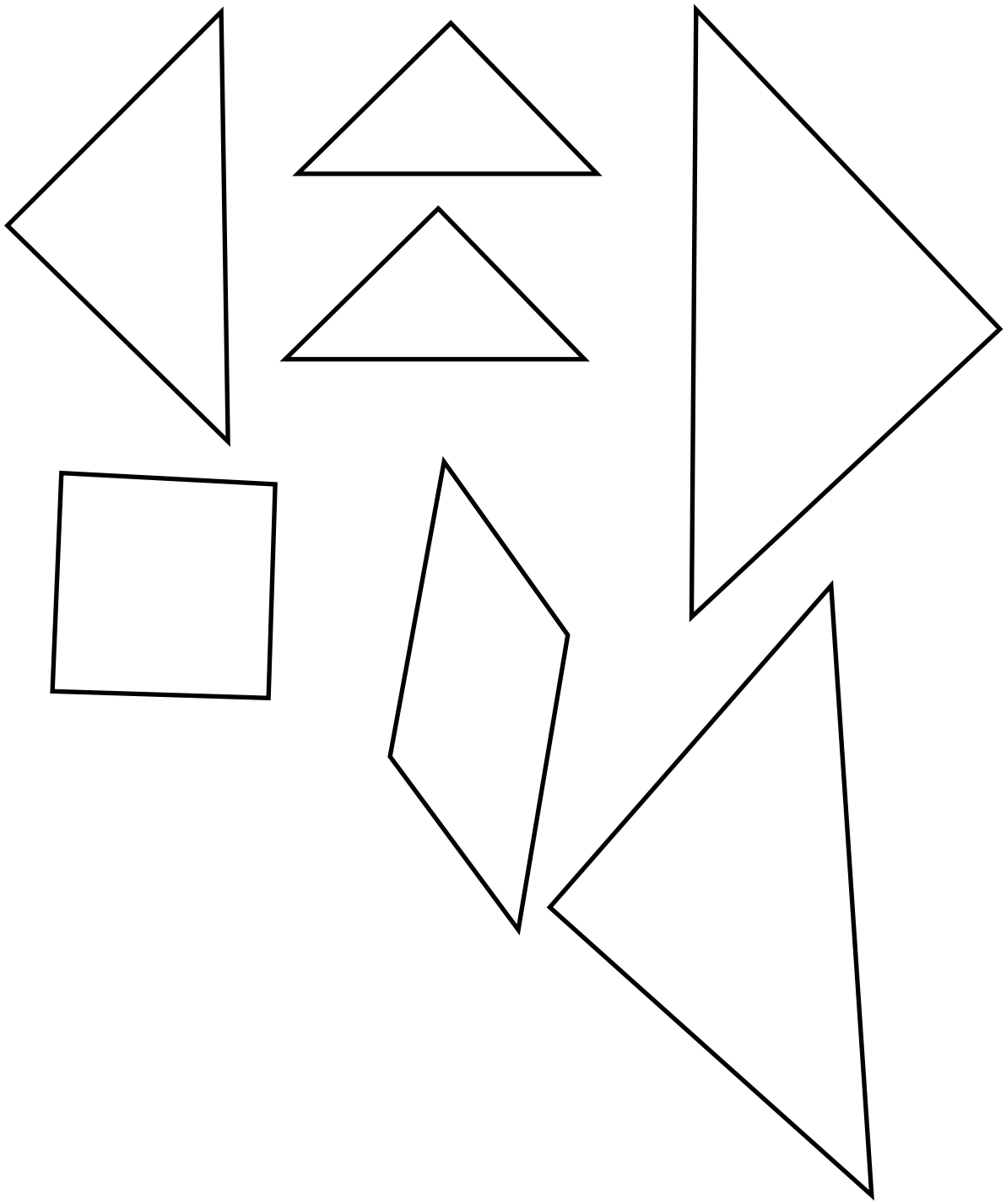
Vocabulary

Quadrilateral: a figure with four sides and four angles

Tangram: a shape that consists of seven pieces, called *tans,* which fit together to form a shape of some sort

Triangle: a figure with three sides and three angles

Handout 10: Tangram Shapes



Reflection

The questions below are prompts to help you record your ideas, but you can also write additional observations about the lesson that the questions do not cover.

Preparation

- How well did the lesson planning help you prepare for this activity?
- What can you do to feel more prepared?

Student Engagement

- How did you assess student engagement?
- What did you notice about student engagement in the different parts of the lesson?
- How satisfied were you with the level of student engagement?
- If you were not satisfied, how could you change the lesson to increase student involvement?

Academic Enrichment

- How did this lesson support other content areas?
- What changes could you make to strengthen academic enrichment and still keep the activity fun?

Classroom Management

- What strategies did you use to make this activity go smoothly?
- What changes would you make if you taught the lesson again?

Lesson 2

Growing Rock Candy

In this lesson, the instructor can either make the rock candy solution in advance or incorporate cooking into the lesson. Students observe the growth of rock candy over a given length of time, record data from their observations, and graph the changes they observe.

Grade Level(s):

3–7

Duration:

1 week of observation followed by a 1-hour lesson

Student Goals:

- Recognize patterns and the rules that explain them
- Use mathematics vocabulary to discuss observed growth patterns
- Select and use appropriate tools to make measurements
- Organize and display data in simple charts and graphs
- Observe growth patterns from a table and graph

Curriculum Connection:

Science

Standards:

These standards and benchmarks are from McREL's online database, Content Knowledge: A Compendium of Content Standards and Benchmarks for K–12 Education (4th edition, 2004; www.mcrel.org/standards-benchmarks).The mathematics portion of the database was developed using National Council of Teachers of Mathematics (NCTM) standards in addition to other nationally recognized standards documents.

Standard 2: Understands and applies basic and advanced properties of the concepts of numbers

Grades 3–5

Benchmark 5: Understands the relative magnitude and relationships among whole numbers, fractions, decimals, and mixed numbers

Standard 3: Uses basic and advanced procedures while performing the processes of computation

Grades 3–5

Benchmark 5: Performs basic mental computations

Standard 4: Understands and applies basic and advanced properties of the concepts of measurement

Grades 3–5

Benchmark 2: Selects and uses appropriate tools for given measurement situations

Benchmark 5: Understands that measurement is not exact

Benchmark 7: Selects and uses appropriate units of measurement, according to type and size of unit

Standard 9: Understands the general nature and uses of mathematics

Grades 3–5

Benchmark 1: Understands that numbers and the operations performed on them can be used to describe things in the real world and predict what might occur

Benchmark 2: Understands that mathematical ideas and concepts can be represented concretely, graphically, and symbolically

Imagine This!

You have found a way to make candy that grows! Students just won't believe that something they cook and can eat later actually will grow right before their eyes. Their daily observations will make it all real as they observe, collect data, and chart their data. You know they are dying to taste it after all the calculations are done!

What You Need

- ❒ Graph paper
- ❒ Pencils (two per student)
- ❒ Ruler (cm)
- ❒ One 6-inch piece of string per student
- ❒ 3 cups of granulated sugar per student
- ❒ 1 cup of water per student
- ❒ One clean glass jar per student
- ❒ Food coloring
- ❒ Stove
- ❒ Saucepan
- ❒ Spoon

Getting Ready

- Prior to the activity, make the rock candy solution. Or, you might choose to incorporate cooking into the activity.
- In a medium saucepan, heat the 1 cup of water and 2 cups of sugar. Stir until the sugar is completely dissolved. Gradually add a few drops of the food coloring and the additional sugar, stirring continuously until all the sugar is dissolved.
- Designate an area where the rock candy can grow without being disturbed for approximately 1 week. Students will need access to this area to measure growth. Limit movement of the rock candy once it has started growing.

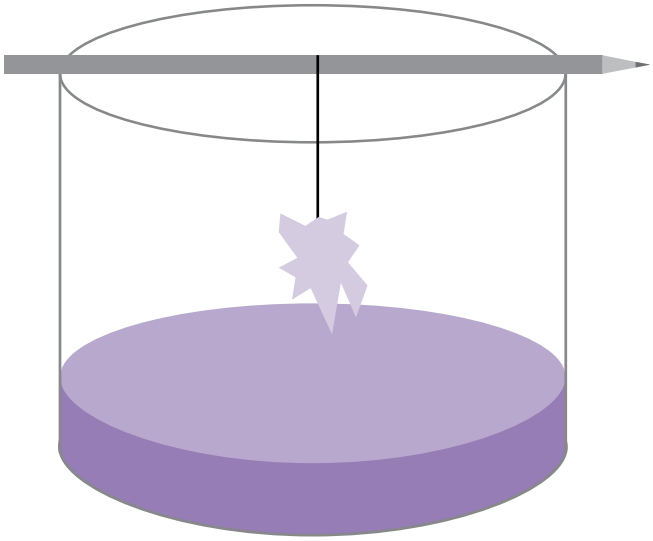
What to Do

- Using the rock candy solution, set up the growing area for the candy. Pour the solution into a clean glass jar, tie the string to the pencil, and suspend it across the mouth of the jar so that the ends hang into the sugar water. See set-up illustration on page 161.
- Have students develop a table containing three columns: Time (days), Height (cm), and Change (cm). They should fill in the initial row with Time=0 and Height=0, leaving the Change row blank.
- On Day 2, give students 10 to 15 minutes to measure their rock candy growth. The students should remove the string from the water and carefully measure the height of the rock candy. Students should enter this information on the next row of the chart and this time complete the Change column (change=today's height − yesterday's height).
- Continue having students chart growth over multiple days until measurable growth has ceased.
- On the final day, have students use graph paper to create a line graph of the candy growth. One axis should be height, and the second axis should be time.
- Using this data, students should describe how the rate of growth varied over time. Encourage them to look not only at the height per day but at what has happened between the recorded heights.

Outcomes to Look for

- Use of vocabulary (such as *slow, fast, increase, decrease*) to describe what has happened between each measurement taken
- Students' ability to focus not simply on the height measurement but on what has happened between the recorded heights
- Comments and answers indicating that students are listening to, monitoring, and applying the problem-solving strategies of their peers

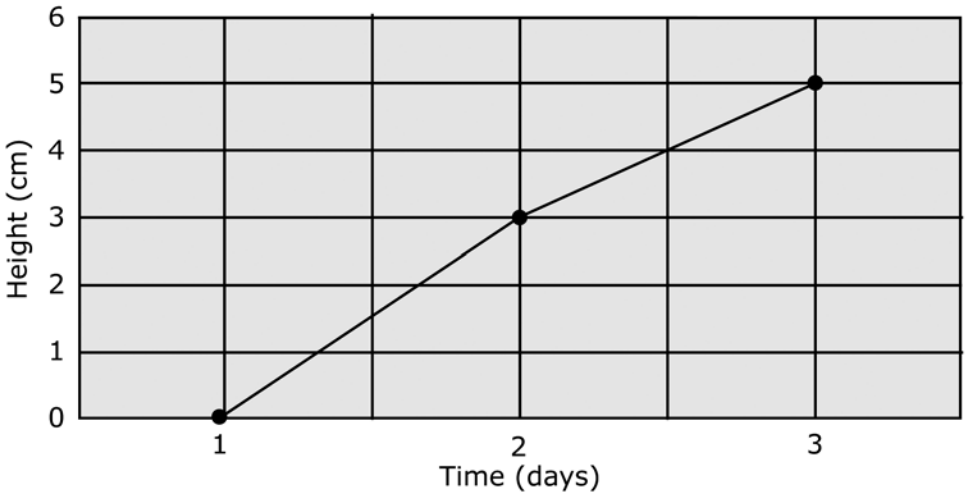
Set-up illustration:



Sample table for rock candy growth:

Time (days)	**Height** (cm)	**Change** (cm)
0	0 cm	—
1	3 cm	3 cm
2	5 cm	2 cm

A line graph illustrating the growth of rock candy:



Reflection

The questions below are prompts to help you record your ideas, but you can also write additional observations about the lesson that the questions do not cover.

Preparation

- How well did the lesson planning help you prepare for this activity?
- What can you do to feel more prepared?

Student Engagement

- How did you assess student engagement?
- What did you notice about student engagement in the different parts of the lesson?
- How satisfied were you with the level of student engagement?
- If you were not satisfied, how could you change the lesson to increase student involvement?

Academic Enrichment

- How did this lesson support other content areas?
- What changes could you make to strengthen academic enrichment and still keep the activity fun?

Classroom Management

- What strategies did you use to make this activity go smoothly?
- What changes would you make if you taught the lesson again?


1. a) 18.88 × □ / 0.08 × □ = 1888 / 8
b) 2.365 × □ / 0.5 × □
c) 48.951 ÷ 0.09

Lesson 3

Graphing Candy With Spreadsheets

In this lesson, students predict how many M&Ms are in a bag, then collect data and graph their findings in Excel. They learn how to log data on a data chart and make a graph from the data.

Grade Level(s):

5–8

Duration:

45–60 minutes

Student Goals:

- Collect data through observations
- Represent data using tables and graphs (by means of Excel)
- Use data for a variety of purposes (formulating hypotheses, making predictions, testing conjectures)
- Determine probability using simulations or experiments
- Enter data into a spreadsheet, use formulas to update solutions automatically, and create a pie graph
- Use ratios and proportions to represent relationships among quantities
- Explain and justify their thinking

Curriculum Connection:

Science, Technology

Standards:

These standards and benchmarks are from McREL's online database, Content Knowledge: A Compendium of Content Standards and Benchmarks for K–12 Education (4th edition, 2004; www.mcrel.org/standards-benchmarks).The mathematics portion of the database was developed using National Council of Teachers of Mathematics (NCTM) standards in addition to other nationally recognized standards documents.

Standard 1: Uses a variety of strategies in the problem-solving process

Grades 5–8

Benchmark 5: Knows the difference between pertinent and irrelevant information when solving problems

Benchmark 6: Understands the basic language of logic in mathematical situations

Benchmark 7: Uses explanations of the methods and reasoning behind the problem solution to determine reasonableness of and to verify results with respect to the original problem

Standard 2: Understands and applies basic and advanced properties of the concepts of numbers
Grades 5–8
Benchmark 7: Understands the concepts of ratio, proportion, and percent and the relationships among them

Standard 3: Uses basic and advanced procedures while performing the processes of computation
Grades 5–8
Benchmark 4: Selects and uses appropriate computational methods a for a given situation
Benchmark 6: Uses proportional reasoning to solve mathematical and real-world problems

Standard 6: Understands and applies basic and advanced concepts of statistics and data analysis
Grades 5–8
Benchmark 5: Uses data and statistical measures for a variety of purposes
Benchmark 6: Organizes and displays data using tables, graphs, frequency distributions, and plots

Standard 7: Understands and applies basic and advanced concepts of probability
Grades 5–8
Benchmark 2: Determines probability using simulations or experiments
Benchmark 5: Understands the relationship between the numerical expression of a probability and the events that produce these numbers

Imagine This!

Computers and candy sound like a good combination for afterschool students. After making predictions and writing ratios about M&Ms, students navigate through an Excel spreadsheet. *And* if you give them permission, they'll munch on those M&Ms while they chart their data.

What You Need

- ❒ One computer for every two to three students
- ❒ An electronic spreadsheet application, such as Excel, and word processing software, such as Word, for writing summaries of findings
- ❒ Internet access for instructor and student computers (optional)
- ❒ Small bags of M&Ms (one bag per student)
- ❒ Copies of Handout 11: Graphing Candy With Spreadsheets

Getting Ready

- Make sure that students have basic keyboarding skills; know how to open, close, and save documents; and know how to open and navigate software applications such as Excel and Word.
- Make sure that you know how to open, close, and save documents, and how to create an Excel worksheet (including using formulas) and use Word.

What to Do

- To begin this lesson, have students estimate the number and color of candies inside their small bags.
- After the estimations have been made, students open their bags to sort, classify, count, and record the M&Ms. Direct students to write ratios to represent their findings.
- Technology plays an integral part in the remainder of this lesson. Following the collection of data, have students use an electronic spreadsheet to create a graph of their findings. Review and print the detailed description in Handout 11: Graphing Candy With Spreadsheets.
- When students finish collecting data, have them compile a set of everyone's findings to estimate the number and color of M&Ms in a mystery bag.
- In order to win the mystery bag, students must not only make a conjecture but also explain their reasoning using the data sets.

Outcomes to Look for

- Student participation and engagement
- Answers that reflect an understanding of prediction
- Ability to explain math reasoning
- Ratios that represent the actual findings
- Reasonable conjectures based on the class set
- Appropriate use of a spreadsheet to create a graph

Teaching Tip

Ratios

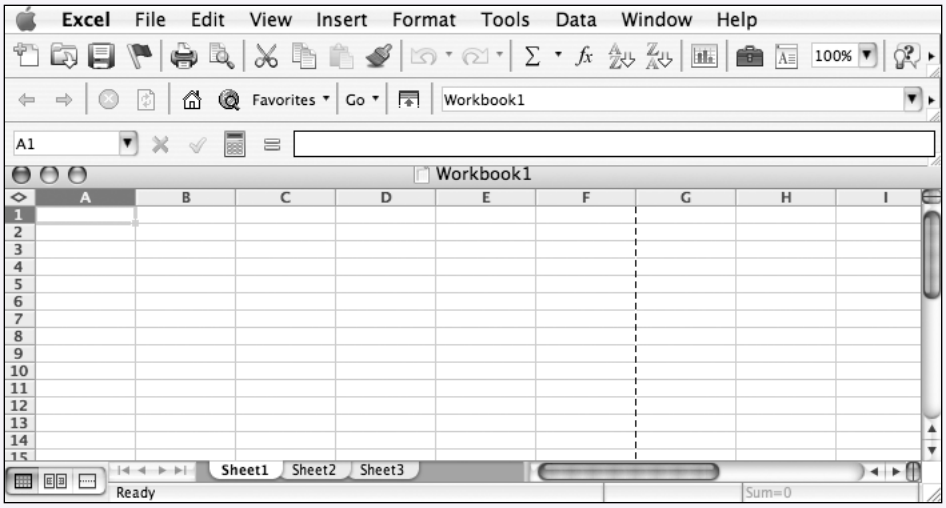
A ratio is a comparison between two numbers, usually represented by two numbers separated by a colon. Students can find multiple ratios with the colored candies. For example, you may ask them to find the ratio of yellow candies to brown candies. If there are seven yellow candies and nine brown candies the ratio of yellow to brown candies would be represented by 7:9. When using ratios, the order of numbers and words is important. The numbers should be written in the same order as stated. For example, in the ratio of yellow to brown candies the number of yellow candies is written in front of the colon while the number of brown candies is written behind it.

To compare ratios, change the ratio to a fraction, with the first number becoming the numerator and the second the denominator. Using the example above, the ratio 7:9 would become 7/9. The ratios are equal if the fractions are equal; for example, 7:9 = 14:18 because 7/9 = 14/18.

Handout 11: Graphing Candy With Spreadsheets

The M&M candy makers claim there is a certain percentage of each color in every bag. Let's see if they are right. Make a spreadsheet to calculate the number of each color that should be in each bag, based on the percentages that the candy maker tells us. Then you will open a bag of M&Ms, count them, and make a comparison to see if the M&M candy makers are right.

1. First open up your spreadsheet application (Microsoft Excel).
2. Click on Start…Programs…Microsoft Excel.
3. When Microsoft Excel opens, a blank spreadsheet will appear like the one below. If it does not automatically appear, you can click on File…New…New Workbook to start a new spreadsheet file.



4. The M&M candy makers say that a bag contains the following color of candies:

   10% blue 30% brown 10% green 20% red

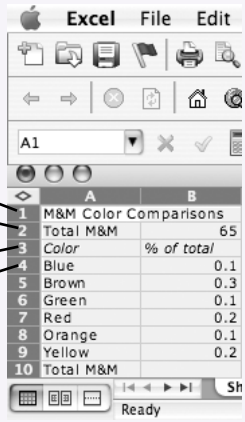
   10% orange 20% yellow

5. Create a spreadsheet to do some counting and comparisons.

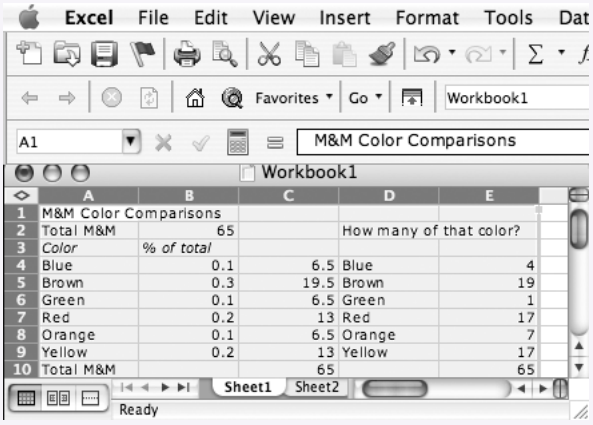
   Set up your table by following the steps below:

Counting and Comparing:

1. Create a title in A1 (M&M Color Comparisons)
2. Create a label for cell A2 (Total M&Ms) total number of M&Ms in your bag in cell B2 (don't eat any yet!)
3. Create and label columns A3 (color) and B3 (% of total).
4. Enter the colors and the company percentage in the columns and rows (A4–A9 and B4–B9).



Next, figure how many of each color should be in your bag (Column C) based on the company's formula. For example, to determine the number of blue, multiply the total number—in the example shown, the total is 65 (B2)—by the percentage of blues (.10 or 10%—shown in B4). Place your cursor in cell C4 and type this formula: =sum(B2*B4) and press the Return key. The correct sum will appear in C4. Use the same procedure to determine the number of other colors. Be sure to use the correct cell numbers in your calculations.



	A	B	C	D	E
1	M&M Color Comparisons				
2	Total M&M	65		How many of that color?	
3	*Color*	*% of total*			
4	Blue	0.1	6.5	Blue	4
5	Brown	0.3	19.5	Brown	19
6	Green	0.1	6.5	Green	1
7	Red	0.2	13	Red	17
8	Orange	0.1	6.5	Orange	7
9	Yellow	0.2	13	Yellow	17
10	Total M&M		65		65

Now, count the actual number of each color and enter those numbers as comparison with what the candy maker said should be in the bag.

Determine the actual percentage of each color in your bag of M&Ms.

1. Use this formula, which will divide the number of an individual M&M color by the total number of M&Ms (to determine its percent of the total) =SUM(E4/E10)
2. Use the same formula for each color. Be sure to use the correct cell number in your calculations.
3. Create a new column to display your results.
4. Were the percentages the same?
5. Create another column to calculate the difference.
6. What formula did you use to do this?
7. What might explain the difference?

Explore on your own

1. Create a chart from your data. To do this go to "Insert" and then "Chart" and then follow the instructions that appear.
2. Change the look of your spreadsheet with Word Art, borders, or clip art.
3. Remember to save your work.

Reflection

The questions below are prompts to help you record your ideas, but you can also write additional observations about the lesson that the questions do not cover.

Preparation

- How well did the lesson planning help you prepare for this activity?
- What can you do to feel more prepared?

Student Engagement

- How did you assess student engagement?
- What did you notice about student engagement in the different parts of the lesson?
- How satisfied were you with the level of student engagement?
- If you were not satisfied, how could you change the lesson to increase student involvement?

Academic Enrichment

- How did this lesson support other content areas?
- What changes could you make to strengthen academic enrichment and still keep the activity fun?

Classroom Management

- What strategies did you use to make this activity go smoothly?
- What changes would you make if you taught the lesson again?

Lesson 4

Learning Math and Musical Pitches With Water Bottles

In this activity, students put different amounts of water into glass beverage bottles to make various musical pitches to create a musical instrument. They learn how to relate volume to tones and pitches, and measure water volume by standard systems. Next, students learn to create and use a mathematical formula to calculate the volume of the air in the bottles. They convert the standard unit measuring system to the metric system and figure out the percentage of air and of water in each bottle. The session ends with a concert using the musical instruments that the students made.

Grade Level(s):

6–8

Duration:

90 minutes

Student Goals:

- Create a musical instrument using water in bottles
- Measure the volume of water in each bottle
- Create and use a mathematical formula to measure the volume of air in the bottles
- Calculate the percentage of water and of air in each bottle
- Convert the volume of water from fluid ounces to milliliters
- Play a simple song with the bottles

Curriculum Connection:

The Arts

Standards:

These standards and benchmarks are from McREL's online database, Content Knowledge: A Compendium of Content Standards and Benchmarks for K–12 Education (4th edition, 2004; www.mcrel.org/standards-benchmarks).The mathematics portion of the database was developed using National Council of Teachers of Mathematics (NCTM) standards in addition to other nationally recognized standards documents.

Standard 4: Understands and applies basic and advanced properties of the concepts of measurement

Grades 6–8

Benchmark 3: Understands the relationships among linear dimensions, area, and volume and the corresponding uses of units, square units, and cubic units of measure

Standard 8: Understands and applies basic and advanced properties of functions and algebra

Grades 6–8

Benchmark 1:. Knows that an expression is a mathematical statement using numbers and symbols to represent relationships and real-world situations

Imagine This!

Your room is filled with water bottles, water, measuring devices, and recording charts! As students make a musical instrument by putting specified amounts of water in each bottle, you circulate among them. Once the students have successfully created the specified musical instrument, they measure and record the amount of water in each bottle. Groups collaborate to figure out a formula for calculating the amount of air in a bottle. They then use their formula to calculate and record the amount of air in each bottle and convert their volumes of ounces into milliliters. For the final activity, each group will perform a short musical melody.

What You Need

- ❒ Five identical glass beverage bottles per group (each group may have a different set of identical beverage bottles to compare sounds of the various groups' bottles in the class).
- ❒ Water for each group
- ❒ Measuring cups with the standard unit of measure for each group
- ❒ Rulers
- ❒ Paper
- ❒ Pencils
- ❒ Recording chart and water markers for each group
- ❒ One permanent marker for each group

Getting Ready

- Assemble materials for each student (ruler, paper, and pencil).
- Assemble materials for each group (five glass beverage bottles, water, measuring cups with standard unit of measure, recording chart, and markers).
- Post amount of water to put in each water bottle as follows: (19 oz/570 ml); (13 oz/390 ml); (11 oz/330 ml); (8 oz/240 ml); and (6 oz/180 ml).
- Post the steps in the directions for the groups to follow.
- Post the structure of the chart (water in oz, water in ml, air volume).

What to Do

- Divide students into groups of five based on who will work well together.
- Go over expectations for behavior and conduct for the lesson.
- Give each student a ruler, paper, and pencil. Give each small group glass beverage bottles, a measuring cup, water, ruler, recording chart, and markers.
- Post the directions below and go over the directions for the lesson:
  - Students fill their beverage bottles with the posted amount of water.
  - Using permanent markers groups number the bottles from 1 to 5, with 5 for the largest amount of water and 1 for the smallest amount.
  - Groups record the amount of water in each bottle in ounces on the group chart.
  - Groups use the formula to calculate and record the amount of air in each bottle. (Air equals the total Volume in bottle minus Water) or ($A = V - W$).
  - Groups convert the standard unit measure of ounces to milliliters in the metric system.
  - Groups figure out the percentage of water and the percentage of air in each bottle.
- Have groups follow the directions as you circulate among them.
- As a large group, compare the groups' calculation of the amount of air and water in each bottle and the percentage of air and water.
- Have students arrange their bottles of water in order from largest amount of water to smallest.
- Have each of the five students in the groups align himself of herself behind a bottle.
- Now, for the final activity, have students use their rulers to play simple note patterns, progressing to simple songs.

Teaching Tip

Go over directions and behavior expectations before having group members start their work together. Briefly review the formula for figuring out the volume of air in the bottles, the standard units and metric units of measurement, and percentages. Answer any questions that students have.

Vocabulary

Customary system: a system of measurement used in the United States (the basic fluid ounce or cup)

Metric system: A system of measurement based on tens (the basic unit of capacity is the liter)

Octave: A musical interval of eight notes

Ounce (oz): a customary unit of weight equal to 1/16 of a pound

Pitch: the level of a sound

Volume: the number of cubic units it takes to fill a solid

The Data Students Record

- Groups record the amount of water in each bottle on the group chart in ounces.
  Answers are 19 oz, 13 oz, 11 oz, 8 oz, 6 oz
- Groups utilize a formula to determine the amount of air in the bottles.
  (Formula is: Air = total Volume in bottle – Water) (A = V – W)
  Answers will vary depending on the size of their bottles.
- Groups convert ounces to milliliter in the metric system. (1 fluid oz = 29.6 milliliters)
  Answers: 19 oz/562 ml; 13 oz/385 ml; 11 oz/326 ml; 8 oz/237 ml; 6 oz/178 ml
- Groups figure out the percentage of water and the percentage of air in each bottle. (Add the volume of the air and water. Divide the air by the total to get the percentage of air. Divide the water by the total to get the percentage of water.)

Extend

- Provide students with three additional bottles. Have students predict how much water it will take in each additional bottle to make a whole octave. Have them fill their bottles with the amount of water they predicted to see if their predictions are correct.
- Ask students to convert the percentage of water and air in the bottles to decimals.

Outcomes to Look for

- Increased knowledge of how math is used in music
- Increased knowledge of pitch and volume

Reflection

The questions below are prompts to help you record your ideas, but you can also write additional observations about the lesson that the questions do not cover.

Preparation

- How well did the lesson planning help you prepare for this activity?
- What can you do to feel more prepared?

Student Engagement

- How did you assess student engagement?
- What did you notice about student engagement in the different parts of the lesson?
- How satisfied were you with the level of student engagement?
- If you were not satisfied, how could you change the lesson to increase student involvement?

Academic Enrichment

- How did this lesson support other content areas?
- What changes could you make to strengthen academic enrichment and still keep the activity fun?

Classroom Management

- What strategies did you use to make this activity go smoothly?
- What changes would you make if you taught the lesson again?

Lesson 5

Geometric Shape Spotting

In this lesson, students work to identify common shapes in their everyday lives. They use a digital camera to record the shapes they have spotted around the school.

Grade Level(s):

K–2

Duration:

Three 1-hour sessions, with a gallery night for parents

Student Goals:

- Recognize three-dimensional shapes in the real world
- Learn the two-dimensional representation of three-dimensional shapes
- Review the vocabulary of three-dimensional shapes
- Work cooperatively with peers
- Use a new tool, a digital camera

Curriculum Connection:

The Arts, Technology

Standards:

These standards and benchmarks are from McREL's online database, Content Knowledge: A Compendium of Content Standards and Benchmarks for K–12 Education (4th edition, 2004; www.mcrel.org/standards-benchmarks).The mathematics portion of the database was developed using National Council of Teachers of Mathematics (NCTM) standards in addition to other nationally recognized standards documents.

Standard 5: Understands and applies basic and advanced properties of the concepts of geometry

Grades K–2

Benchmark 1: Understands basic properties of and similarities and differences between simple geometric shapes

Benchmark 3: Understands that geometric shapes are useful for representing and describing real world situations

Imagine This!

Young photographers are seeking geometric shapes—circles, triangles, squares, and rectangles—around the classroom and the school building. As they take a shape walk, students write the name and picture of the shapes on index cards, so they can place the cards in front of the shapes they find in the school. Once a shape is found and identified with an index card, the young photographers are ready to take a digital picture of the shape! As true photographers, they will showcase their photo-geometric art in a class gallery for parents to come to see.

What You Need

- ❒ Three-dimensional physical models of a triangular prism, rectangular prism, cube, sphere, and cone
- ❒ Shape cards with two-dimensional pictures of the geometric solids, triangular prism, rectangular prism, cube, sphere, and cone
- ❒ Name cards with the names of the geometric shapes, triangular prism, rectangular prism, cube, sphere, and cone
- ❒ Digital camera(s)
- ❒ Index cards
- ❒ Markers
- ❒ Printer with a new color cartridge
- ❒ Copy paper
- ❒ Construction paper

Getting Ready

- Create the name cards and shape cards prior to the activity. Create at least four sets. You will use these as a model for students to copy later.
- Prior to the shape walk, allow students to practice using the digital cameras so that during the shape walk they are learning about the shapes and not about how to use the cameras.
- Determine an area in the school or building that has many of these shapes for the students to take a walk through and take pictures.
- Enlist the help of other adults or older students for the shape-walk session.
- Take a few pictures of your own to provide as models.
- Mount the pictures on construction paper to model how to do this for the gallery.

Session 1: Reviewing Shapes

What to Do

- Using the physical models of the shapes, review with students the names of these shapes. Say the name of the shape and have students repeat the name. Show them the name of the shape in print.
- Then review with the students what the two-dimensional sketches of these shapes look like. Show students the cards that you made as well as other two-dimensional pictures of these shapes.
- Ask the students to look around the classroom to find examples of these shapes. As the students point out examples, have them label the object using either the two-dimensional sketch or a name card that you have prepared.
- Allow all students a chance to successfully find an example within the classroom.
- Next, have the students create their own shape labels using the index cards. The shape labels should have a two-dimensional sketch of the shape along with the name of the shape.

Teaching Tip

Help students understand that they can recognize shapes even when the objects they see are not exactly like the shapes they imagine. For students who are struggling with this task, give them only one shape to look for during the walk.

Session 2: Taking a Shape Walk

What to Do

- Review school rules and behavior rules before starting the shape walk.
- Practice using digital cameras before the walk. Make sure everyone has a chance to try out a camera before you begin.
- Break the students into smaller groups for the shape walk. One adult should be with each small group. Group size will be determined by the number of digital cameras available but should be no larger than four students per group.
- Allow students to walk around the school or building and find the four geometric shapes you have been studying. The shapes can be either artificial or natural.
- Have students label and take pictures of different shapes. Students should include the shape labels in the pictures to indicate what shapes they are photographing.

Session 3: Preparing a Gallery Show

What to Do

- Before the next class (or during the class, if you wish), print the students' pictures. (Printing them on copy paper is fine.)
- Have students prepare their pictures for a gallery show of their work by gluing their photos on construction paper.
- Decide where the gallery of students' work will be showcased and have the students mount their photos in that spot.

Extend

- Invite parents to come and see the gallery. Students can take their parents on a shape walk around the school and show them the geometric shapes they found and photographed. Juice and cookies would round out the evening!

Outcomes to Look for

- Student participation and engagement
- Using tools productively
- Answers that reflect an understanding of shapes in the real world
- Correct use of mathematical terms when describing shapes
- Student recognition of geometric shapes in the world

Vocabulary

Circle: a two-dimensional figure formed by a curved line surrounding a center

Cube: a solid figure with six square faces

Rectangle: a two-dimensional figure with four right angles and four sides

Rectangular prism: a solid figure with six rectangular faces

Solid figure: a three-dimensional figure

Sphere: an object similar in shape to a ball

Square: a two-dimensional figure with four right angles and four equal sides

Triangle: a two-dimensional geometric figure formed of three sides and three angles

Triangular prism (pyramid): a solid figure with four triangular faces and a rectangular base

Reflection

The questions below are prompts to help you record your ideas, but you can also write additional observations about the lesson that the questions do not cover.

Preparation

- How well did the lesson planning help you prepare for this activity?
- What can you do to feel more prepared?

Student Engagement

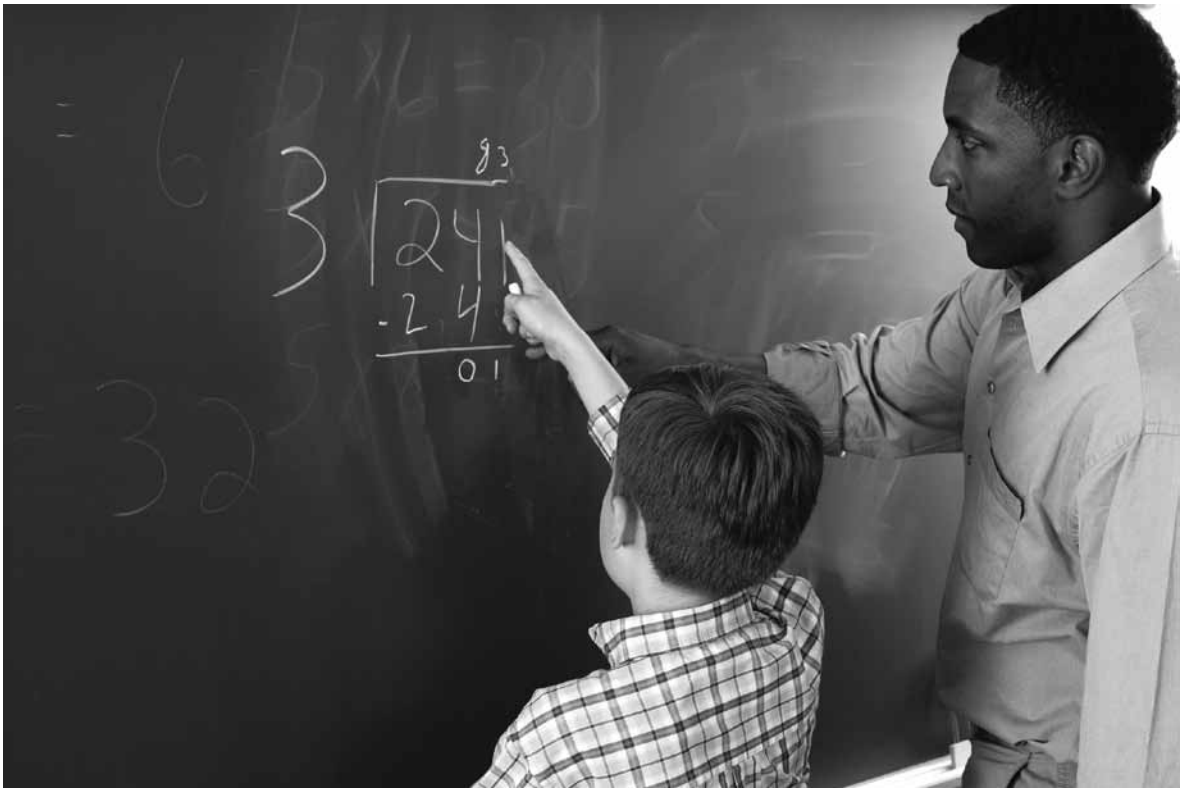
- How did you assess student engagement?
- What did you notice about student engagement in the different parts of the lesson?
- How satisfied were you with the level of student engagement?
- If you were not satisfied, how could you change the lesson to increase student involvement?

Academic Enrichment

- How did this lesson support other content areas?
- What changes could you make to strengthen academic enrichment and still keep the activity fun?

Classroom Management

- What strategies did you use to make this activity go smoothly?
- What changes would you make if you taught the lesson again?



Practice 6

Math Tutoring

What Is It?

Math Tutoring involves working with students on specific math skills. This work can take place in ongoing one-on-one or small-group sessions. Tutors, students, and day-school teachers work together to identify skills or areas where students need help and design activities and review sessions to build specific math skills.

What Is the Content Goal?

The key goal of *Math Tutoring* is to provide problem-solving experiences that build students' understanding of specific math facts and skills. The content of *Math Tutoring* draws from the day-school learning and the specific concepts and skills identified for each student.

What Do I Do?

Begin by talking to the day-school teacher to find out what math concepts and skills students are learning, the standards for each grade level, and which students need help. For each student, identify with the day-school teacher the specific math facts or skills that are difficult, examples of problems that the student struggles with, and activities that could help clarify a concept and build understanding. Talk to the individual students as well and ask them what math skills are difficult for them, what their strengths are, and what kinds of activities they are interested in. Fun activities engage students and increase their desire to learn. Once specific skill areas have been identified, determine short- and long-term goals. For example, if a younger student is struggling to add two-digit numbers, a short-term goal would be to master equations using base-10 blocks or other manipulatives. A long-term goal would be for the student to be able to add without using manipulatives. Provide regular, positive feedback to encourage students to succeed. At the end of each tutoring session, allow time to discuss what was learned and what skills and activities require more practice.

Why Does It Work?

Research indicates that regular, high-quality one-on-one tutoring may be the most effective afterschool activity for improving academic achievement. One-on-one and small-group mathematics tutoring from well-trained staff allows afterschool programs to target students' individual strengths, weaknesses, and interests by providing direct, diagnostic mathematics instruction and mentoring. This type of tutoring is most effective when tied to the day-school, which allows children to practice and reinforce what they are learning in the classroom.

Getting Started

video

Go to the *One-on-One and Small-Group Tutoring* practice found in the literacy section of the Afterschool Training Toolkit (www.sedl.org/afterschool/toolkits/literacy/pr_tutoring.html). Click on the video "One-on-One Tutoring" taken at Delaware Elementary School in Indiana. In addition, you can go to the *Tutoring, Mentoring and Building Study Skills* practice in the homework section of the Afterschool Training Toolkit (www.sedl.org/afterschool/toolkits/homework/pr_study_skills.html) to see a video for math tutoring.

Use the before, during, and after writing prompts to write down your ideas on how you might involve your students in math tutorials and tutoring.

BEFORE YOU WATCH THE VIDEO, write down what you already know about one-on-one tutoring and math tutorials or both.

DURING THE VIDEO, consider the following:

How does the instructor work with the students to lay the groundwork for the activity and get them started?

How does the instructor interact with the kids? What does he or she do to keep them engaged?

What academic skills, like reading or math, are students reinforcing while they participate in the activity? Be sure to give specific examples.

AFTER YOU WATCH THE VIDEO, write what modifications you might need to make to teach this lesson in your own class.

Lesson 1

One-on-One Tutoring

This lesson provides a starting point for how one-on-one tutoring can be used to enhance student learning in afterschool. Using day-school teachers' recommendations, the afterschool instructor provides a student with tutoring that either targets math skills where the student needs support or involves enrichment activities that enhance math strengths.

Grade Level(s):

K–12

Duration:

Sessions of 15–20 minutes

Curriculum Connection:

Various Connections

Standards:

These standards and benchmarks are from McREL's online database, Content Knowledge: A Compendium of Content Standards and Benchmarks for K–12 Education (4th edition, 2004; www.mcrel.org/standards-benchmarks). The mathematics portion of the database was developed using National Council of Teachers of Mathematics (NCTM) standards in addition to other nationally recognized standards documents.

The standards addressed would depend on the questions the teacher writes and the grade level of the students. Below are the categories of math standards that could be addressed.

Number and Operations (includes Arithmetic and Number Sense)

Patterns, Relationships, and Algebraic Thinking

Geometry and Spatial Visualization

Measurement

Probability and Statistics

Problem Solving

Reasoning and Proof

Communication

Connections

Imagine This!

Your class is busy working in small, cooperative groups on homework today. This gives you the opportunity to pull one student at a time out of the groups for 15 minutes apiece so that you can work one-on-one with each student on a math skill that the day-school teacher has asked you to address. In the space of a 90-minute class, you have time to work with six students individually.

What You Need

❒ Pens and pencils

❒ Writing materials

❒ Computer (optional)

❒ Manipulatives (optional)

❒ Materials and assignments from day school

Getting Ready

- Meet with day-school teachers to identify students who need support or enrichment activities; learn more about the standards and benchmarks at each grade level; and identify specific skill areas, strengths, and learning goals for each student.
- Work with day-school teachers to develop an assessment tool for each student's learning goals. Discuss and design projects and activities that will give students opportunities to practice specific skills and that will indicate that students are learning.
- Find a quiet, comfortable room where students can focus on the task at hand.

What to Do

- Begin tutoring sessions with a discussion of the day's goals to make sure that students understand what they are supposed to do. You might ask, "How will we know you learned this?"
- Preview the steps involved in that day's session and work with individual students on each step. Encourage students to ask questions as they move through each problem. Ask questions that encourage students to talk about their approach to the problem.
- Occasionally, teachers request that tutors spend time working through homework during tutoring sessions. Balance homework help with other efforts to keep students interested in and focused on independent learning projects.
- Provide positive feedback to encourage students' success.
- Debrief what was accomplished. Each session should end with the tutor and student discussing what was accomplished and what needs to be done to prepare for the next session. Tutors should be willing to allow students to pursue new questions or ideas if this exploration will contribute to deeper understanding of the content.

Outcomes to Look for

- Student engagement and participation
- Progress in identified skill areas
- Increased confidence in identified skill areas
- Answers that reflect increased understanding of learning goals
- Students communicating about what they have learned and how they learned

Reflection

The questions below are prompts to help you record your ideas, but you can also write additional observations about the lesson that the questions do not cover.

Preparation

- How well did the lesson planning help you prepare for this activity?
- What can you do to feel more prepared?

Student Engagement

- How did you assess student engagement?
- What did you notice about student engagement in the different parts of the lesson?
- How satisfied were you with the level of student engagement?
- If you were not satisfied, how could you change the lesson to increase student involvement?

Academic Enrichment

- How did this lesson support other content areas?
- What changes could you make to strengthen academic enrichment and still keep the activity fun?

Classroom Management

- What strategies did you use to make this activity go smoothly?
- What changes would you make if you taught the lesson again?

Lesson 2

Small-Group Tutoring

This lesson provides a starting point for how small-group tutoring can be used to enhance students' learning in afterschool. Using their day-school teachers' recommendations, the afterschool instructor has students work in small groups either on activities that target specific math skills and areas where students need support, or on enrichment activities that enhance their strengths.

Grade Level(s):

K–12

Duration:

20–30 minutes

Curriculum Connection:

Various Connections

Standards:

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The standards addressed would depend on the questions the teacher writes and the grade level of the students. Below are the categories of math standards that could be addressed.

Number and Operations (includes Arithmetic and Number Sense)

Patterns, Relationships, and Algebraic Thinking

Geometry and Spatial Visualization

Measurement

Probability and Statistics

Problem Solving

Reasoning and Proof

Communication

Connections

Imagine This!

Your classroom is humming with small cooperative groups of students helping each other in math concepts and skills. Older students can be your teachers for younger students by guiding them through fractions or multiplication, while at the same solidifying their own math skills.

What You Need

- ❒ Pens and pencils
- ❒ Writing materials
- ❒ Computer (optional)
- ❒ Manipulatives (optional)
- ❒ Materials and assignments from day school

Getting Ready

- Meet with day-school teachers to identify students who need support or enrichment activities; learn more about the standards and benchmarks at each grade level; and identify specific skill areas, strengths, and learning goals for each student.
- Work with day-school teachers to develop an assessment tool for each student's learning goals. Discuss and design projects and activities that will give students opportunities to practice specific skills and that will indicate that students are learning.
- Group students based on common learning goals and skills.
- Select materials and prepare activities for each student to work on.

What to Do

- Define the day's goals and skills. Begin tutoring sessions with a discussion of the day's goals. Ensure that the learning goals are ones that the students are invested in achieving by asking a question such as, "How will we know you learned this?"
- Group students and monitor both collaboration skills and learning progress.
- Encourage students to work together; ask questions; and communicate about the activity, how they are approaching the problem, and what they are learning.
- Balance homework help with other efforts to keep students interested in and focused on small-group activities and independent learning goals.
- Provide positive feedback and encourage students' success.
- Debrief what was accomplished. Each session should end with a discussion of what was accomplished and what needs to be done to prepare for the next session. Tutors should be willing to allow students to pursue new questions or ideas if this exploration will contribute to deeper understanding of the content.

Outcomes to Look for

- Student engagement and participation
- Progress in identified skill areas
- Increased confidence in identified skill areas
- Answers that reflect increased understanding of learning goals
- Students communicating about what they have learned and how they learned
- Students working together to problem solve

Reflection

The questions below are prompts to help you record your ideas, but you can also write additional observations about the lesson that the questions do not cover.

Preparation

- How well did the lesson planning help you prepare for this activity?
- What can you do to feel more prepared?

Student Engagement

- How did you assess student engagement?
- What did you notice about student engagement in the different parts of the lesson?
- How satisfied were you with the level of student engagement?
- If you were not satisfied, how could you change the lesson to increase student involvement?

Academic Enrichment

- How did this lesson support other content areas?
- What changes could you make to strengthen academic enrichment and still keep the activity fun?

Classroom Management

- What strategies did you use to make this activity go smoothly?
- What changes would you make if you taught the lesson again?

Lesson 3

Learning With Tutorials

You can increase both students' math knowledge and technology skills with a computer arrangement. Using age-appropriate tutorials from the Internet, CDs, and DVDs, you can set up a study center where students learn from tutorials. In your ongoing conversations with your students' day-school teachers, ask which areas of math students need the most help with for tutorials in afterschool.

Grade Level(s):

K–12

Duration:

Sessions of 15–20 minutes

Student Goals:

- Enhance students' understanding of math concepts
- Increase technology skills
- Increase students' abilities to find answers themselves and work independently

Curriculum Connection:

Technology

Standards:

These standards and benchmarks are from McREL's online database, Content Knowledge: A Compendium of Content Standards and Benchmarks for K–12 Education (4th edition, 2004; www.mcrel.org/standards-benchmarks). The mathematics portion of the database was developed using National Council of Teachers of Mathematics (NCTM) standards in addition to other nationally recognized standards documents.

The standards addressed would depend on the content and the grade level of the students. Below are the categories of math standards that could be addressed.

Number and Operations (includes Arithmetic and Number Sense)

Patterns, Relationships, and Algebraic Thinking

Geometry and Spatial Visualization

Measurement

Probability and Statistics

Problem Solving

Reasoning and Proof

Communication

Connections

Imagine This!

In an afterschool class, each student needs individual help with his or her learning. The schedule and class size make it difficult to tutor each student individually during the afterschool session. However, the class has access to two computers, one with Internet access and the other without. The class also has access to the school library computers.

What You Need

❒ Student computers with multimedia capability

❒ Internet access for instructor and student computers

❒ Adult volunteers

Getting Ready

- Discuss the students' needs with the day-school teachers to determine the most appropriate tutorials.
- When selecting tutorials, consider content, age, and gender appropriateness, and compatibility with your computer and operating system.
- Review your afterschool program's Internet-use policy and rules, and review these with your students. Post these rules where they can see them.
- Arrange for an adult volunteer to help you on tutorial days.
- Consider using some of the following Web sites:
  - Learn 4 Good Kids' Corner: free access to hundreds of educational games, activities, worksheets, and lessons (www.learn4good.com/kids)
  - Pitsco's Ask an Expert (http://askanexpert.com)
  - Ask Dr Math (http://mathforum.org/dr.math/dr-math.html)
  - The Math Tutor (www.fliegler.com/mathman.htm)
  - Math.com (www.math.com/)

What to Do

- Direct students to appropriate computers.
- Explain the focus of the activity.
- Show students how to access the sites you have chosen and then have them try the tutorials.
- If several students have the same need, then consider having them work as a team.
- Monitor the time students spend working on the tutorials. Help students stay focused on the tutorials and use the Web sites appropriately.

Extend

- Check with the day-school teacher to see if computer enrichment activities are available as part of the supplementary textbook materials students use during the day.

Outcomes to Look for

- Student engagement and participation
- Progress in identified skill areas
- Increased confidence in identified skill areas
- Answers that reflect increased understanding of learning goals
- Students communicating about what they have learned and how they learned

Reflection

The questions below are prompts to help you record your ideas, but you can also write additional observations about the lesson that the questions do not cover.

Preparation

- How well did the lesson planning help you prepare for this activity?
- What can you do to feel more prepared?

Student Engagement

- How did you assess student engagement?
- What did you notice about student engagement in the different parts of the lesson?
- How satisfied were you with the level of student engagement?
- If you were not satisfied, how could you change the lesson to increase student involvement?

Academic Enrichment

- How did this lesson support other content areas?
- What changes could you make to strengthen academic enrichment and still keep the activity fun?

Classroom Management

- What strategies did you use to make this activity go smoothly?
- What changes would you make if you taught the lesson again?

Lesson 4

Homework Help: Ask an Expert!

With only one computer and Internet access, you can provide your students with math homework help. Using the best ask-an-expert Web sites, set up a cyber study center where students ask online experts questions related to their homework assignments. In your ongoing conversations with your students' day-school teachers, ask which topics students should discuss with experts.

Grade Level(s):

2–12

Duration:

Sessions of 15–20 minutes

Student Goals:

- Complete and turn in homework on time
- Correctly address homework instructions
- Evaluate information provided from online sources
- Express questions by writing accurately and responsibly

Curriculum Connection:

Technology

Standards:

These standards and benchmarks are from McREL's online database, Content Knowledge: A Compendium of Content Standards and Benchmarks for K–12 Education (4th edition, 2004; www.mcrel.org/standards-benchmarks).The mathematics portion of the database was developed using National Council of Teachers of Mathematics (NCTM) standards in addition to other nationally recognized standards documents.

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Geometry and Spatial Visualization

Measurement

Probability and Statistics

Problem Solving

Reasoning and Proof

Communication

Connections

Imagine This!

It's homework time in the afterschool program. As students get out their books and notebooks, two eighth-grade girls gather at a computer to help each other with their math homework. They are struggling with a geometry problem on perimeters. After logging on to a math-mentoring Web site, they search the forum archives for questions and answers about perimeters. They find some messages that help them answer most of their problems but remain stumped on two questions. They post a question to the online math expert and log on the next day to see what responses they have received.

What You Need

❒ Instructor computer with Internet access and projector

❒ Student computer(s) with Internet access

❒ Bookmarked ask-an-expert Web sites

❒ Adult volunteer or student aide

Getting Ready

- Look over the following ask-an-expert Web sites:
  - Pitsco's Ask an Expert (http://askanexpert.com)
  - Ask Dr. Math (http://mathforum.org/dr.math/dr-math.html)
  - Jiskha Homework Help (www.jiskha.com)
  - AllExperts (http://allexperts.com)
  - Infoplease Homework Center (www.infoplease.com/homework/hwhelper.html)
- Arrange for an adult or older student volunteer to assist students with the ask-an-expert process.

Session 1: Getting Ready

What You Need

❒ Instructor computer with Internet access and projector

❒ Bookmarked list of ask-an-expert Web sites

What to Do

- Tell your students that you are going to show them how to find answers to their most challenging homework questions.
- Show students the list of ask-an-expert Web sites and how to access those sites.
- Review rules on asking a question. These rules, such as those found on Pitsco's Ask an Expert Web sites (http://askanexpert.com), should be common to most of these sites.
- Remind students that these experts will not do their homework for them but are rather resources to help students do their own work and to learn from that effort.
- At the middle school and high school levels, students may consult these experts as resources for a paper or project. Remind students to cite appropriately these people's contributions.
- You will also want to review your program's or school's Internet-usage policy and rules, and post a copy close to the student computers.

Teaching Tip

When to Ask an Expert

As you implement your ask-an-expert online homework help program, take some time to consider how it will fit into your existing homework sessions. If you have a limited number of computers available for online help, you might consider having a sign-up sheet. For more information about homework help in afterschool, see the homework section of the Afterschool Training Toolkit (www.sedl.org/afterschool/toolkits/homework/index.html).

Session 2 and Beyond: Asking Experts

What You Need

❒ Student computer(s) with Internet access

❒ Bookmarked ask-an-expert Web sites

❒ Adult volunteer or older student aide

What to Do

- Have the students consult experts for help with their homework by using the ask-an-expert Web sites.
- If several students have the same question, allow them to work as a team to get an answer from the experts.
- Assign an aide to this station to monitor and help.

Extend

- If you have more than one computer available for student use, broaden the scope of your cyber study center. Stock an additional computer with appropriate, high-quality learning activities.
- Check with day-school teachers to see if computer enrichment games are available with the textbooks students are using during day-school. Additionally, Web sites such as Fun Brain and Gamequarium provide links to many fun, free online learning games.

Outcomes to Look for

- Student engagement and participation
- Progress in identified skill areas
- Increased confidence in identified skill areas
- Answers that reflect increased understanding of learning goals
- Students communicating about what they have learned and how they learned
- Students working together to problem solve

Reflection

The questions below are prompts to help you record your ideas, but you can also write additional observations about the lesson that the questions do not cover.

Preparation

- How well did the lesson planning help you prepare for this activity?
- What can you do to feel more prepared?

Student Engagement

- How did you assess student engagement?
- What did you notice about student engagement in the different parts of the lesson?
- How satisfied were you with the level of student engagement?
- If you were not satisfied, how could you change the lesson to increase student involvement?

Academic Enrichment

- How did this lesson support other content areas?
- What changes could you make to strengthen academic enrichment and still keep the activity fun?

Classroom Management

- What strategies did you use to make this activity go smoothly?
- What changes would you make if you taught the lesson again?

Practice 7

Family Connections

What Is It?

Family Connections describes methods to support family and community involvement in and enthusiasm for math in afterschool. Examples include planning and offering parent workshops, family nights, or family visits to the program. Family math events are planned times when parents can visit their child's afterschool program or participate in an event sponsored by the afterschool program. The afterschool staff can lead these events, or they may choose to find local experts or community members to lead them.

What Is the Content Goal?

The goal of *Family Connections* is to engage parents, caretakers, and students in meaningful math experiences and problem-solving activities that help support students' math learning both in day school and afterschool.

What Do I Do?

Use surveys (or involve an afterschool advisory committee) to gather information from your families and community to get a sense of their interests, needs, and preferences; and to help maximize participation in the events. Involve day-school and afterschool teachers to select a specific outcome and an appropriate design for the event. For example, a workshop might be the best way to help parents learn powerful strategies for helping students with mathematics homework, whereas a family mathematics fair with game booths might be offered to teach parents fun activities they could re-create at home.

Involve day-school teachers from the regular day program and parents in the planning of these events. Parents can highlight issues and challenges they face in supporting their children's mathematical learning. Teachers bring knowledge of the day-school program curriculum as well as a wealth of ideas for supporting learning at home. Speaking with both groups will allow you to plan an event that is beneficial and supported by both the parents and teachers. For specific considerations for planning parent workshops, family nights, or family visits to the program, visit the resources section of the *Family Connections* practice.

Why Does It Work?

Parental interest and support are primary factors in a student's educational success. Many parents do not become involved in their children's schooling because they see few opportunities to be involved, sense an indifferent attitude of the school personnel, are intimidated by the educational jargon, or have transportation, safety, or childcare issues. Many parents who do not have these problems still do not feel equipped to help their children, especially since mathematics content becomes increasingly difficult as students get older, and the parents might not have the content knowledge to assist their children. There have also been changes in the way that mathematics is taught, which can present some confusion and frustration for parents. Parents might also carry their own negative mathematical experience with them. By taking these items into consideration, afterschool practitioners can build an environment where parents feel knowledgeable and comfortable to help their children succeed in mathematics.

Getting Started

video

Go to the *Involving Day Schools, Families, and Communities* practice in the homework section of the Afterschool Training Toolkit (www.sedl.org/afterschool/toolkits/homework/pr_families_communities.html). Click on the video for involving schools and families in the afterschool program. Parents are involved with conferences in afterschool, just as they are with day-school conferences.

Use the before, during, and after writing prompts to write down your ideas on how you might involve families in the afterschool program.

BEFORE YOU WATCH THE VIDEO, write down what you already know about involving families in afterschool programming.

DURING THE VIDEO, consider the following:

How does the instructor work with the students to lay the groundwork for the activity and get them started?

How does the instructor interact with the kids? What does he or she do to keep them engaged?

What academic skills, like reading or math, are students reinforcing while they participate in the activity? Be sure to give specific examples.

AFTER YOU WATCH THE VIDEO, write what modifications you might need to make to teach this lesson in your own class.

Lesson 1

Family Math Nights

Family math nights are nights set aside at afterschool where parents, guardians, and community members are invited to experience math with their children. Participants have the opportunity to attend a variety of math events and to explore content, activities, and games that support mathematical learning.

Grade Level(s):

K–8

Duration:

30 minutes–2 hours

Standards:

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Patterns, Relationships, and Algebraic Thinking

Geometry and Spatial Visualization

Measurement

Probability and Statistics

Problem Solving

Reasoning and Proof

Communication

Connections

Imagine This!

Parents, guardians, and community members are playing math games and learning math with students and instructors! That's a family math night! Children guide their family members through a variety of math centers, math stations, or events. How about Rational Number Bingo or Measuring Hands and Feet? Family members play games or complete math centers with their children while learning strategies, games, and activities they can use at home to support their children.

What to Do

Planning is an integral step for a successful family math night. Key planning steps include:

- Establishing goals (Is there a particular topic or learning strategy that will be taught? Will it be a celebration of student work?)
- Location (Will the event be held in the school cafeteria, classrooms, gymnasium, in a community center, etc.?)
- Attendance (How many people will be invited? A certain grade range? The entire afterschool program?)
- Date and time (Does an evening or Saturday work better for parents? Make sure to check community and school calendars for conflicts.)
- Staffing (Do you need a steering committee to help in the planning and execution? Where will the volunteers come from?)
  - A steering committee can help with the planning of the event. You might consider individuals who could fill roles such as event coordinator, publicity coordinator, activities coordinator (plans and makes sure materials are present for learning activities), food and prize coordinator, community coordinator, volunteer coordinator, and so on.
  - Volunteers can be afterschool staff, day-school teachers, parents, students, school administration, or community members. Volunteers will be useful to serve as greeters, registration help, activity facilitators, and such the day of the event.
- Time allotment during event (How will the time during the event be broken up? If discussing a particular learning strategy, one suggestion might be to establish activity centers that parents and students visit and participate for the first 30 to 45 minutes of the night. Then allow 30 minutes for all of the participants to reconvene and discuss their experiences with the activities, the learning that occurred, and how this might be used in the home setting.)
- Promotion of event (How will news of the event spread? Letters to volunteers? Announcements or fliers to families? Letters to teachers describing the event and requesting support? Press releases? Hearing about the event many times and in many ways tends to increase attendance.)

Outcomes to Look for

- Parent responsiveness and attendance
- Parent and student engagement in learning
- Increased parental involvement
- Increased parental awareness about mathematics
- Increased parental awareness about math homework help
- New ideas from parents
- Increased communication between home and school

Reflection

The questions below are prompts to help you record your ideas, but you can also write additional observations about the lesson that the questions do not cover.

Preparation

- How well did the lesson planning help you prepare for this activity?
- What can you do to feel more prepared?

Student Engagement

- How did you assess student engagement?
- What did you notice about student engagement in the different parts of the lesson?
- How satisfied were you with the level of student engagement?
- If you were not satisfied, how could you change the lesson to increase student involvement?

Academic Enrichment

- How did this lesson support other content areas?
- What changes could you make to strengthen academic enrichment and still keep the activity fun?

Classroom Management

- What strategies did you use to make this activity go smoothly?
- What changes would you make if you taught the lesson again?

Lesson 2

Family Math Workshops

Family math workshops are formal opportunities for parents or caretakers to learn about the types of mathematics that their children are learning in the classroom, the activities that can be used at home, and the strategies to help with children's homework. Workshops might be led by an invited speaker, teacher, or other expert in the selected topic.

Grade Level(s):

K–8

Duration:

30 minutes–2 hours

Standards:

These standards and benchmarks are from McREL's online database, Content Knowledge: A Compendium of Content Standards and Benchmarks for K–12 Education (4th edition, 2004; www.mcrel.org/standards-benchmarks).The mathematics portion of the database was developed using National Council of Teachers of Mathematics (NCTM) standards in addition to other nationally recognized standards documents.

The standards addressed would depend on the content and the grade level of the students. Below are the categories of math standards that could be addressed.

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Geometry and Spatial Visualization

Measurement

Probability and Statistics

Problem Solving

Reasoning and Proof

Communication

Connections

Imagine This!

Your school library is filled with parents or guardians of your students. All are ready to learn how to teach math to their children! You have brought in an engaging facilitator who will lead your participants in practicing and talking about math concepts. Participants will develop their own mathematical thinking, increase their knowledge of general math skills, and gain a better understanding of how they can tutor their children at home.

What to Do

The first step in planning family math workshops is to determine the challenges that parents and caretakers face when they help their children with their mathematical learning. It is important that the parents see the workshop as beneficial to their own ability to help their children learn. Establishing a small group of parents who can assist in the workshop planning will allow you the opportunity to make sure the needs of the parents are being met.

After establishing the needs, key considerations in planning the event include:

- Establishing frequency (How often should workshops be held? Monthly? Quarterly?)
- Establishing a date and time (When will most parents be able to attend? An evening? Saturday?)
- Establishing a place (Where will the event be held? In the school? Community center?)
- Selecting a topic and or speaker to facilitate the agenda
- Examining childcare needs (Do we need to offer childcare during the event to encourage attendance? What activities will the children do?)
- Selecting facilitators (Who is knowledgeable on the topics to be covered? Are they available to speak?)
- Preparing materials (What supplemental materials might the participants need?)
- Creating an agenda (How will the time be laid out? All-group lecture? Small, breakout work groups? Grade-level discussions?)

Outcomes to Look for

- Parent responsiveness and attendance
- Increased parental involvement
- Increased parental awareness about mathematics
- Increased parental awareness about math homework help
- New ideas from parents
- Increased communication between home and school

Reflection

The questions below are prompts to help you record your ideas, but you can also write additional observations about the lesson that the questions do not cover.

Preparation

- How well did the lesson planning help you prepare for this activity?
- What can you do to feel more prepared?

Student Engagement

- How did you assess student engagement?
- What did you notice about student engagement in the different parts of the lesson?
- How satisfied were you with the level of student engagement?
- If you were not satisfied, how could you change the lesson to increase student involvement?

Academic Enrichment

- How did this lesson support other content areas?
- What changes could you make to strengthen academic enrichment and still keep the activity fun?

Classroom Management

- What strategies did you use to make this activity go smoothly?
- What changes would you make if you taught the lesson again?


12+2+3 = 17
8+1=9
7x4 = 28
12-6=6
10+1 = 11
2x4 = 8

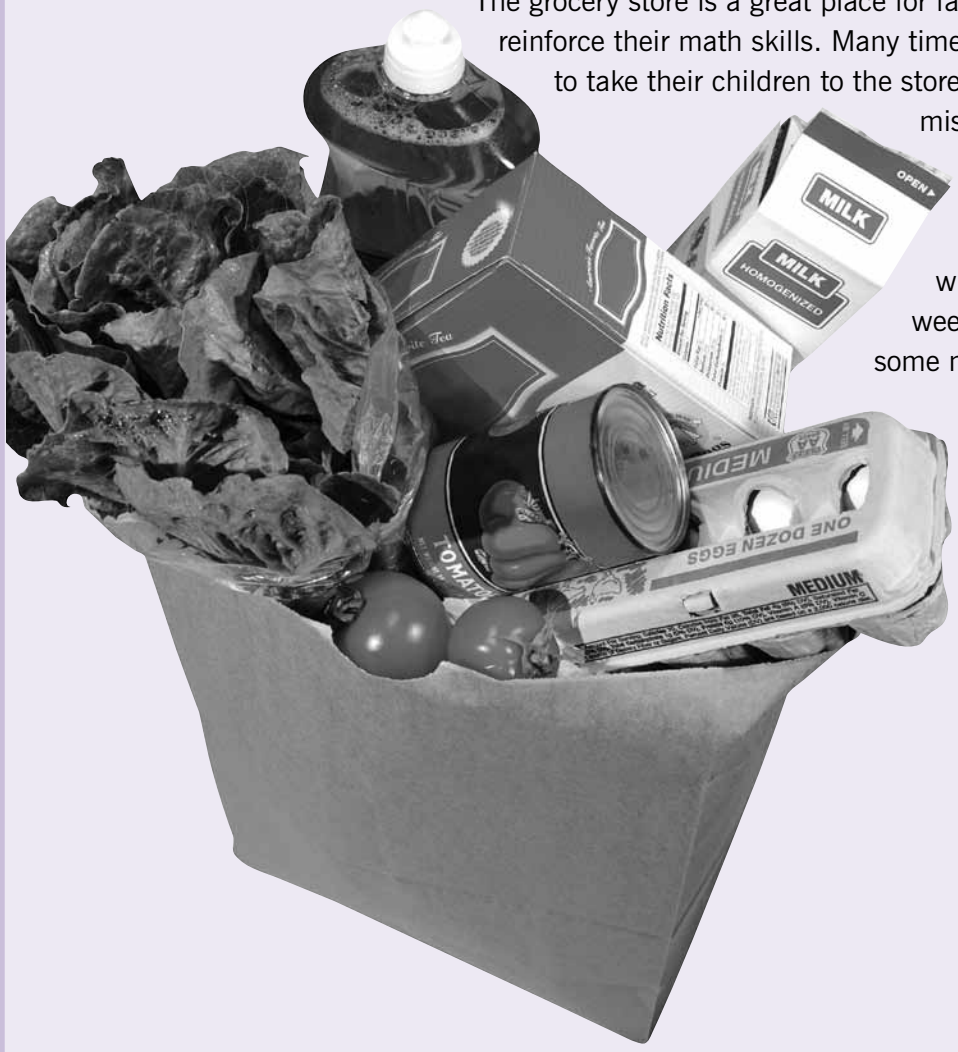
Lesson 3

Grocery Store Math

Unlike the previous sections of this manual, this section does not list detailed and complete lessons for children; rather, it provides many ideas that parents and guardians can implement before, during, and after the grocery shopping experience. Each suggested idea is followed by standards reinforced with the activity.

Like the standards throughout the manual, these standards and benchmarks are from McREL's online database, Content Knowledge: A Compendium of Content Standards and Benchmarks for K–12 Education (4th edition, 2004; www.mcrel.org/standards-benchmarks). The mathematics portion of the database was developed using National Council of Teachers of Mathematics (NCTM) standards in addition to other nationally recognized standards documents.

The grocery store is a great place for families to help students reinforce their math skills. Many times parents are hesitant to take their children to the store out of fear they will misbehave. By giving them a task at the store or upon returning home, children will be more willing to help with this weekly chore and learn some math, too!



Imagine This!

You are having fun grocery shopping with your kids! Yes, that's right! There are many, many mathematical ways you can have a good time at the grocery store while teaching your child math and shopping at the same time. Check out some of the ideas below and have fun!

Idea 1: Shopping Bingo

Grade Level(s):

K–2

- Using the weekly ads, help your child create a bingo card. Take an 8½ by 11 inch piece of paper and fold it in half and then in half again. Repeat until the fold lines create 16 squares.
- Look through the grocery store flier in the newspaper, and with your child cut out numbers that are seen in the advertisements. For example, you might cut out "3 for $1," a picture of a dozen eggs, or the math term *1 gallon.*
- With your child, paste each of these examples into a different square on the page. You can reinforce the page by gluing it on cardboard.
- Take the card with you to the store and have your child mark off a square if he or she spots those numbers, words, or measurements during the trip to the store.
- Make sure to reward your child at the end of the trip for his or her hard work in playing shopping bingo!

Standard: Understands and applies basic and advanced properties of the concepts of numbers

Idea 2: How Many Do We Need?

Grade Level(s):

K–2

- When preparing for a trip to the grocery store, have your child help with the list.
- Write the items on the list and then encourage your child to place marks next to the items representing how many of each item is needed at the store. This will help to reinforce the idea of collecting and organizing data.

Standard: Collects and represents information about objects or events in simple graphs

Idea 3: How Are These Alike?

Grade Level(s):
K–2

- Upon returning from the store, unpack a bag of items and ask your child to sort the items into categories. It is important that the child chooses his or her own categories.
- Once the child is finished, ask him or her to explain how the items in each group are alike.

Standards: Orders objects qualitatively by measurable attribute
Sorts and groups objects by attributes

Idea 4: How Much Does It Hold?

Grade Level(s):
K–2

- For younger students, reinforce their counting skills by having them count the number of items in a bag as you unpack the groceries after a trip to the store.
- You may ask them to estimate the number of items they think they will find in the bag before they begin to unpack the bag.

Standards: Counts whole numbers
Estimates quantities in real-world situations

Idea 5: Pounds of Produce

Grade Level(s):
3–5

- Reinforce the child's ability to accurately measure and estimate weight while in the produce section.
- Tell your child the weight you would like of a particular item and ask him or her to estimate how much of that fruit or vegetable they think that weight will be.
- Once the child has made an estimate, have him or her use the grocery store scale to measure the actual weight of the object.
- Ask the child if there is too much or too little and how he or she knows that.
- Then ask your child to estimate how much or how many more of that object he or she will need to add or subtract to reach the desired weight.

Standards: Uses specific strategies to estimate quantities and measurements
Selects and uses appropriate units of measurement, according to type and size of unit

Idea 6: How Much Is It?

Grade Level(s):

3–5

- Allow children to figure out how much the actual grocery bill will be by looking at the items purchased.
- If you have more than one child with you, create a friendly competition where the children try to get the closest to the actual dollar amount spent.
- You will need to provide each child with paper and pencil to write down the amount of each item.
- You may also want to provide each child with a calculator for this activity.
- For older students, remind them to add in tax and subtract the appropriate amount for coupons or other discounts that you will receive.

Standards: Uses explanations of the methods and reasoning behind the problem solution to determine reasonableness of and to verify results with respect to the original problem

Adds, subtracts, multiplies, and divides decimals

Solves real-world problems involving number operations (e.g., computations with dollars and cents)

Idea 7: What's the Better Deal?

Grade Level(s):

6–8

When shopping on a budget, you pay careful attention to how much each item costs and want to make sure that you get the best deal possible. Older children can help you figure out the best deal possible while also reinforcing their math skills. While shopping at the store, you often come across multiple brands of the item you want to purchase.

- Ask the child to figure out which item has the best unit price and therefore would be the best deal.
- Children will need to take into account the size of the object (oz, lbs, etc.) as well as the cost of the object.
- Many times this exercise can be deceiving, especially if an item is on sale, so make sure the child takes into account any sales or coupons that might come into play.
- Once your child has figured out the best deal, make sure to have him or her rationalize why he or she chose that item.

Standards: Constructs informal logical arguments to justify reasoning processes and methods of solutions to problems

Uses proportional reasoning to solve mathematical and real-world problems

Reflection

The questions below are prompts to help you record your ideas, but you can also write additional observations about the lesson that the questions do not cover.

Preparation

- How well did the lesson planning help you prepare for this activity?
- What can you do to feel more prepared?

Student Engagement

- How did you assess student engagement?
- What did you notice about student engagement in the different parts of the lesson?
- How satisfied were you with the level of student engagement?
- If you were not satisfied, how could you change the lesson to increase student involvement?

Academic Enrichment

- How did this lesson support other content areas?
- What changes could you make to strengthen academic enrichment and still keep the activity fun?

Classroom Management

- What strategies did you use to make this activity go smoothly?
- What changes would you make if you taught the lesson again?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Planning Worksheet: Supporting Math Learning in Afterschool

Begin by connecting with the day-school teacher to find out more about the math standards and grade-level benchmarks. Then identify the skills, standards, or learning goals to incorporate in afterschool.

Grade Level:

Skill/Standard/Learning Goal:

Learning Goal	1. Write the math content standards or learning goals in your own words:
Supporting Knowledge and Skills	2. Now break the learning goal(s) into more specific and manageable pieces: What will students need to know to meet the goal? *Tip: Think about specific facts, concepts, vocabulary, rules, principles, and/or timelines that students need to know to meet the goal.* What will students need to do to meet the goal? *Tip: Think about specific processes, procedures, or other skills that students need to know how to do to be successful with the goal.*
Activities	3. What activities will provide students with opportunities to learn or practice using this knowledge or skills? *Tip: Think in terms of existing activities that you could modify or new ones that you could create.* In what ways do these activities support other goals (youth development, working together, presenting ideas) that you have for your students? *Tip: Think about specific physical, social, moral, emotional, and/or behavioral knowledge and skills that students need to be successful with the activity.*
Assessments	4. How will you know if students learn what you want them to learn? *Tip: Explain what you will see and hear that indicates that students acquired the specific knowledge and skills you identified in Step 2.*

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The content of the Afterschool Training Toolkit is based on more than 4 years of research and observations at 53 afterschool programs with evaluation data suggesting an impact on student learning. The content also draws from a review of relevant research studies and the experience and wisdom that each of the developers brought to the project. The collective experience of the developers includes afterschool programming, professional development, educational research, program development, program management, and direct instructional experience with students.

The developers believe that these practices and materials will help afterschool leaders and educators create high-quality programs that will motivate, engage, and inspire students' learning and participation.

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Technical Assistance and Professional Development for
21st Century Community Learning Centers

This guide to the Afterschool Training Toolkit was created with the support of the U.S. Department of Education for the use of 21st Century Community Learning Centers. Used with the online Afterschool Training Toolkit, this guide will give you the resources you need to build fun, innovative, and academically enriching activities that not only engage students but also extend their knowledge in new ways and increase academic achievement.

NATIONAL PARTNERSHIP FOR
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