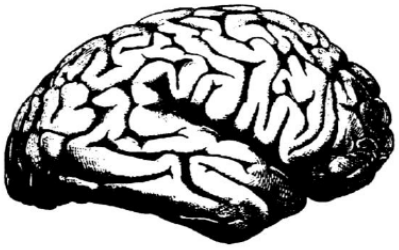
You Can Grow Your Brain

New Research Shows the Brain Can Be Developed Like a Muscle

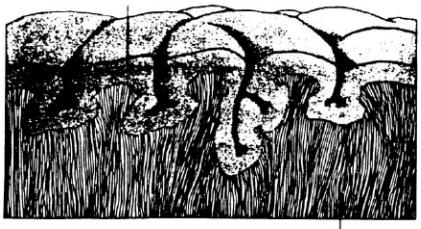
Many people think of the brain as a mystery. We don't often think about what intelligence is or how it works. And when you do think about what intelligence is, you might think that a person is born either smart, average, or dumb—either a "math person" or not—and stays that way for life.

But new research shows that the brain is more like a muscle—it changes and gets stronger when you use it. Scientists have been able to show just how the brain grows and gets stronger when you learn.



Everyone knows that when you lift weights, your muscles get bigger and you get stronger. A person who can't lift 20 pounds when they start exercising can get strong enough to lift 100 pounds after working out for a long time. That's because muscles become larger and stronger with exercise. And when you stop exercising, the muscles shrink and you get weaker. That's why people say "Use it or lose it!"

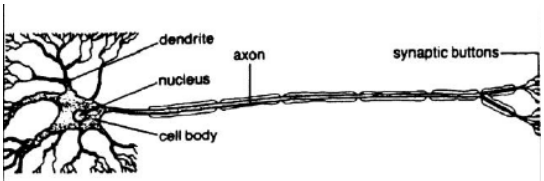
But most people don't know that when they practice and learn new things, parts of their brain change and get larger, a lot like the muscles do. This is true even for adults. So it's not true that some people are stuck being "not smart" or "not math people." You can improve your abilities a lot, as long as you practice and use good strategies.



A Section of the Cerebrum

Inside the outside layer of the brain—called the cortex—are billions of tiny nerve cells, called neurons. The nerve cells have branches connecting them to other cells in a complicated network. Communication between these brain cells is what allows us to think and solve problems.

When you learn new things, these tiny connections in the brain actually multiply and get stronger. The more you challenge your mind to learn, the more your brain cells grow.



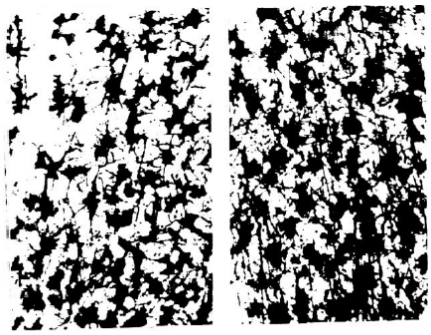
A Typical Nerve cell

Then, things that you once found very hard or even impossible to do—like speaking a foreign language or doing algebra—become easier. The result is a stronger, smarter brain.

How Do We Know That The Brain Can Grow Stronger?

Scientists started thinking the human brain could develop and change when they studied adult animals' brains. They found that animals who lived in a challenging environment, with other animals and toys to play with, were different from animals who lived alone in bare cages.

While the animals who lived alone just ate and slept all the time, the ones who lived with different toys and other animals were always active. They spent a lot of time figuring out how to use the toys and how to get along with other animals.


Nerves in brain of animal living in bare cage.

Brain of animal living with other animals and toys.

These animals had more connections between the nerve cells in their brains. The connections were bigger and stronger, too. In fact, their whole brains were about 10% heavier than the brains of the animals who lived alone without toys.

The adult animals who were exercising their brains by playing with toys and each other were also "smarter" –they were better at solving problems and learning new things.

Can Adults Grow Their Brains?

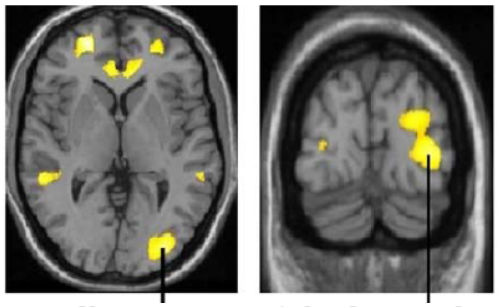
Scientists have recently shown that adults can grow the parts of their brains that control their abilities—like the ability to do math or even to juggle.

In one study, scientists found a group of adults who were not jugglers. They taught half how to practice juggling in the right way. These people practiced

for a long time and got much better at juggling. The other half didn't practice, and didn't get better.

Next, the scientists used a brain scanner to compare the brains of the two groups of people. They found that the people who learned how to juggle actually grew the parts of their brains that control juggling skills—the visual and motor areas. Their brains had changed, so they actually had more ability.

This was surprising because these people said before the study that they couldn't juggle—just like some people say they're "not good at math." But when they learned good strategies for practicing and kept trying, they actually learned and grew their brains.



In Yellow: Parts of the brain that grew when adults learned to juggle

doi:10.1371/journal.pone.0002669.g001

This can happen because learning causes permanent changes in the brain. The jugglers' brain cells get larger and grow new connections between them. These new, stronger connections make the juggler's brain stronger and smarter, just like a weightlifter's toned muscles.

A Formula For Growing Your "Math Brain":
Effort + Good Strategies + Help From Others

Scientists have also found that learning to juggle is a lot like getting better at math. When people learn and practice new ways of doing algebra or statistics, it can grow their brains—even if they haven't done well in math in the past.

Strengthening the "math" part of your brains usually happens when you try hard on challenging math problems. But it's not just about effort. You also need to learn skills that let you use your brain in a smarter way.

If you use a bad strategy, you may not learn—even if you try hard. A few people study for math by doing the same set of easy problems and skipping the hard ones, or just re-reading the textbook, because it feels easier. Yet when it comes time to do the test, they don't do well because they didn't work on problems that stretched their brains and taught them new things. When this happens, they may even say "I'm just not smart at math."

But the truth is that everyone can become smarter at math if they practice in the right way. If a weight lifter watched other people exercise all day long, he wouldn't get any stronger. And if someone tried to learn how to juggle by just reading a book about juggling, they wouldn't learn. You actually have to practice the right way—and usually that means the hard way—to get better at something. In fact, scientists have found that the brain grows more when you learn something new, and less when you practice things you already know.

This means that it's not just how much time and effort you put in to studying math, but whether, when you study, you learn something new and hard. To do that, you usually need to use the right strategies. People often learn those good strategies from others, like teachers or students who do well. Luckily, strategies are easy to learn if you get help.

The Truth About "Smart" and "Dumb"

People aren't "smart" or "dumb" at math. At first, no one can read or solve equations. But with practice, they can learn to do it. And the more a person learns, the easier it gets to learn new things—because their brain "muscles" have gotten stronger.

This is true even for adults who have struggled for a long time to learn something. Dr. Wittenberg, a scientist from Wake Forest University, said "We used to think adults can't form new brain connections, but now we know that isn't true… The adult brain is like a muscle, and we need to exercise it."

People who don't know this can miss out on the chance to grow a stronger brain. They may think they can't do it, or that it's too hard. It does take work to learn, just like becoming stronger physically or becoming a better juggler does. Sometimes it even hurts! But when you feel yourself get better and stronger, you realize that all the work is worth it!

References:

A similar version of this article was written by Lisa Blackwell and can be downloaded from: www.brainology.us/websitemedia/**youcangrowyourintelligence**.pdf

Blackwell, L. A., Trzesniewski, K. H., & Dweck, C. S. (2007). Theories of intelligence and achievement across the junior high school transition: A longitudinal study and an intervention. *Child Development*, *78*, 246-263.

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How can I support my child with learning math?
Parent Guide: Grades 6-8 Math

Goal: You will learn strategies to support your child with learning math.

Three main take homes:

I) Find out what your child is learning in class.

II) Understand what your child knows and use questioning to help clarify and deepen your child's thinking.

III) Provide your child with additional math experiences.

I. Find out what your child is learning in class.
Washington State has established performance expectations (standards) for students K-12, which describe what the students should know and be able to do. A brief summary is shown in **ATTACHMENT A** and a more detailed summary is included in **ATTACHMENT B**. A complete set can be found at www.k12.wa.us/CurriculumInstruct/Mathematics/default.aspx.

- Look at her **daily planner** for homework.

- Look at her **math journal** and **textbook** for specific content.

Math 6-8 Resources

- Download the **parent letter (ATTACHMENT C)** for the unit that your child is working on which will include important concepts and examples to help you support her learning. (Spanish parent guides are available as well)

  Go to http://www.phschool.com/cmp2/parent_guide/

- View the **video tutors** which are short interactive tutorials for each lesson.

  Go to: http://www.phschool.com/atschool/cmp2/program_page.html
  Select grade level, then select "video tutors"

- View additional on-line materials, like **Homework Help, Skills Practice, Active Math Online**, and more.

  Go to: http://www.phschool.com/atschool/cmp2/program_page.html
  Select grade level, then select item

Algebra 1 Resources

- Access **on-line textbook**. The online text has interactive features which enable students to link from pages in the book to practice problems, dynamic explorations, and calculator notes

  Go to http://math.kendallhunt.com/
  Enter your "class pass" (in upper right hand side of screen)

- Download a **Guide for Parents (in English and Spanish) (ATTACHMENT C)** for the unit that your child is working on which will include: A brief summary of each chapter, includes tips for working with students, chapter summary exercises and review exercises with complete solutions.

  Go to: http://math.kendallhunt.com/x4540.html

- View additional on-line resources which include:

  Condensed Lessons (in English and Spanish)—A detailed explanation of each lesson. These can provide extra help for students who have fallen behind or missed class, as well as support for adults who want to understand the details of the mathematics.

  More Practice Your Skills—a set of additional exercises for each lesson in the book for students who want extra practice.

  Calculator Notes, Programs and Data—helpful information, programs and tips for using calculators for specific activities.

  Dynamic Explorations—Structured investigations available online so students and their families can explore mathematics concepts at home

  Go to: http://math.kendallhunt.com/x4540.html

II. Understand what your child knows and use questioning to help clarify and deepen your child's thinking.

See **Attachment D: Questioning Strategies** to learn a process that will help you facilitate a conversation to help her access, solve, and extend her understanding.

- *Scenario 1: She doesn't have a strategy to solve the problem yet.*
- *Scenario 2: She has a strategy that she is going to try.*
- *Scenario 3: She solves a problem correctly (or incorrectly).*

For additional resources, see **Attachment E: Helping your Child with Homework**.

III) Provide your child with additional math experiences.

Playing games with your child is an important way for your child to learn math.

1) For card games, see **Attachment F: Games**

2) For on-line games, see **Attachment G: Getting Started Using Everyday Math on-line**. The EDM program is used for K-5 students; however, if your child needs extra practice then they can access this site:

login: student919 password: 354

3) Some board games that involve mathematical thinking include:

(Note: Math and Stuff has a great selection of games. Mention Pathfinder and our school gets credit)

Sudoku 5x5 (Ages 8 to adult, single player)
This number-based logic game – popularized in Japan, where it's name translates as "one number" - has become a hit for its addictive problem-solving allure and simple elegance. Now it's time for kids to take up the challenge! Sudoku 5x5 packs the educational opportunities of the game into the perfect package for fun and learning alike: magnetized number pieces, a magnetic playing surface, and 48 different challenge cards on which to play, ranging from "Beginner" to "Expert" levels. Kids will love the brain-tingling challenge of making each row, column, and colored section contain the numbers 1 through 5. And all while they practice coordination and sequencing!
Math Dice (Ages 8 to adult, 2 or more players)
In this simple game of mental math, players set their minds racing to creatively calculate a target number. The product of two "target dice" makes the "target number." Then, after rolling three "scoring dice," players must add, divide, square, and subtract to come closest to the target number in the end. When billed as a game, kids may balk at taking up the challenge, but when played as a fun break from practice sheets and textbooks, Math Dice does the trick.
Ka-Ching! (Ages 10 to adult, 2 players)
Kids may not recognize the real world value of math skills, but in this buy low, sell high stock market game, multiplication is key. "Stock" cards of different values and colors are arranged in overlapping columns, and players can choose to either invest by buying a top card, or cash in by selling back two of the same color. Because a pair of cards yields the product of their values, kids must practice strategy and mental multiplication to figure out when to dump their stocks, and when to buy. Although the gameplay lacks some pizazz, Ka-Ching! is a great way to help the math medicine go down, especially if used as a fun alternative to multiplication tables and practice sets.
Chess
A board game of strategic skill for two players.

ATTACHMENTS

Attachment A: Brief Summary of standards

Attachment B: Summary table of standards

Attachment C: Parent Letter

Attachment D: Questioning Strategies

Attachment E: Helping your Child with Homework

Attachment F: Games

Attachment G: Getting Started Using Everyday Math on-line

Questioning Practice

Scenario 1: She doesn't know what to do yet. (Resource: use parent letter)
Example: (Grade 8: Growing, Growing, Growing: Exponential Relationships)

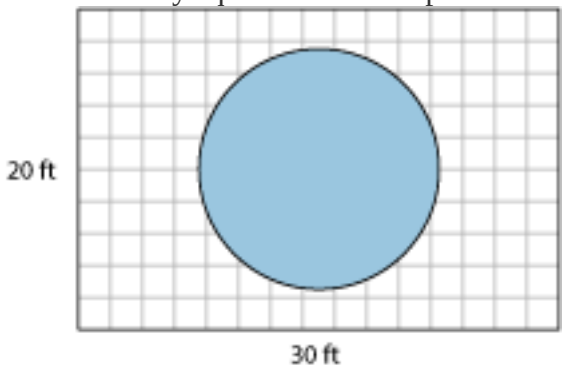
1. Suppose a reward is offered. At the start, $10 is put in a fund. On the first day, $20 is added; on the second day, $40 is added; and on each succeeding day, the reward is doubled. How much money is added on the tenth day?

Parent	Child
What do you know?	
What are you trying to find out?	
How can you solve it?	"I'm not sure"
Ask "question to learn" questions.	Student makes a drawing of situation, but still doesn't know.
Let's look at the parent letter.	
Questions:	

Scenario 2: She doesn't know what to do yet. (Resource: Use on-line Homework Help)
Example (Grade 6: Covering and Surrounding: Investigation 5, ACE Exercise 36)

2. The Nevins want to install a circular pool with a 15-foot diameter in their rectangular patio. The patio will be surrounded by new fencing and the patio area surrounding the pool will be covered with new tiles.

a. How many feet od fencing are needed to enclose the patio?
b. How much plastic is needed to cover the pool if there is a 1-foot overhang?
c. How many feet of plastic tubing are needed to fit around the edge of the pool?
d. How many square feet of the patio will be covered with tiles?



Parent	Child
What do you know?	
What are you trying to find out?	

How can you solve it?	"I'm not sure"
Ask "question to learn" questions.	
Let's use the on-line Homework Help.	
Read the "Hint" questions: • When you find the length of fence around the patio are you finding perimeter or area? • What is the radius of the cover of the pool with the 1-ft overlap? • When you find the amount of plastic that will cover the pool are you finding circumference or area? • What is the radius of the pool? • When you find the amount of plastic tubing that will fit around the pool are you finding circumference or area?	

Scenario 3: She solves a problem correctly (or incorrectly) and you want to clarify and deepen her thinking.

Use example 2 above.

Parent	Child
Possible Questions:	

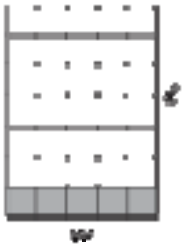
6th grade math

Unit: Covering and Surrounding: Two-Dimensional Measurement

- **Review Parent Letter**

- ***Scenario 1: She doesn't know what to do yet. (Resource: use parent letter)***

1. Determine the area and perimeter of the following:



Parent	Child (doesn't know what to do yet)
What do you know?	
What are you trying to find out?	
How can you solve it?	"I'm not sure"
Ask "question to learn" questions.	Student makes a drawing of situation, but still doesn't know.
Let's look at the parent letter.	
Possible questions:	

Scenario 2: She doesn't know what to do yet. (Resource: Use on-line Homework Help)
Example (Grade 6: Covering and Surrounding: Investigation 3, ACE Exercise 25)

2. Karl and Rita are building a playhouse for their daughter. The floor of the playhouse will be a rectangle that is 6 feet by 8 – 1/2 feet.

a. How much carpeting do Karl and Rita need to cover the floor?
b. How much molding do they need around the edges of the floor?
c. The walls will be 6 feet high. A pint of paint covers about 50 square feet. How much paint do they need to paint the inside walls? Explain.
d. Make your own plan for a playhouse. Figure out how much carpeting, wood, paint, and molding you would need to build the playhouse.

Parent	Child (doesn't know what to do yet)
What do you know?	
What are you trying to find out?	
How can you solve it?	"I'm not sure"
Ask "question to learn" questions.	Student makes a drawing of situation, but still doesn't know.
Let's use on-line homework help. Read the "Hint" questions: 1. Sketch a rectangle to represent the floor and label its length and width. 2. Is the amount of carpeting represented by perimeter or area? 3. Is the amount of molding of the floor represented by perimeter or area? 4. Sketch a rectangle that could represent a wall of the playhouse and label its length and width. 5. Should you find the perimeter or the area when figuring the amount of wall to be painted?	

Scenario 3: She solves a problem correctly (or incorrectly) and you want to clarify and deepen her thinking.

Use example 2 above.

Parent	Child
Possible Questions:	

Math Standards: 6 - 8

ATTACHMENT A

By the end of 6th Grade

*A central theme in Grade 6 is **proportional reasoning.** Students begin to develop multiplicative and proportional reasoning. Ratios, rates, and percents, as well as study of two- and three-dimensional figures, support understanding of proportions. Students are introduced to variables, one-step equations, and graphing of simple functions.*

Number Sense: Multiply and divide fractions and decimals with understanding. Use approximations of fractions and decimals to estimate computations and verify that answers make sense. Extend knowledge of fractions to develop an understanding of what a ratio is and how it relates to a rate and a percent. Extend mental math skills with all operations—addition, subtraction, multiplication, and division—with whole numbers, fractions, and decimals. Expand understanding of our number system through introduction to negative numbers for describing positions or quantities below zero.
Geometry: Extend understanding of area and perimeter to more complex two-dimensional figures, including circles. Find the surface area and volume of simple three-dimensional figures.
Algebra: Develop understanding of how letters are used to represent numbers in mathematics. Use tables, words, numbers, graphs, and equations to describe simple linear relationships. Write and evaluate expressions and write and solve equations.
Processes: Move more fully into the symbolic world of algebra and higher-level mathematics. Move easily among representations—numbers, words, pictures, or symbols—to understand and communicate mathematical ideas, to make generalizations, draw logical conclusions, and verify the reasonableness of solutions to problems.

By the end of 7th Grade

*A central theme in Grade 7 is **application of proportions.** Students learn about proportions (i.e., a proportion is the equating of two ratios) and apply that knowledge. Procedures for computing surface area and volume and study of probability provide opportunities to use proportions. Negative numbers are introduced to extend number sense to all rational numbers; this is critical for algebraic reasoning. Students solve two-step equations and learn different ways to display data.*

Number Sense: Add, subtract, multiply, and divide rational numbers—fractions, decimals, and integers—including both positive and negative numbers. Extend work with ratios to solve problems involving a variety of proportional relationships, such as making conversions between measurement units or finding the percent increase or decrease of an amount. Use exponents to write numbers in terms of their most basic (prime) factors.
Geometry: Solve problems involving the proportional relationships found in similar figures. Extend understanding of surface area and volume to include finding surface area and volume of cylinders and volume of cones and pyramids. Apply formulas and solve a range of problems involving three-dimensional objects. Extend coordinate graphing skills to plotting points with both positive and negative coordinates on the coordinate plane.

Math Standards: 6 - 8

Algebra: Graph proportional relationships and identify the rate of change as the slope of the related line.
Data: Apply understanding of rational numbers and proportionality to concepts of probability. Understand how probability is determined and make related predictions. Revisit how to interpret data, using more sophisticated types of data graphs and thinking about the meaning of certain statistical measures.
Processes: Move more fully into the symbolic world of algebra and higher-level mathematics. Move easily among representations—numbers, words, pictures, or symbols—to understand and communicate mathematical ideas, to make generalizations, draw logical conclusions, and verify the reasonableness of solutions to problems.

By the end of 8th Grade
A central theme in Grade 8 is algebraic thinking. Students consolidate their understanding of multiplicative and proportional reasoning and apply these ideas to fundamental concepts of algebra. Study of linear functions helps students generalize their understanding of proportions to situations involving linear relationships that are not proportional.

Another theme is statistics. Techniques for summarizing and analyzing data are further developed and comparison of two data sets with unequal numbers of data elements provides a sophisticated application of proportions. Study of linear functions helps students generalize their understanding of proportions to situations involving linear relationships that are not proportional. (source OSPI document)

There is also a greater emphasis on verifying and justifying solutions. Finding and knowing a solution is not enough. 8th graders must communicate clearly and use mathematical vocabulary and symbols appropriately to convince as well as refine their thinking to see when their reasoning is logical and appropriate to the task.

Number Sense: Use scientific notation to represent very large and very small numbers, especially as these numbers are used in technological fields and in everyday tools like calculators or personal computers.
Use exponents in expressions containing both numbers and variables. Introduction to simple irrational numbers.
Algebra: Solve a variety of linear equations and inequalities. Build on understanding of proportional relationships and simple linear equations to work with a broader set of linear relationships; learn what functions are. Model applied problems with mathematical functions represented by graphs and other algebraic techniques.
Geometry: Work with lines and angle in solving problems using triangles. Use known relationships involving sides and angles of triangles to find unknown measures. Work with squares and square roots, especially in problems with two- and three-dimensional figures. Use basic geometric theorems such as the Pythagorean Theorem.
Data: Analyze statistical studies or short statistical statements from newspapers, television, or the Internet. Use mean, median, and mode to summarize and describe information, even when these measures may not be whole numbers. Use knowledge of linear functions to analyze trends in displays of data. Create displays for two sets of data

in order to compare the two sets and draw conclusions. Expand understanding of probability to more complex situations.
Processes: Move more fully into the symbolic world of algebra and higher-level mathematics. Move easily among representations—numbers, words, pictures, or symbols—to understand and communicate mathematical ideas, to make generalizations, draw logical conclusions, and verify the reasonableness of solutions to problems.

By the end of Algebra 1
Numbers, Expressions, and Operations: Extend understanding of the number system to real numbers represented by the number line. Work with integer exponents, scientific notation, and radicals, and use variables and expressions to solve problems. Write and manipulate a wide variety of algebraic expressions.
Characteristics and Behavior of Functions: Formalize and deepen understanding of functions, their characteristics, and their use. Recognize functions of the form $y = f(x)$, where any allowable x-value yields a unique y-value. Learn and use representations and basic transformations of functions.
Linear Functions, Equations, and Inequalities: Use linear functions to model situations involving a constant rate of change. Solve sets of linear equations and inequalities in two variables, interpreting the intersection of the lines as the solution. Use graphical and numerical methods to approximate solutions to equations. Use linear functions to analyze relationships, represent and model problems, and answer questions.
Quadratic Functions and Equations: Graph quadratic functions, and solve quadratic equations with real roots. Use quadratic functions to represent and model problems and answer questions in situations that are modeled by these functions. Solve quadratic equations by factoring.
Data: Select and use mathematical models to represent, describe, and compare data sets. Determine the relationship between two variables; make and defend appropriate predictions, conjectures, and generalizations. Understand limitations of conclusions based on results of a study or experiment; recognize common misrepresentations.
Additional Content: Develop a basic understanding of arithmetic and geometric sequences and of exponential functions, including their graphs and other representations.
Processes: Use algebra and the properties of number systems to develop valid mathematical arguments, make and prove conjectures, and find counterexamples to refute false statements, using correct mathematical language, terms, and symbols. Formalize a coherent problem-solving process: analyze the situation to determine the question(s) to be answered, synthesize given information, and identify implicit and explicit assumptions. Examine solution(s) to determine reasonableness, accuracy, and meaning in the context of the original problem.

ATTACHMENT B: 6th Grade Standards

6TH GRADE MATH STANDARDS

List of Performance Expectations	Core Content #1: Multiplication and Division of Fractions and Decimals	Core Content #2: Mathematical Expressions and Equations	Core Content #3: Ratios, Rates and Percents	Core Content #4: Two- and Three-Dimensional Figures	Core Content #5: Additional Key Content	Core Processes #6: Reasoning, Problem Solving, and Communication
A	Compare and order non-negative fractions, decimals, and integers using the number line, lists, and the symbols <, >, or =. N	Write a mathematical expression or equation with variables to represent information in a table or given situation. A	Identify and write ratios as comparisons of part-to-part and part-to-whole relationships. N	Determine the circumference and area of circles. GM	Use strategies for mental computations with non-negative whole numbers, fractions, and decimals. O	**Analyze** a problem situation to determine the question(s) to be answered.
B	Represent multiplication and division of non-negative fractions and decimals using area models and the number line, and connect each representation to the related equation. O	Draw a first-quadrant graph in the coordinate plane to represent information in a table or given situation. A	Write ratios to represent a variety of rates. N	Determine the perimeter and area of a composite figure that can be divided into triangles, rectangles, and parts of circles. GM	Locate positive and negative integers on the number line and use integers to represent quantities in various contexts. N	**Identify** relevant, missing, and extraneous information related to the solution to a problem.
C	Estimate products and quotients of fractions and decimals. O	Evaluate Mathematical expressions when the value for each variable is given. A	Represent percents visually and numerically, and convert between the fractional, decimal, and percent representations of a number. D	Solve single- and multi-step word problems involving the relationships among radius, diameter, circumference, and area of circles, and verify the solutions. GM	Compare and order positive and negative integers using the number line, lists, and the symbols <, >, or =. N	**Analyze and compare** mathematical strategies for solving problems, and select and use one or more strategies to solve a problem.
D	Fluently and accurately multiply and divide non-negative fractions and explain the inverse relationship between multiplication and division with fractions. O	Apply the commutative, associative, and distributive properties, and use the order of operations to evaluate mathematical expressions. O	Solve single- and multi-step word problems involving ratios, rates, and percents, and verify the solutions. AO	Recognize and draw two-dimensional representations of three-dimensional figures. GM		**Represent a problem situation**, describe the process used to solve the problem, and verify the reasonableness of the solution.
E	Multiply and divide whole numbers and decimals by 1000, 100, 10, 1, 0.1, 0.01, and 0.001. O	Solve one-step equations and verify solutions. A	Identify the ratio of the circumference to the diameter of a circle as the constant π, and recognize 22/7 and 3.14 as common approximations of π. GM	Determine the surface area and volume of rectangular prisms using appropriate formulas and explain why the formulas work. GM		**Communicate the answer(s)** to the question(s) in a problem using appropriate representations, including symbols and informal and formal mathematical language.
F	Fluently and accurately multiply and divide non-negative decimals. O	Solve word problems using mathematical expressions and equations and verify solutions. A	Determine the experimental probability of a simple event using data collected in an experiment. PS	Determine the surface area of a pyramid. GM		**Apply** a previously used problem-solving strategy in a new context.
G	Describe the effect of multiplying and dividing a number by one, by zero, by a number between zero and one, and by a number greater than one. O		Determine the theoretical probability of an event and its complement and represent the probability as a fraction or decimal from 0 to 1 or as a percent from 0 to 100. PS	Sort and classify prisms and pyramids by their attributes, such as: types of faces, number of faces, edges, and vertices. GM		**Extract and organize** mathematical information from symbols, diagrams, and graphs to make inferences, draw conclusions, and justify reasoning.
H	Solve single- and multi-step word problems involving operations with fractions and decimals and verify the solutions. AO					**Make and test conjectures** based on data (or information) collected from explorations and experiments.

ATTACHMENT B: 7th Grade Standards

7TH GRADE MATH STANDARDS

List of Performance Expectations	Core Content #1: Rational Numbers and Linear Equations	Core Content #2: Proportionality and Similarity	Core Content#3: Surface Area and Volume	Core Content #4: Probability and Data	Core Content #5: Additional Key Content	Core Processes #6: Reasoning, Problem Solving, and Communication
A	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
B	Represent addition, subtraction, multiplication, and division of positive and negative integers visually and numerically.	Solve single- and multi-step problems involving proportional relationships and verify the solutions.	Determine the volume of pyramids and cones using formulas.	Determine the theoretical probability of a particular event and use theoretical probability to predict experimental outcomes.	Write the prime factorization of whole numbers greater than 1, using exponents when appropriate.	**Identify** relevant, missing, and extraneous information related to the solution to a problem.
C	[illegible]	[illegible]	[illegible]	[illegible]		**Analyze and compare** [illegible]
D	Define and determine the absolute value of a number.	Make scale drawings and solve problems related to scale.	Solve single- and multi-step word problems involving surface area or volume and verify the solutions.	Construct and interpret histograms, stem-and-leaf plots, and circle graphs.		**Represent a problem situation,** describe the process used to solve the problem, and verify the reasonableness of the solution.
E	[illegible]	[illegible]		[illegible]		**Communicate** [illegible]
F	Write an equation that corresponds to a given problem situation, and describe a problem situation that corresponds to a given equation.	Determine the slope of a line corresponding to the graph of a proportional relationship and relate slope to similar triangles.				**Apply** a previously used problem-solving strategy in a new context.
G	[illegible]	[illegible]				[illegible]
H		Determine whether or not a relationship is proportional and explain your reasoning.				**Make and test conjectures** based on data (or information) collected from explorations and experiments.
I		[illegible]				

ATTACHMENT B: 8th Grade Standards

8TH GRADE MATH STANDARDS					
List of Performance Expectations	Core Content #1: Linear Functions and Equations	Core Content #2: Properties of Geometric Figures	Core Content #3: Summary and Analysis of Data Sets	Core Content #4: Additional Key Content	Core Processes #5: Reasoning, Problem Solving, and Communication
A	A	GM	PS	N	
B	Solve one- and two-step linear inequalities and graph the solutions on the number line. A	Determine missing angle measures using the relationships among the angles formed by parallel lines and transversals. GM	Select, construct, and analyze data displays, including box-and-whisker plots, to compare two sets of data. PS	Solve problems involving operations with numbers in scientific notation and verify solutions. O	**Identify** relevant, missing, and extraneous information related to the solution to a problem.
C	A	GM	PS	O	**Analyze and compare** mathematical
D	Determine the slope and y-intercept of a linear function described by a symbolic expression, table, or graph. A	Represent and explain the effect of one or more translations, rotations, reflections, or dilations (centered at the origin) of a geometric figure on the coordinate plane. GM	Describe different methods of selecting statistical samples and analyze the strengths and weaknesses of each method. PS	Identify rational and irrational numbers. N	**Represent a problem situation**, describe the process used to solve the problem, and verify the reasonableness of the solution.
E	A	N	PS		**Communicate**
F	Solve single- and multi-step word problems involving linear functions and verify the solutions. A	Demonstrate the Pythagorean Theorem and its converse and apply them to solve problems. GM	Determine probabilities for mutually exclusive, dependent, and independent events for small sample spaces. PS		**Apply** a previously used problem-solving strategy in a new context.
G	A	GM	PS		**Extract and organize**
H					**Make and test conjectures** based on data (or information) collected from explorations and experiments.

ATTACHMENT B

ALGEBRA 1 MATHEMATICS STANDARDS

Standard Performance Expectations	Quad Question 1 Solving Problems	Quad Cluster 2 Numbers, Expressions, & Operations	Quad Cluster 3 Characteristics & Behaviors of Functions	Quad Standard 4 Linear Functions, Equations, & Inequalities	Quad Standard 5 Quadratic Functions and Equations	Core Concept 6 Data and Distributions	Five Fundamental 1 Additional Key Content	Five Processes Reasoning, Problem Solving, Communication
A	Select and justify functions and equations to model and solve problems. A	Know the relationship between real numbers and the number line, and compare and order real numbers with and without the number line. N	Determine whether a relationship is a function and identify the domain, range, roots, and independent and dependent variables. A	Write and solve linear equations and inequalities in one variable. A	Represent a quadratic function with a symbolic expression, a graph, in a table, and with a description, make connections among representations. A	Use and evaluate the accuracy of summary statistics to describe and compare data sets. DSP	Sketch exponential function's graph in the form $y = ab^n$ where n is an integer, describe effects that changes in the parameters a and b have on the graph, & answer questions that arise in situations modeled by exponential functions. A	Analyze a problem situation and represent it mathematically. CP
B	Solve problems that can be represented by linear functions, equations, and inequalities. A	Recognize the multiple uses of variables, determine all possible values of variables that satisfy prescribed conditions, and evaluate algebraic expressions that involve variables. A	Represent a function with a symbolic expression, as a graph, in a table, and using words, and make connections among these representations. A	Write and graph an equation for a line given the slope and the y-intercept, the slope and a point on the line, or two points on the line, and translate between forms of linear equations. A	Sketch the graph of a quadratic function, describe the effects that changes in the parameters have on the graph, interpret x-intercepts as solutions to quadratic equation. A	Make valid inferences and draw conclusions based on data. DSP	Find and approximate solutions to exponential equations. A	Select and apply strategies to solve problems. CP
C	Solve problems that can be represented by a system of two linear equations or inequalities. A	Interpret and use integer exponents, square/cube roots, apply the laws and properties of exponents to simplify and evaluate exponential expressions. A	Evaluate $f(x)$ at a (i.e., $f(a)$) and solve for x in the equation $f(x) = b$. A	Identify and interpret the slope and intercepts of a linear function, including equations for parallel and perpendicular lines. A	Solve quadratic equations that can be factored as $(ax + b)(cx + d)$ where a, b, c and d are integers. A	Describe how linear transformations affect the center and spread of univariate data. DSP	Express arithmetic and geometric sequences in both explicit and recursive forms, translate between the two forms, explain how rate of change is represented in each form, and use the forms to find specific terms in the sequence. AN	Evaluate a solution for reasonableness, verify its accuracy, and interpret the solution in the context of the original problem. CP
D	Solve problems that can be represented by quadratic functions and equations. (see also AZ.1.C) A	Determine whether approximations or exact values of real numbers are appropriate, depending on the context, and justify the selection. N		Write and solve systems of two linear equations and inequalities in two variables. A	Solve quadratic equations that have real roots by completing the square and by using the quadratic formula. A	Find the equation of a linear function that best fits bivariate data that are linearly related, interpret the slope and y-intercept of the line, and use the equation to make predictions. DSP	Solve an equation involving several variables by expressing one variable in terms of the others. A	Generalize a solution strategy for a single problem to a class of related problems, and apply a strategy for a class of related problems to solve specific problems. CP
E	Solve problems that can be represented by exponential functions and equations. A	Use algebraic properties to factor and combine like terms in polynomials. NA		Describe how changes in the parameters of linear functions & functions containing an absolute value of a linear expression affect their graphs & the relationships they represent. A		Describe the correlation of data in scatterplots in terms of strong or weak and positive or negative. DSP		Read and interpret diagrams, graphs, and text containing the symbols, language, and conventions of mathematics. CP
F		Add, subtract, multiply, and divide polynomials. NA						Summarize mathematical ideas with precision and efficiency for a given audience and purpose.
G								Synthesize information to draw conclusions, and evaluate the arguments and conclusions of others.
H								Use inductive reasoning about algebra and properties of numbers to make conjectures, use deductive reasoning to prove or disprove conjectures.

N Numbers O Operations A Algebra GM Geometry Measurement DSP Data/Statistics/Probability CP Core Process

Dear Family,

The next unit in your child's mathematics class this year is ***Covering and Surrounding: Two-Dimensional Measurement***. The focus is area (covering) and perimeter (surrounding). The unit helps students develop an understanding of perimeters and areas of rectangles, triangles, parallelograms, and circles. Students use estimating and counting to find areas and perimeters of irregular figures.

UNIT GOALS

The overarching goal of this unit is to help students understand what it means to measure. Students study two kinds of measurements: perimeter and area. Since students often do not know how each of these measures affects the other, students study them together to probe the relationships.

Students develop strategies for measuring perimeter and area. Their strategies are discussed and used to formulate rules for finding area and perimeter of different figures. Many ideas from previous units will be revisited and extended in this unit. For example, from the *Prime Time* unit, the connection between factors and dimensions of rectangles will be used.

HELPING WITH HOMEWORK

You can help with homework and encourage sound mathematical habits as your child studies this unit by asking questions such as:

- How do you know which measurements of a figure are involved—area or perimeter?
- How can you find the area and perimeter of an irregular shape?
- How can you find the area and perimeter of a regular shape?
- Is an exact answer required?
- Is there a relationship between area and perimeter that will help solve the problem?

In your child's notebook, you can find worked-out examples from problems done in class, notes on the mathematics of the unit, and descriptions of the vocabulary words.

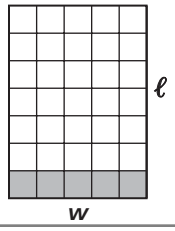
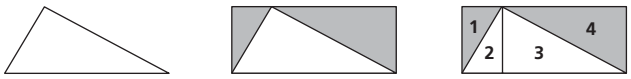
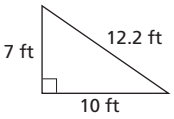
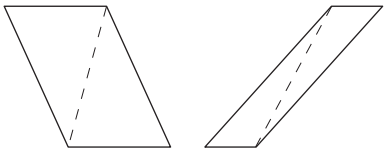
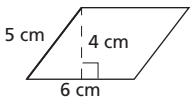
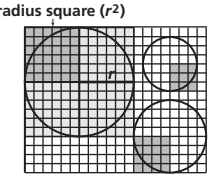
HAVING CONVERSATIONS ABOUT THE MATHEMATICS IN *COVERING AND SURROUNDING*

You can help your child with his or her work for this unit in several ways:

- Encourage him or her to use the measuring tools you have at home, such as measuring tapes and rulers, to practice making measurements.
- Help your child develop personal referents for estimating lengths and distances. For example, the distance from home to school might be one mile, or the span of your child's hand might be six inches. Use these referents to estimate other distances and lengths.
- Help your child develop personal referents for estimating area. Use the area of his or her bedroom to estimate areas of other rooms.
- Look over your child's homework and make sure all questions are answered and that explanations are clear.

A few important mathematical ideas that your child will learn in *Covering and Surrounding* are given on the back. As always, if you have any questions or concerns about this unit or your child's progress in class, please feel free to call.

Sincerely,

Important Concepts	Examples
The Measurement Process • Identify an object and the attribute to be measured. • Select an appropriate unit. • Repeatedly "match" the unit to the attribute of the object (or phenomenon, such as time). • Determine the number of units.	**Measuring Perimeter** Measuring perimeter requires counting how many linear units are needed to surround an object. **Measuring Area** Measuring area requires counting how many square units are needed to cover an object.
Area of Rectangles Students begin finding the area by counting the number of squares enclosed. To count more efficiently, they find the number of squares in one row and multiply by the number of rows. In other words, find the area by multiplying the length (how many in a row) by the width (the number of rows).	There are 5 squares in the first row and 7 rows in all. The area of the rectangle is $5 \times 7 = 35$ square units or, in general, $\ell \times w$. 
Perimeter of Rectangles Students count the number of linear units surrounding the rectangle. To count more efficiently, they can take the measure of the length plus the width and double that amount. They can also calculate two lengths plus two widths to get the perimeter of a rectangle.	The perimeter of the figure above is $2(7 + 5)$ or $2 \times 7 + 2 \times 5$ or, in general, $2(\ell + w)$ or $2\ell + 2w$.
Area of Triangles Students use their knowledge of rectangles to find the area of triangles. If we surround a triangle with a rectangle, we can see that the area of the triangle is half of the area of the rectangle. The triangle may be turned to a convenient side as the base, if needed.	 Sections 1 and 2 are congruent. 3 and 4 are congruent. The area of the triangle is $\frac{1}{2}\ b \times h$ where b is the base of the triangle (length of the rectangle) and h is the height of the triangle (width of the rectangle).
Perimeter of Triangles Students find the perimeter of a triangle by measuring the lengths of the three sides and adding them together.	The perimeter of the triangle is $7 + 10 + 12.2$, or 19.2 ft. 
Area of Parallelograms Students draw a diagonal creating two congruent triangles. The parallelogram and triangle have the same length of the base and height. Students find the area of the parallelogram by multiplying the base and height, without dividing by two, as they did when finding the area of a triangle.	The area of a parallelogram is the area of two triangles $2 \times (\frac{1}{2}\ b \times h)$, or just $b \times h$. 
Perimeter of Parallelograms The perimeter of parallelograms is found by measuring the lengths of the four sides and adding them together.	The perimeter of the parallelogram is $2(5 + 6)$ or $2 \times 5 + 2 \times 6 = 22$ cm. 
Area of Circles Students find the number of "radius squares," whose side lengths are equal to the radius, that cover the circle. They find they need a little more than three, or pi.	The area of a circle is pi $\times$ a "radius square" or pi $\times$ radius $\times$ radius $= \pi \times r \times r = \pi r^2$ 
Perimeter of Circles (Circumference) Students count the number of diameter lengths needed to surround the circle. It is a little more than three, or pi.	The circumference of a circle is pi $\times$ diameter $= \pi d$.

On the **CMP Parent Web Site,** you can learn more about the mathematical goals of each unit, see an illustrated vocabulary list, and examine solutions of selected ACE problems. **http://PHSchool.com/cmp2parents**

ATTACHMENT D

Questioning Strategies

I) To help your child think about a problem, use a K-W-H (Know-What-How) strategy.

1) "What do you **k**now?"
2) "**W**hat are you trying to find out?"
3) "**H**ow can you solve it?" (Make sure you give them time to think and process their ideas)

A) She doesn't know what to do <u>yet</u>.

1) Question to learn:
- "Have you solved similar problems that would help? Let's look at your notebook."
- "What terms do you understand or not understand?"
- "Can you make a drawing to show what you know?"
- "Can you describe a strategy we could try?"

2) Use other resources (see the "Parent Guide" for detailed information):
- Download the parent letter for the unit that your child is working on which will include important concepts and examples to help you support her learning.
- View on-line Homework Help
- View the Video Tutors which are short interactive tutorials for each lesson

B) She has a strategy that she is going to try. While working on the problem…

- Do you see any patterns or relationships that will help solve this?
- How can you organize the information?
- Can you describe a strategy you can use to solve this?
- Can you make a drawing to explain your thinking?
- What would happen if. . . ?

C) She solves a problem correctly (or incorrectly) and you want to clarify and deepen her thinking.

- "How did you solve it?"
- "Help me understand this part…"
- "How does the math in this problem relate to other problems you have seen?"
- "Can you explain/show why this is true?"
- "How can you convince me your answer makes sense?"
- "Does your answer seem reasonable? Why or why not?"
- "That's great that you can solve it like that, I'm wondering if you can think of a another way to solve it?"
- What if you had started with…rather than…?

Helping Your Child With Homework

In helping your child learn, one goal is to assist them in figuring out as much as they can for themselves. Good questions and good listening will help make sense of mathematics, build self-confidence, and encourage mathematical thinking and communication. Here are some questions you can use to guide your child's thinking:

Getting Started

- What do you need to find out?
- What do you need to know?
- What terms do you understand or not understand?
- Have you solved similar problems that would help? Let's look at your notebook.

Working on the Problem

- How can you organize the information?
- Do you see any patterns or relationships that will help solve this?
- Can you describe a strategy you can use to solve this?
- Can you make a drawing to explain your thinking?
- What would happen if. . . ?

Reflecting On a Solution

- Has the question been answered?
- How do you know your solution is reasonable?
- How can you convince me your answer makes sense?
- What mathematical skills and ideas did you use to solve the problem?
- What did you try that did not work?

Clarifying and Extending Thinking

- Help me understand this part. . .
- Can you explain it in a different way?
- Is there another possibility or strategy that would work?
- How is this connected to other ideas that you have learned?

Helping Your Child Become Organized

Find a Study Place If possible, arrange for a quiet area. Have available materials such as graph paper, notebook paper, a ruler with both metric and standard units, a calculator (graphing for 7th–12th grade), and a dictionary.

Develop a System Help your child develop a system for writing down assignments and keeping track of progress. Check to make sure your child does so consistently.

Develop Note Taking Skills Help your child develop a system for taking meaningful notes. Frequently, note taking is taught during class, so it may just be a matter of seeing if your child is properly taking notes.

Organize Your Notebook Many children need assistance in organizing and maintaining a notebook. Routinely check to see if your child is correctly following the program's guidelines for keeping notebooks.

Foster Time Management Skills Encourage and expect your child to get work done on time, to stay caught up, to get help in a timely manner, and to correct errors in work. You may want to help your child go over incorrect or incomplete work and talk about how the work could be improved.

Master the Needed Skills It is generally expected that middle school students know whole number addition, subtraction, multiplication, and division. If your child is not proficient with these basic skills, help them master the needed skills.

Find Study Buddies Encourage your child to identify study buddies or another student they can call to work with on assignments, get clarification, or find out about makeup work.

Doing More Math at Home

Two important goals for all students are that they learn to value mathematics and become confident in their ability to do mathematics. Parents can help them develop a "can do" disposition toward math, by nurturing their curiosity and providing support and encouragement.

Point Out Real-World Mathematics Mathematics is everywhere, yet many children don't see it. Point out and reinforce mathematics skills at home. For example:

- Talk about how you use math at work or home.
- Involve your child in tasks that require computing, measuring, estimating, building, problem solving, and reasoning.
- Look for activities that require your child to use their mathematical skills such as building scale models, cooking, planning trips, and playing logic games.

Have Your Child Explain What They Learned Invite your child to explain what was learned in class. It gives them an opportunity to clarify their thinking, to practice new skills, and to communicate mathematically.

Look for Games Using games and activities is an another way of teaching and/or reinforcing mathematics skills and thinking.

Look for Articles Many articles have data that might interest your child (e.g., sports statistics, data on teenage smoking, facts about natural disasters). Share them and talk about what the numbers mean.

Share Strategies Have your child share their strategies for problem solving, mental computation, and estimation. Share your strategies with them.

Look for Software If your child has access to a computer, look for software that reinforces and teaches mathematical concepts.

ATTACHMENT F

Middle School Grade Games

Factor Top It

Materials: number cards 0-9 (4 of each) (a "10" can represent a "0") Players: 2-4
Skill: Finding factors of a number
Object of the game: To score the most points in 5 rounds.

1. Shuffle the deck and place it number side down on the table.
2. In each round, players take turns. When it is your turn:
   - Draw 2 cards from the top of the deck.
   - Use the cards to make a 2-digit number.
   - Record the number and all of its factors on a piece of paper.
   - Find the sum of all the factors. This is your score for the round.
3. Play 5 rounds.
4. The winner is the player with the most points at the end of 5 rounds.

Example:

Player 1: Cards 5 and 9 are used to form the number 95.
Factors: 1, 5, 19, 95
Score: 1+5+19+95 = 120

Player 2: Cards 2 and 5 are used to form the number 52.
Factors: 1, 2, 4, 8, 11, 22, 44, 88
Score: 1+2+4+8+11+22+44+88 = 180

Player 2 scored the most points for this round.

Fraction/Whole Number Top It

Materials: number cards 1-10 (4 of each) Players: 2-4
Skill: Multiplication of whole numbers and fractions
Object of the game: To collect the most cards.

1. Shuffle the cards and place them number side down on the table.
2. Each player turns over 3 cards. The card numbers are used to form 1 whole number and 1 fraction.
   - The first card drawn is placed number-side up on the table. This card number is the whole number.
   - The second and third cards drawn are used to form a fraction and are placed number-side up next to the first card. The fraction that these cards form must be less than or equal to 1.
3. Each player calculates the product of their whole number and fraction and calls it out as a mixed number. The player with the largest product takes all the cards. Players may use a calculator to compare their products.

4. In case of a tie for the largest product, each tied player repeats steps 2 and 3. The player with the largest product takes all the cards from both plays.
5. The game ends when there are not enough cards left for each player to have another turn. The player with the most cards wins.

Example:
Amy turns over a 3, a 9, and a 5, in that order.
Roger turns over a 7, a 2, and an 8, in that order.
Amy's product is $3*\frac{5}{9}=\frac{15}{9}=\frac{5}{3}=1\frac{2}{3}$
Roger's product is $7*\frac{2}{8}=\frac{14}{8}=\frac{7}{4}=1\frac{3}{4}$
Roger's product is larger, so he takes all of the cards.

Advanced Version: Each player turns over 4 cards and forms 1 fraction from their first 2 cards and a second fraction from their last 2 cards. (All fraction must be less than or equal to 1).

Multiplication Top It

Materials: deck of cards (numbers 1-10) Players: 2-4
Skill: multiplication and division facts

1. The rules are the same as for Addition Top It, except that players find the product of the numbers instead of the sum.
2. The player with the largest product takes all the cards. Answers can be checked with a multiplication table or calculator.

Variation: Uses only the number cards 1-9. Each player turns over 3 cards, forms a 2-digit number, then multiplies the 2-digit number by the remaining number.

Division Top It

1. Use only the number cards 1-9. Each player turns over 3 cards and uses them to generate a division problem as follows:
- Choose 2 cards to form the dividend.
- Use the remaining card as the divisor.
- Divide and drop any remainder.

2. The player with the largest quotient takes all the cards.

Advanced Version: Use only the number cards 1-9. Each player turns over 4 cards, chooses 3 of them to form a 3-digit number, then divides the 3-digit number by the remaining number. Players should carefully consider how they form their 3-digit numbers. For example, 462/5 is greater than 256/4.

ATTACHMENT G

Everyday Math Online Access Directions

Dear Families,

We are excited to announce that your family is now able to access the Everyday Math online tools from any computer that has an Internet connection. We hope that you will find both the Online Games and the Interactive Student Reference Book useful for supporting your child at home. (Note: You will need to download **"Shockwave"** onto your computer in order to play the games. This is a free program.)

Here is how it works:

1) Open Internet Explorer or another web browser and go to http://em-ccss.everydaymathonline.com

2) Enter your student's username and press **"LOG IN".**

4) Then the password window will show up. Enter the 3 digit password from your student's card. Then click "**LOG IN**".

5) Then you can choose between using the Online Games or the Interactive Student Reference Book.

Online Games

When you choose the online games, your child can select a grade range and then pick a game from the menu. The games allow students a fun way to practice what they are learning at school.

Interactive Student Reference Book

When you choose the reference book, you can look up math terms in the glossary, search for a topic in the table of contents, or see examples of problems being solved. When you see the open book icon on a math homework assignment, go to the suggested page number in the online reference book to find further explanation and examples.

We hope you find these tools useful in supporting your student at home. Have fun doing math together!

login: student919 password: 354

Estimadas Familias,

Estamos entusiasmados en anunciar que su familia ya tiene acceso a las herramientas enlínea de Matemáticas Diarias en cualquier computadora que tenga conexión de Internet. Esperamos que los Juegos Enlínea y el Libro de Referencia Estudiantil le sean de utilidad en ayudar a su niño/a en casa.

Así funciona:

1) Abra "Internet Explorer" o cualquier otro buscador y vaya a http://em-ccss.everydaymathonline.com

2) Entre el nombre de usuario de su estudiante y presione **"LOG IN".**

4) La ventana para el código de paso aparecerá. Entre el ccódigo de 3 dígitos que aparece en la tarjeta de su estudiante. Luego haga clic en **"LOG IN".**.

5) Ahí puede escoger usar los Juegos Enlínea o el Libro de Referencia Estudiantil.

Juegos Enlínea
Al escoger los juegos su niño/a debe seleccionar el rango de grados que sea más apropiado y escoger del menú de juegos. Los juegos serán una manera muy divertida de practicar lo que han estado estudiando en la escuela.

Libro Interactivo de Referencia Estudiantil (También en Español)
En el libro de referencia puede buscar términos matemáticos en el glosario, buscar tópicos en la tabla de contenido o ver ejemplos de cómo solucionar problemas. Cuando vea el dibujo del libro abierto en la tarea, puede ir a la página indicada en el libro de referencia para ver más ejemplos y explicaciones. Para español presione el botón en la esquina superior derecha.

Esperamos que esto le sea útil. Diviértanse juntos con matemáticas!

Sinceramente,