The Probability of Pursuit

Students will:

- Practice grade-level appropriate math skills.
- Develop mathematical reasoning.
- Move flexibly between concrete and abstract representations of mathematical ideas in order to solve problems, model mathematical ideas, and communicate solution strategies.

Use the following games to help students practice the following [and many other] grade-level appropriate math skills.

Note: Some skills are repeated in multiple age groups and grades, and so can be worked on with multiple age-groups.

2nd Graders:

- Guess the number
- Coordinate graphs
- Fractions (order, compare, identify)
- Multiplication tables up to 5
- Multiplication tables up to 10
- More, less, and equally likely
- Certain, probable, unlikely, and impossible
- Median, mode, and range
- Divisors and quotients up to 5
- Divisors and quotients up to 10

3rd Graders:

- Working on multiplication and division facts up to 12
- Coordinate graphs
- Guess the number
- Word Problems
- Calculate probability
- Make predictions
- Addition, subtraction, multiplication, and division terms

4th Graders:

- Practicing multiplication and division facts to 12
- Multiply 1 digit numbers by larger numbers.
- Numeric patterns: word problems
- Graph points on a coordinate plane
- Guess two numbers based on sum, difference, product, and quotient
- Mean, median, mode, and range
- Number sequences involving decimals
- Multiplying two digit numbers by two digit numbers.
- Divide larger numbers with one digit divisors.
- Calculate probability
- Make predictions
- Divide by two digit numbers.
- Word Problems

5th Graders:

- Practicing multiplication and division facts to 12
- Add, subtract, multiply, and divide whole numbers
- Multi-step Word Problems
- Place values in decimal numbers
- Calculate probability
- Make predictions
- Even and odd arithmetic patterns
- Put integers in order
- Make Predictions
- Fractions
- Reduce fractions to simplest form (Ex. Write 4/10 in simplest form)

6th Grade:

- Add, subtract, multiply, and divide whole numbers, fractions, integers, mixed numbers, money amounts, and decimals
- Word problems with multiple steps or extra or missing information
- Reduce fractions to simplest form (Ex. Write 4/10 in simplest form)
- Coordinate graphs review
- Calculate mean, median, mode, and range
- Probability of opposite, mutually exclusive, and overlapping events
- Compound events - find the number of outcomes by counting
- Probability of one event
- Make predictions
- Fractions

7th Grade:

- Add, subtract, multiply, divide, and simplify whole numbers, rational numbers, fractions, integers, mixed numbers, money amounts, and decimals
- Word problems with multiple steps or extra or missing information
- Decimal numbers
- Fractions
- Make predictions
- Probability of simple events

- Probability of opposite, mutually exclusive, and overlapping events
- Calculate mean, median, mode, and range

8th Grade and higher:

- Add, subtract, multiply, divide, and simplify whole numbers, rational numbers, fractions, integers, mixed numbers, money amounts, and decimals
- Word problems with multiple steps or extra or missing information
- Calculate mean, median, mode, and range
- Make predictions
- Fractions
- Probability of simple events
- Probability of opposite, mutually exclusive, and overlapping events
- Decimal numbers

The Probability of Pursuit

Three of a Kind

Materials:

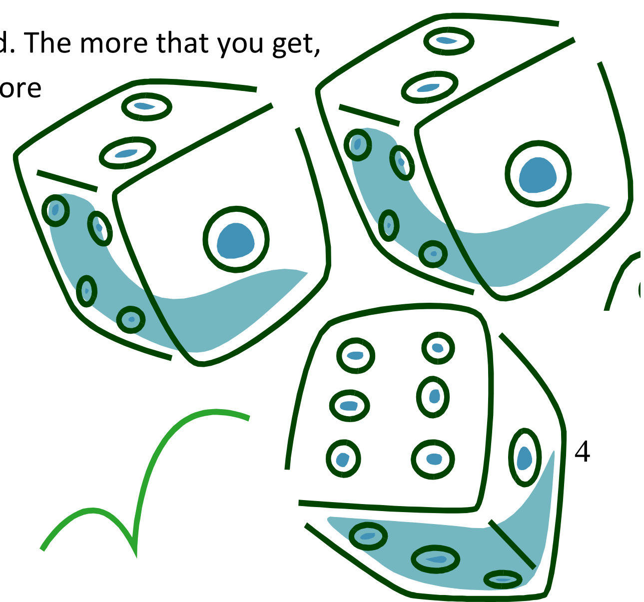
- 5 Dice
- Pencil and Paper

Skills:

- Addition/Multiplication
- Number Recognition

The object of the game is to get 3 or more of a kind. The more that you get, the more you score. The player with the highest score after a fixed number of rounds (5 works well) is the winner.

Roll the dice. You must have 2 of a kind to continue playing. If you don't, write "0" for your

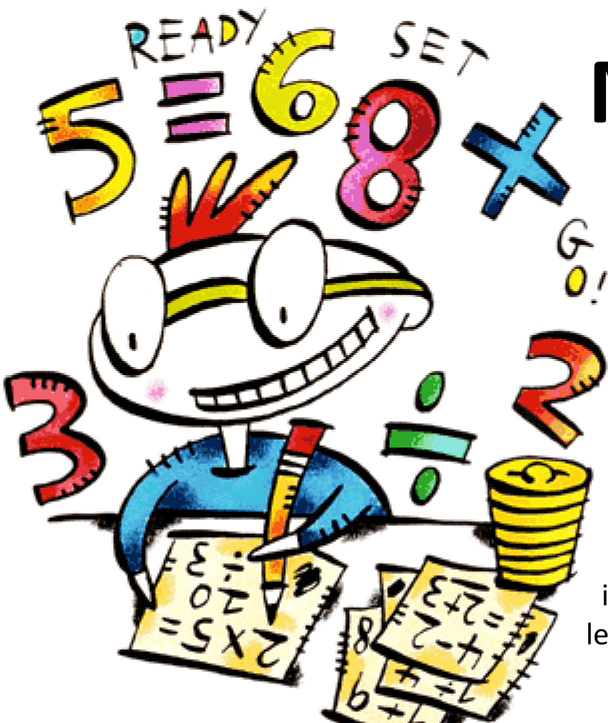


score for this round and pass the dice to the next player.

If you rolled 3, 4 or 5 of a kind on that first roll, score as below:

3 of a kind = 3 points
4 of a kind = 6 points
5 of a kind = 12 points

If you rolled only 2 of a kind, you have one more turn to improve your score. Put those 2 dice aside and roll the others again. If you succeed, score as above. If you don't, you get no score this turn!



Math time =Story time?

Multiplication Rhymes, Songs, and Stories

Multiplication doesn't need to give the teacher or kids the blues…Work with students to make up silly sayings and songs to remember their multiplication and division facts, especially the "hard ones." The kids really get in to making up ones for their hard ones and can illustrate them for even more kinesthetic and visual learning opportunities.

Samples:
"Had two 8's, dropped them on the floor, picked them up, had 64."

4 x 4
A 4 by 4 is a mean machine
I'm gonna get one, when I'm 16.
4 x 4 = 16

4 x 6 I'm hatching chicks
Ooooops!
I dropped them on the floor.
Would have been "eggs-actly" 24!
4 x 6 = 24

4 x 8
Clean your plate.
I ate the 'goo'
Now I'm thirsty-too! (32)
4 x 8 = 32

7 packs of gum
Each with 8 sticks.
Open up, Big Mouth,
Can you chew all 56?
7 x 8 = 56

4s = "Old MacDonald Had a Farm" 4, 8, 12, 16, 20, 24; 28, 32, 26, 40, With a four here and four there, here a four, there a four, everywhere a four, four; 4, 8, 12, 16, 20, 24 ... (etc.)

7s = "She'll be Comin' 'Round the Mountain"
(Sing it southern and slow -- really drag it out -- to start on verse one, then fast and furiously on the second verse.) Seven, fourteen, twenty-one, twenty-eight, thirty-five, forty-two, forty-nine, fifty-six, sixty-three --------(hold the 63 for empahsis and let the note go up on the end -- hold it . . .) (Then start again and drag out the 7) SSSSSSSeeeeeeevvvvvvveeeeeeennnnnnn, (then as fast as you can possibly go) 14, 21, 28, 35, 42, 49, 56, 63 -- Ye haw!

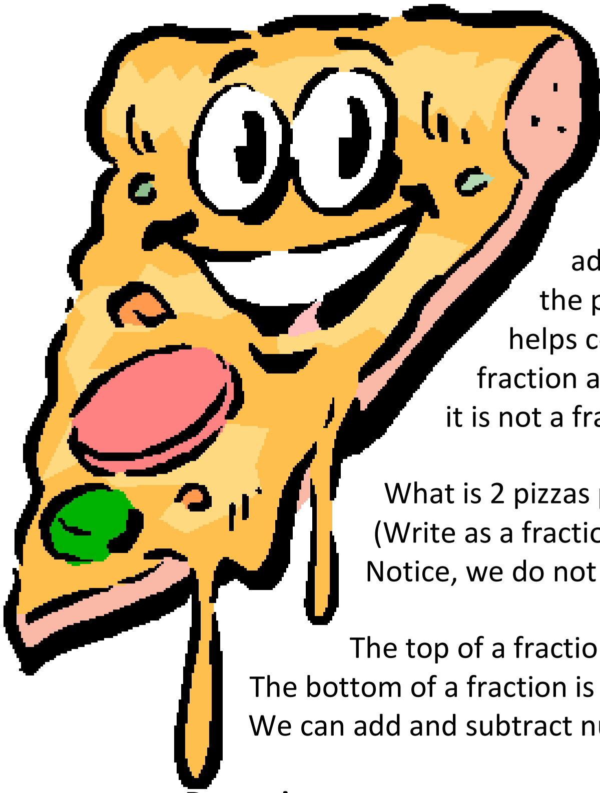
9s = "Addams Family" Da, da, da, dum . . . Da, da, da, dum . . . da, da, da, dum, da, da, da, dum, da, da, da, dum . . . 9, 18, 27, 36, 45, 54, 63, 72, 81 . . . da, da, da, dum . . . (I think you get the picture! This is a big favorite!)

Variation: Think of the rhythm when soldiers are marching and have kids work in groups to come up with them,

Sample: 7 times 7 is 49, don't bend down you'll hurt your spine.

Have the class vote on the best and can make a book of class best multiplication marches and then put it in motion. Physical movement helps students learn math facts, including multiplication. Go outside and march in a circle, skip-counting by a given number: (6) "6! 12! 18! 24! 30!" and so on. When they get fast at it, march and skip-count backwards. When they can do any table backwards and forwards, they won't have any trouble figuring out a specific fact.

Pizza Pursuit!



Fractions are as easy as pizza!

One way to help students to understand the basics of adding and subtracting fractions (denominators must be the same; add/subtract the numerators; DO NOT add/subtract the denominators) is to teach the students what the parts of a fraction really are: numbers and names. This also helps combat the frequently-taught but incorrect idea that a fraction and a ratio are the same. A ratio may look like a fraction, but it is not a fraction.

What is 2 pizzas plus 3 pizzas? 5 pizzas
(Write as a fraction: 2/pizzas + 3/pizzas = 5/pizzas)
Notice, we do not end up saying the answer is 5 cakes.

The top of a fraction is a NUMBER: 1, 2, 3, etc.
The bottom of a fraction is a NAME: half, third, fourth, etc.
We can add and subtract numbers. We cannot add and subtract names.

Denominate means: to name
Political parties **nominate** (name) their candidates.
Religious **denominations** are identified by their names.
The **denominations** of money are the names of the coins and bills.

Ask each student their "denominator." Don't give it away. Ask each one until one finally says their name. Continue through the room... Their name is their denominator.

When you practice adding and subtracting fractions with like denominators, actually say "pizzas" instead the fraction name. Then say, "Instead of pizzas, we are using ..." and let them answer with the appropriate denominator.
It is fun when doing subtraction to say, "If we have 5 pizzas and eat 3 pizzas, besides a stomachache, what is left?"
The transition to unlike denominators is automatic. If the names are not the same, you can't add the fractions.
2/pizzas + 3 salads is still 2/pizzas and 3/salads (unless we discover a "common denominator" -- a common name: food).
Once the students know they must have a common name (denominator) in order to add or subtract, they have a reason to learn about common denominators.

By the way, always begin common denominators without worrying about the Least Common Denominator (LCD). Once students can find a common denominator (multiply the denominators), add or subtract, and then reduce, they can be led to finding "easier" denominators to work with. Students who have too much difficulty with LCD can still get the correct answer; they just have more reducing to do. Those who can find a lower common denominator have less reducing.

Math Concepts: Fractions

This game's goal is to assemble a whole pie out of paper pizza slices — and to learn about fractions in the process.

Materials

- Blank wooden dice or paper dice
- Marker
- 5 drawings of pizzas on card stock or printouts of pizza photographs
- Glue (optional)
- Card stock (optional)
- Scissors
- 1 paper plate for each player

Instructions

To set up the game, use the mark the sides of a blank paper or wooden die (available at craft stores) or several dies as follows: 1/2, 1/3, 1/4, 1/8, 1/12, etc, and label one side "Take a Piece." Use the Family Fun photographed pizzas:
(http://familyfun.go.com/assets/cms/pdf/playtime/FF0910MATH_pizza_pursuit.pdf)
which have already been divided into fractions as samples, and print them out (if desired, glue the printouts to card stock to make them sturdier) or have players draw five pizzas on card stock circles. Cut one pizza in half, another in quarters, and so on, corresponding to the fractions on the dies.

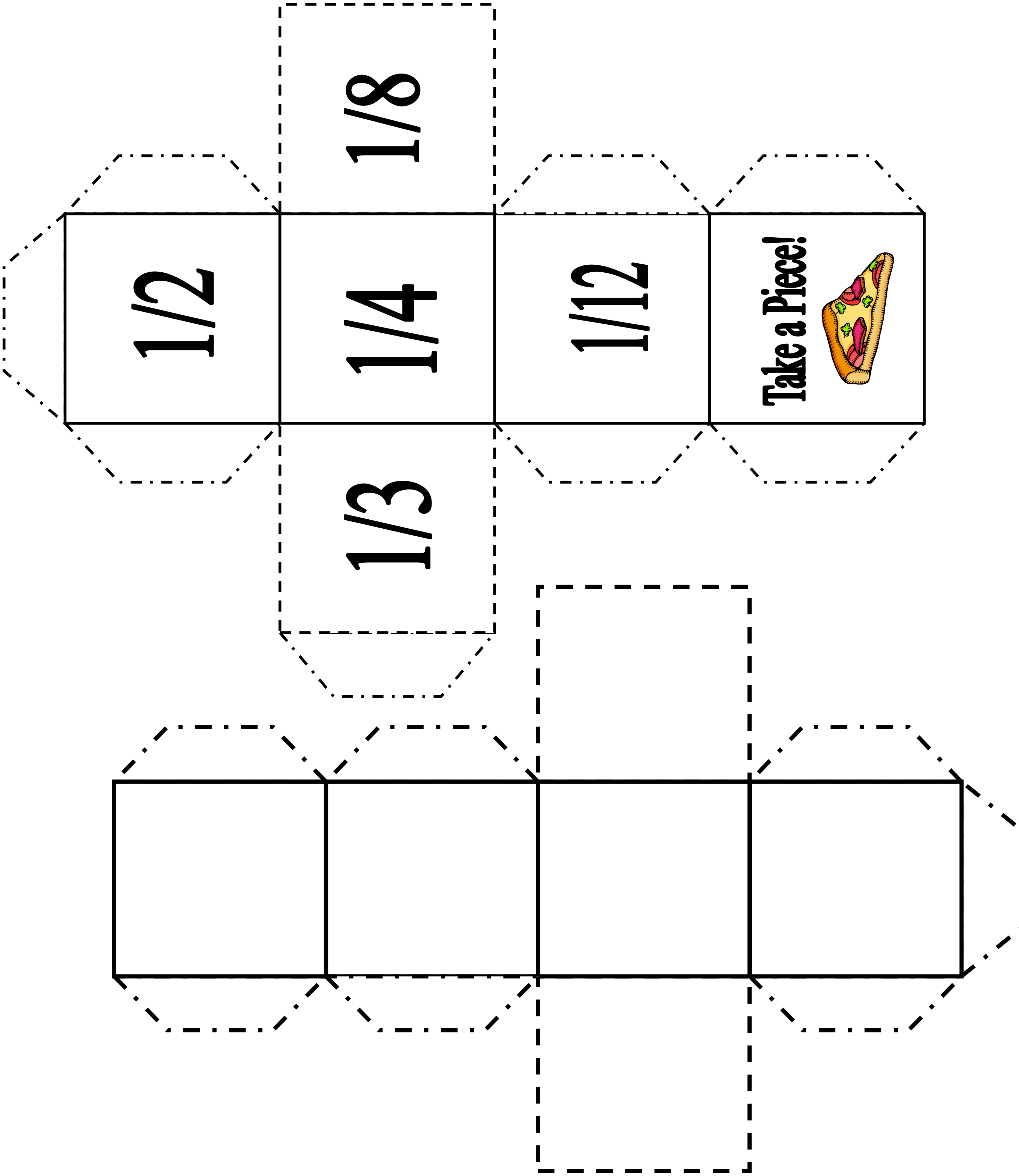
As you cut the pizza pies into fractions, on an index card write a line and under it put a 2. Tell students that that is because we broke that pie into 2 parts. Then cut the next pizza into quarters, make the index card with a line and a 4, and the third pie into sixths. Then put one "slice" of each pie on a plate, put the index card next to it and write the 1 on top of the line to show the children that each piece is one half, one fourth, one sixth, one eighth, one twelfth. Discuss the fractions, have a discussion on which is bigger and why. This is an important concept for students to grasp, the bigger the denominator the smaller the fraction.

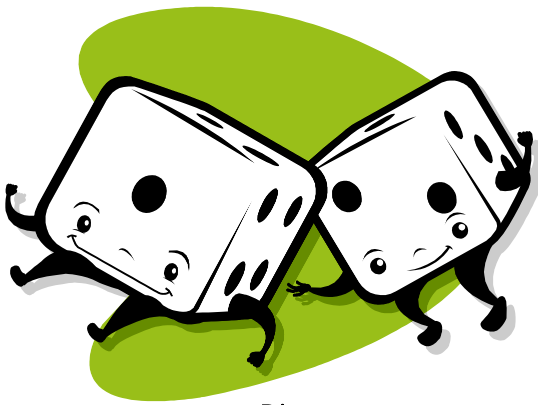
Another idea to help students understand, is to write the fraction in a totally vertical orientation as:

1 out of
2 equal parts

It helps students to understand the how and why of written fractions

Give each player a paper plate. The first player rolls the die, then chooses the correct-size slice. If a player rolls "Take a Piece," she takes a slice from someone else's plate. As the number of slices dwindles, players may substitute equivalents, taking two quarter slices to make a half slice, for example. If a player rolls a fraction that would result in her having more than a whole pie, she takes nothing. The first player to complete a pie wins.


1/8
1/2
1/4
1/12
Take a Piece!
1/3

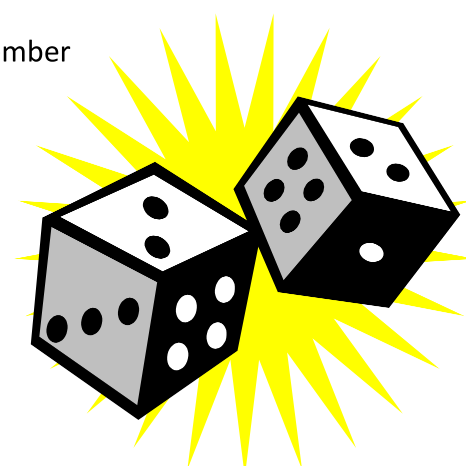


Hunting for Snake Eyes!

Dice are a great way to teach even your youngest students about probability. The different combinations they offer are the perfect grounds for many standardized test questions. For instance, your eighth graders might need to answer a question such as, "What's the probability that the total of two rolled dice will be 9?"

$$\text{Probability} = \frac{\text{The number of ways a result can happen}}{\text{The number of possible results}}$$

Here's a quick activity that will help your student figure out and remember the difference between rolling Snake Eyes and Lucky Number Seven!

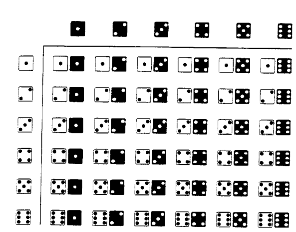


Materials:

- A pair of dice, two different colors (we'll use red and blue for examples)
- A piece of paper
- Some M&M's or another small inexpensive treat

What You Do:

1. Ask students how many different ways there are to roll 2 dice. Remind them that there are 6 options on both sides. Together, you can determine that there are 6 x 6 = 36 possible rolls.
2. Ask them how many ways there are to roll a total of "2" using two dice. After thinking, they should conclude that there's only one way: 1 + 1
3. Ask him how many ways there are to roll a total of "7." He should come up with 6 ways: 1 + 6, 6 + 1, 2 + 5, 5 + 2, 3 + 4, 4 + 3.
4. Time to figure out all of the rolls. Work with your students to fill out the last two columns of the following chart. They have already figured out "2" and "7," and they can do the rest the same way. *Have younger students and visually oriented students fill out and use the included dice chart (like the one to the right)*



to help them visually see the possibilities.

Total to Roll	Ways to Get the Total	Probability of that Roll
2	1	1 /36
3		/ 36
4		/ 36
5		/ 36
6		/ 36
7	6	6 /36 = 1/6
8		/ 36
9		/ 36
10		/ 36
11		/ 36
12		/ 36

When they are done, the chart should look like this:

Total to Roll	Ways to Get the Total	Probability of that Roll
2	1	1 / 36
3	2	2 / 36 = 1/18
4	3	3 / 36 = 1/12
5	4	4 / 36 = 1/9
6	5	5 / 36
7	6	6 / 36 = 1/6
8	5	5 / 36
9	4	4 / 36 = 1/9
10	3	3 / 36 = 1/12
11	2	2 / 36 = 1/18
12	1	1 / 36

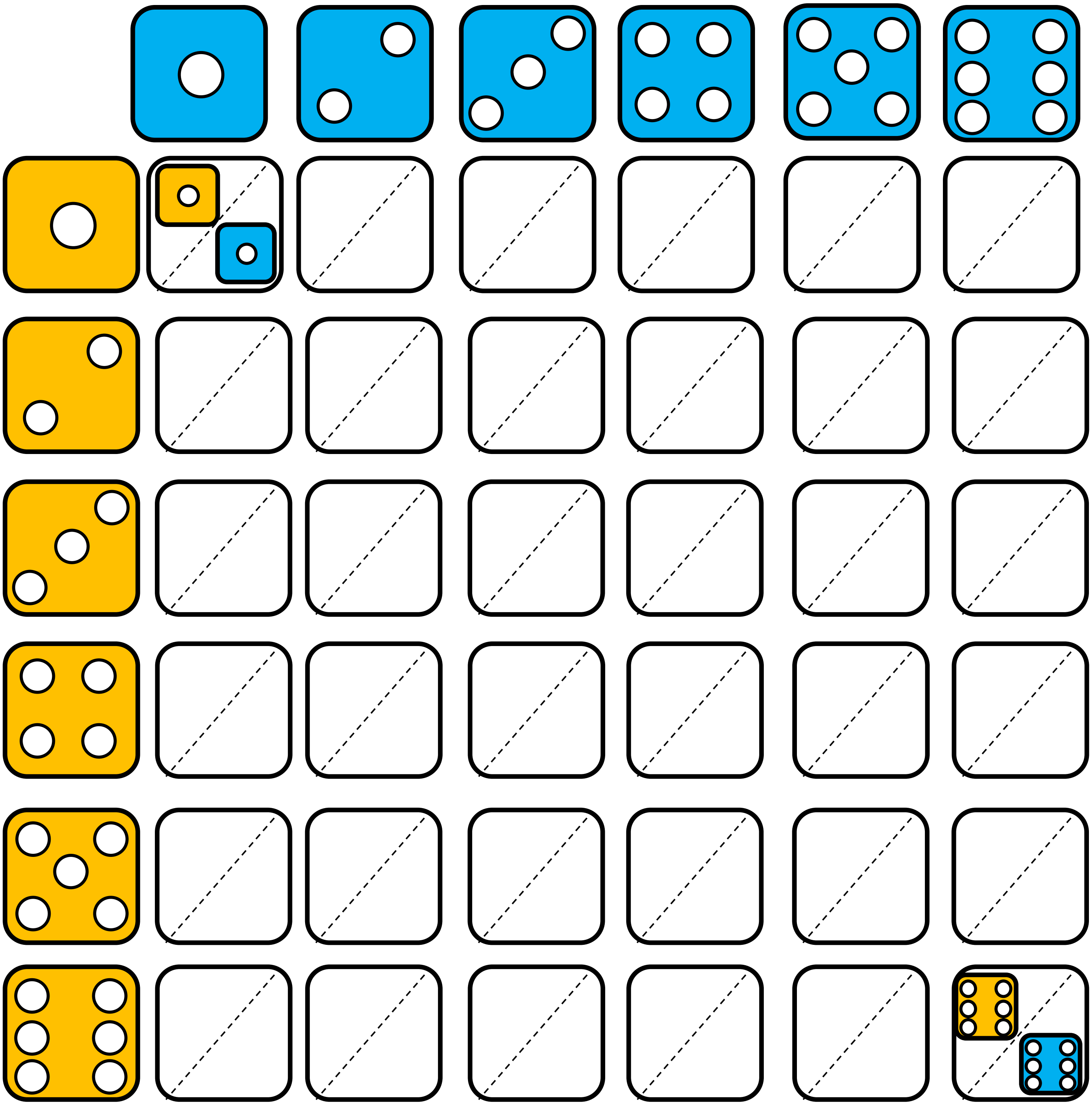
5. Here's a dice challenge for any student. First, tell them the roll you want them to try and get. Then, give them two opportunities to win a small reward. They can win an award if they roll what you asked them to get. *With older students, they can win another award for guessing the correct probability of rolling what you've asked of them. Younger students can win another award by counting up the ways to roll it on their dice chart they filled out (next page).*

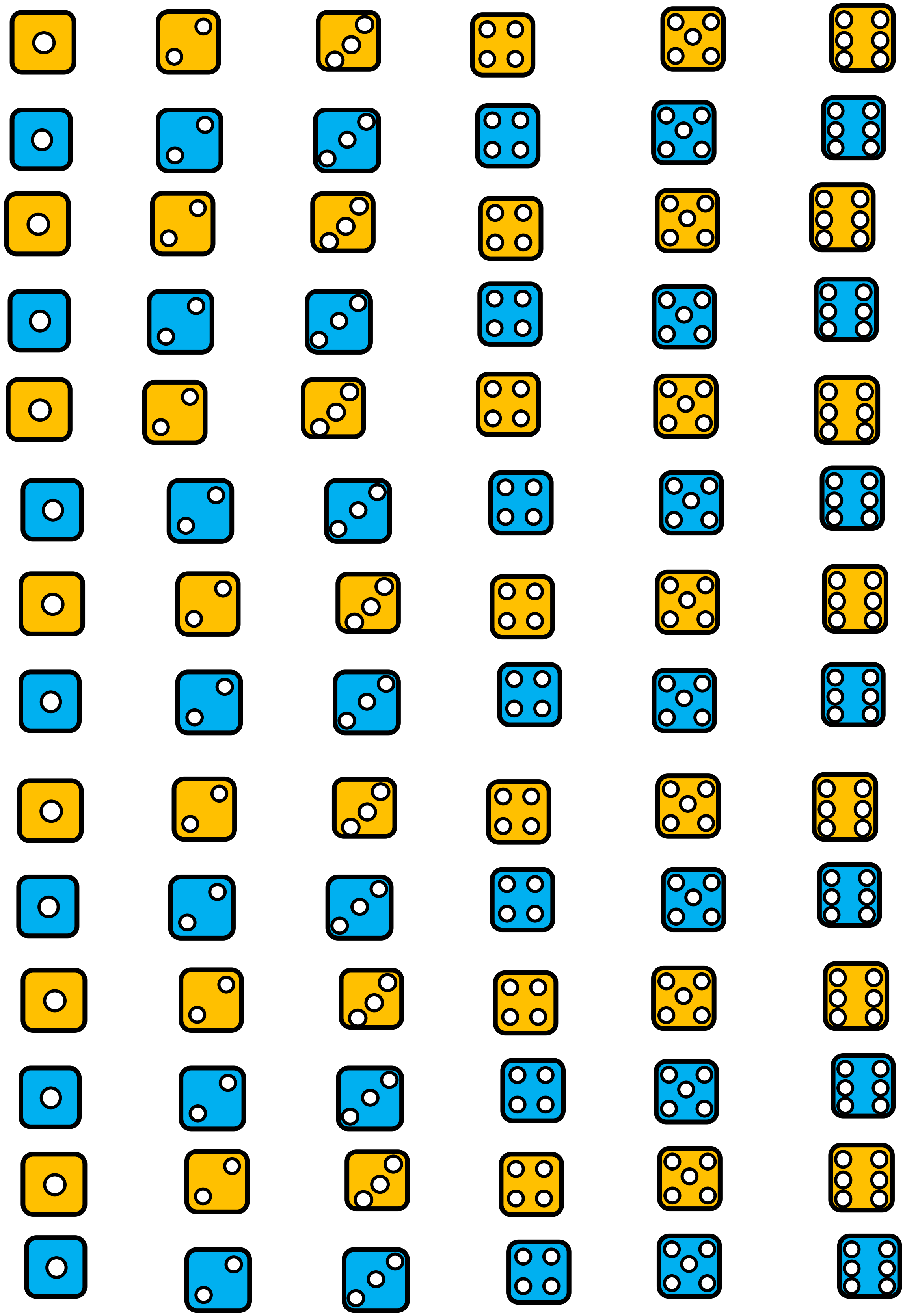
- Roll a total of "9" (1/9)
- Roll a total of "11" (1/18)
- Roll a total of 8" (5/36)
- Roll a total of "12" (1/36)
- Roll a total of "5" (1/9)

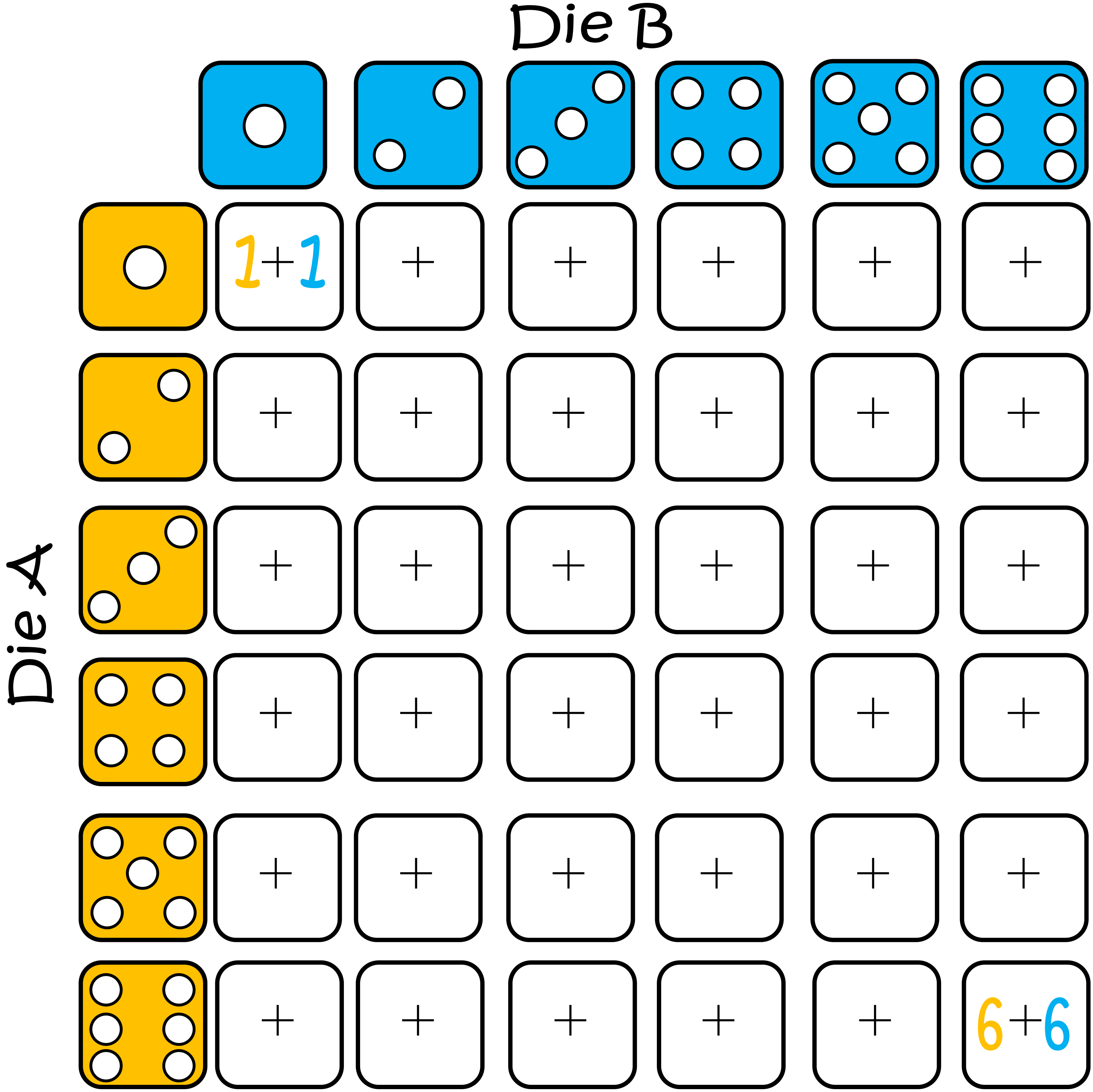
- Roll a "7" *or* an "11" (6/36 + 2/36 = 8/36 = 2/9)
- Roll a "2" *or* "6" (1/36 + 5/36 = 6/36 = 1/6)
- Roll a "2" *or* a "6" *or* a "7" *or* an "11" (1/36 + 5/36 + 6/36 + 2/36 = 14/36 = 7/18)
- You can make up your own as you go

Tell your older students, if they don't already know, that the game "Craps" is all about rolling two dice over and over. Ask them if he could figure out why "7," "2," and "12" are the most important rolls. If you know more about the game, it's a great way to teach probability.

Name: ____






Die B
Die A
1+1
6+6

Baseball Math

http://www.scholastic.com/teachers/lesson-plan/baseball-math

Keep everyone excited, focused on math, and having fun right down to the last day of school with baseball math! This unique game challenges them to create their own baseball leagues and gives them practice in combinations, schedules, decimals, and percentages as they compete.

The Game

Choose two volunteers to demonstrate a simple baseball game for the class. Give each a die and four place markers (e.g. cubes, chips, coins). Provide a game board-a piece of unlined white paper with a baseball diamond drawn on it. Then guide students:

1. Roll the dice to decide who will bat first. That player puts his or her place markers behind home plate.

Batting Table

Dice Roll/Results
7/Single
2/Home Run
8/Strike
3/Pop Out
9/Strikeout
4/Single
10/Foul Ball
5/Ground Out
11/Double
6/Pop Out
12/Strike

2. Each player then rolls a die, or makes the pitch. The numbers on the dice are added together; match the sum to the batting table above for the result. A sum of seven, for example, is a single.
3. The player at bat moves the first marker according to the batting table. Play continues as in a regular baseball game for three innings. The player with the most runs wins.

Distribute dice, boards, and markers to kids and have them try their own practice games.

Extension: The League

After the practice game, tell students they will be forming their own baseball leagues. Split the class into two groups, the American League and the National League. Within the two groups, have kids partner to become managers of their baseball team. Each pair chooses a team name. Provide time for each league to meet and create a schedule. First, tell students the days available for play; for instance, a couple are a good stretch with which to work. The schedule should have each team playing every other team in its league at least twice. Meet as a class to review the two league schedules. Have both leagues model their mathematical scheduling strategies on the board through diagrams or charts, demonstrating how they accounted for all possibilities. Display the schedules and distribute copies to the class.

The Standings

Begin play according to the schedules. Games typically take about 10 minutes and can be played toward the end of a class period, after students have finished their other assignments. Have players record the final scores after each game, then arrange for partner teams to take turns collecting and analyzing the results. They should report back with the overall win/loss record, winning percentage in decimal form, and ranking for each team. (See sample, below.)

You may want to preface this task with a mini-lesson on using division to find percentages, either as a paper-and-pencil exercise or with a calculator. This is a great opportunity to see clearly the relationship between fractions and decimals, as well as their usefulness. Check and post each report.

SAMPLE STANDINGS

Team	Games	Wins	Losses	Win Pct.
Dodgers	5	4	1	.800
Mets	5	3	2	.600
Cubs	5	2	3	.400

Continue to play through the schedules set up by the leagues. If you have time, schedule playoffs and a World Series between the National League winner and the American League winner. You'll find that kids may not want school or at least the leagues to end this year!

Skunk

Materials:

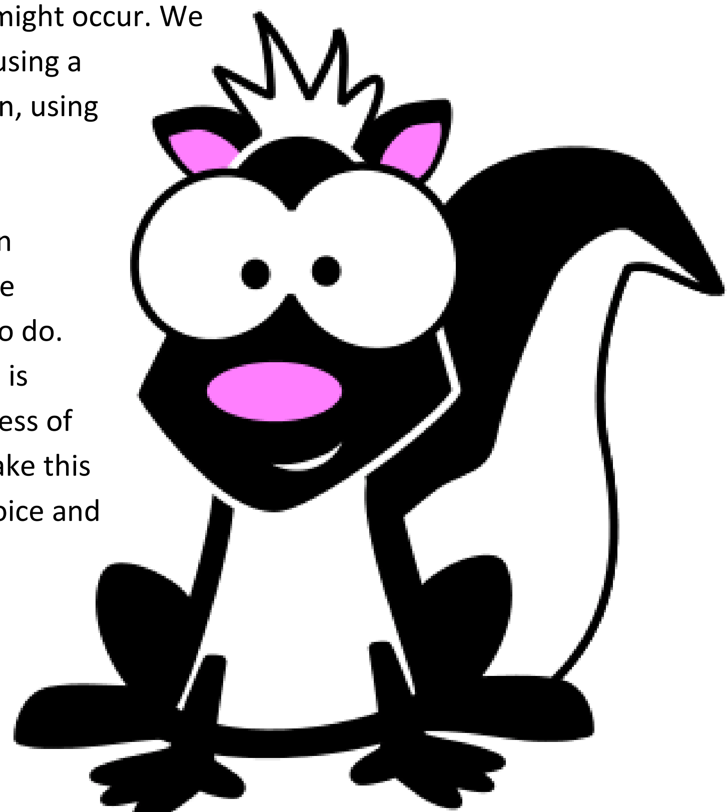
- pair of 6-sided dice (or for older grades use 10-, 12-, or 20-sided dice)
- calculator
- paper
- pencil

Write the following questions on the chalkboard or overhead:

- I might make more money if I was in business for myself; should I quit my job?
- An earthquake might destroy my house; should I buy insurance?
- My mathematics teacher might collect homework today; should I do it?

Ask students to share their responses to each of these scenarios. Ask students why their responses may be different from their classmates. Ideally the class discussion will mirror some of the concepts which follow.

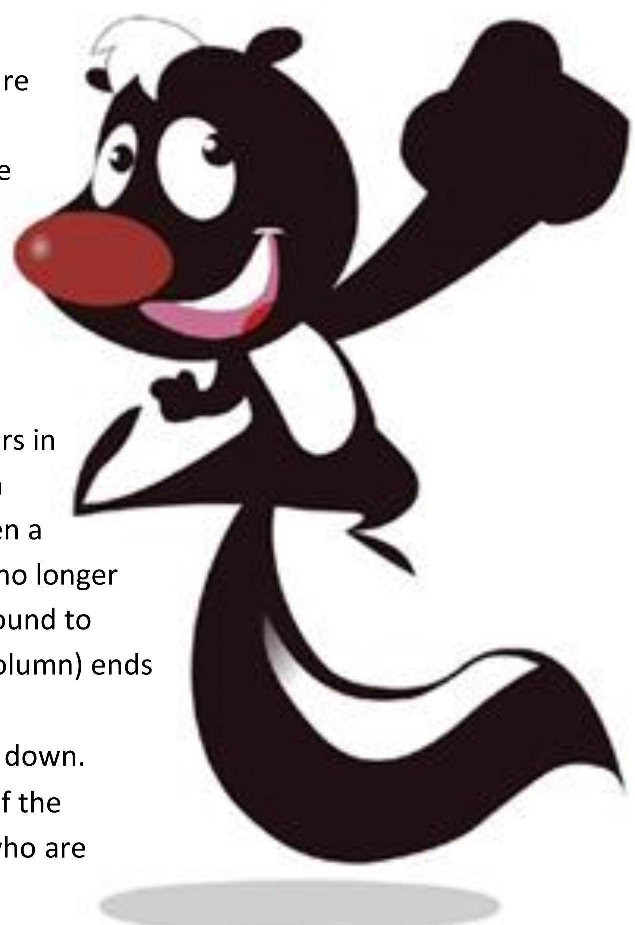
Every day each of us must make choices like those described above. The choices we make are based on the chance that certain events might occur. We informally estimate the probabilities for events by using a variety of methods: looking at statistical information, using past experiences, asking other people's opinions, performing experiments, and using mathematical theories. Once the probability for an event has been estimated, we can examine the consequences of the event and make an informed decision about what to do. Making the connection between choice and chance is basic to understanding the significance and usefulness of mathematical probability. We can help students make this connection by giving them experiences wherein choice and change come into play followed by tasks that cause them to think about, and learn from, those experiences.



The game of SKUNK presents students with an experience that clearly involves both choice and chance. SKUNK is a variation on a dice game also known as "pig" or "hold'em." The object of SKUNK is to accumulate points by rolling dice. Points are accumulated by making several "good" rolls in a row but choosing to stop before a "bad" roll comes and wipes out all the points. SKUNK can be played by groups, by the whole class at once, or by individuals. The whole-class version is described following an explanation of the rules. The rules for play are the same for each of the five rounds.

The best way to teach SKUNK to the class is to play a practice game.

1. Each student writes the word "SKUNK" in large letters at the top of a piece of scrap paper, making a column under each letter, or use the included sheet. Each letter of SKUNK represents a different round of the game; play begins with the "S" column and continue through the "K" column. The object of SKUNK is to accumulate the greatest possible point total over five rounds.
2. All students stand by their desks, and the teacher rolls the dice and announces the two numbers. (Everyone playing uses that roll of the dice; unlike other games, players do not roll the dice for just themselves.) Depending on the grade level or the ability of the students, the teacher can have students add, subtract, multiply, or divide the two numbers. The students will do so quietly in their heads and then enter their answers in the first column "S." (The teacher should record each answer on a piece of paper as well.)
3. After each roll, players may choose either to remain standing or to sit down. Those who are standing get the results of the next dice roll; those who sit down keep the score they have accumulated for that round regardless of future dice rolls. Once someone sits down, that person may not stand up again until the beginning of the next round.



4. The students continue to record their answers in the "S" column until they choose to sit down and play it safe or until the round ends. When a student has chosen to sit down, he/she can no longer collect points and must wait until the next round to stand up and rejoin the game. A round (or column) ends when one of the following occurs:
   - All the students have chosen to sit down.
   - The teacher has rolled a 1 on one of the dice. In this case, all the students who are

still standing will lose all their points for that column only. Their total for that column will go to 0.

- The teacher has rolled "snake eyes." In this case, all the students who are standing will lose all their points in each completed column and in the current column. Their score will now be 0.

5. After a round ends, all the students may stand up again and begin collecting points for the next column.
6. After all five rounds have been played, the students will add up all of the columns to determine their total score. The student with the highest overall score wins. The Teacher may want to have students' double check their calculations with a calculator. The teacher's answer sheet can also be used to verify students' scores.

Thinking about SKUNK

Although playing SKUNK is fun, thinking about SKUNK is essential for student understanding of the underlying concepts. In groups of two or three, students should complete the questions on the handout.

Groups of students could organize whole-class experiments to find answers to problems 4, 5, 6. As a class, share results and solutions to the questions posed.

Suggested solutions and discussion points

For question 1, the chance part of SKUNK is the dice roll and choice part is the decision to sit down or remain standing.

Many games can be listed for question 2. Games of pure chance include Candy Land and bingo. Games involving almost pure choice, disregarding who goes first and your opponent's ability, include chess and tic-tac-toe. Most games, such as hearts, basketball, or Monopoly, involve both choice and chance. The game of Uno is mostly chance no matter what choices are made. But poker can be either mostly chance or mostly choice depending how is it played. Strategies are useful only in games that allow for choices. But even

Image Credit: http://www.ohnitsch.net/wordpress/wp-content/uploads/2008/09/080924_skunk.jpg.

games that have choices can be mostly chance for a player who makes choices without any strategy.

Question 3 can lead to class discussions that involve interesting probabilities and decisions from students' lives. Some events that a thirteen-year-old would ascribe mostly to chance include these: you find a $20 bill, you calculator is stolen, having a bad acne outbreak, your cousin becomes a famous musician, your best friend has to go to a different high school then you, and the like. Some typical events resulting from a thirteen-year-old's choices might include these: a girl dances with you because you asked her, you flunk a quiz because you didn't study, you get paid your allowance because you do your chores, and so on.

Questions 4, 5, and 6 can be done either by experimenting or making theoretical arguments. For example, for question 5, dice could be rolled many times and the points noted. Then the points could be totaled and the average value per time calculated. One theoretical approach is to list the equally likely outcomes for rolling a pair of dice where SKUNK points are accumulated. Twenty-five equally likely outcomes yield points. Such a list of outcomes is shown in Table 1. Rolls including a "one" are not shown because no points are accumulated on the rolls.

Table 1

First Die \ Second Die	2	3	4	5	6
2	4	5	6	7	8
3	5	6	7	8	9
4	6	7	8	9	10
5	7	8	9	10	11
6	8	9	10	11	12

The average of all the equally likely values is 8. This value can be either calculated or observed from the symmetry of the table.

Note: One difficulty of the game is trying to keep students from calling out the answers. If students are silent, then all children can practice their math facts in their heads. Also, when students have their scores, they tend to rush up front to show the teacher. The Teacher may wish to make a rule of having students remain in their seats and raising their hands when ready to share scores. The Teacher may then display a child's total score on the board and ask if anyone had a higher score. The Teacher would repeat this until he or she had the top two or three scores.

Thinking about SKUNK

NAME ______________________________

Discuss with your group and write out answers to each of the following.

1. SKUNK is a game that involves both choice and chance.

- What part of SKUNK involves choice? ____

  ____

- What part of SKUNK involves chance? ____

  ____

2. Think of some other games you know.

- Which games involve mostly choice? ____
- Which games involve mostly chance? ____

Rate each game on a scale of 1-10, with 1 meaning "pure chance", 5 meaning "chance and choice about equal," and 10 meaning "pure choice." Justify your ratings.

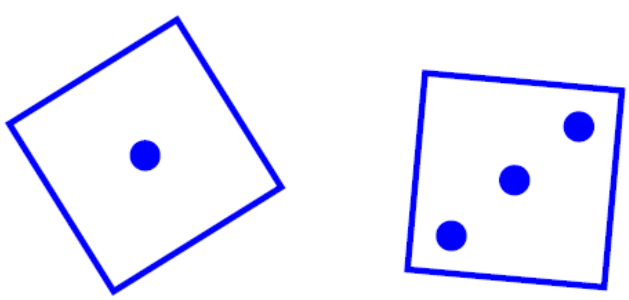
3. In life, many things happen. Some are the result mostly of chance or "luck," and others mostly result from the choices and decisions you make. Think about some things that happened recently in your life.

- List two things that happened to you mainly because of chance. ____________________

  ____

- List two things that happened to you mostly because you made a choice. _____________

  ____



Choose one or more of the following to investigate in-depth:

4. Rolling a 1 in SKUNK is a disaster. To get a better score it would be useful to know, on average, how many good rolls happen before a 1 or double 1's come up.

- Decide on a way to find out. ______________________________
- Carry out your plan and describe the results. ______________________________

5. In SKUNK, when a 1 isn't rolled, what is the average score on a single roll of the dice?

- Decide on a way to find out. ______________________________
- Carry out your plan and describe the results. ______________________________

6. What are some strategies that could be used to play SKUNK?

- Describe a "play-it-safe" strategy. ______________________________

  ____
- Describe a risky strategy. ______________________________

  ____
- Estimate the kind of scores each strategy would be likely to produce. ______________

  ____

  ____
- Play SKUNK using each of your strategies and keep a record of your scores. _________

  ____

  ____
- How well do your results agree with what you expected? ______________________________

  ____

S	k	u	n	k

Total:	Total:	Total:	Total:	Total:

Deal or No Deal?

The game show Deal or No Deal is a great way to practice being a Wizard of Odds. At its heart, the show is about figuring out your chances of getting a better deal by playing on or taking the bank's offer-- in other words, your probability of getting the better deal.

For younger students the game by itself is a great chance to practice prediction, money skills, addition, and subtraction.

Remind older students about probability before playing the game. Start with a question such as: "Every time I flip a coin, I have a 50/50 chance of landing on heads or tails. So if I flip it 50 times, I should get 25 heads and 25 tails, right?" This kicks off a discussion about theoretical probability, which you will then test. Have pairs of students flip a coin 50 times and tally heads and tails, one recording, one flipping. Then come back together and compared their data (experimental probability) to your theoretical probability.

Materials:

- Briefcase cards numbered 1-26
- Bank offer cards to provide a random offer each round
- Cash cards to hide under the Briefcase cards
- Deal/No Deal flip card to accept or not accept the deal
- Graphic organizer where students will calculate the probability of getting a better deal by saying "no deal" after each bank offer.

The game play is simple:

1. Take one briefcase to hold onto which could be yours at the end of the game.
2. Each round, players open a diminishing number of briefcases, starting with six in Round One and ending with one in Round Nine. (Round 1 = 6 cases, 2 = 5 cases, 3 = 4 cases, 4 = 3 cases, 5 = 2 cases, 6 = 1 case, and every other round would also be one case to open.)

3. After the briefcases are opened, the bank makes an offer, and the player can accept it (deal) and the game is over, or reject it (no deal) and keep playing.
4. If the player rejects all bank offers, they will be left with their briefcase and one other, and choose which they will open. Whatever they choose is the amount they win.
5. Students will write in the results of each round, like so:

Round	Bank Offer	# of briefcases left with more money than Bank Offer	Probability of winning more than Bank Offer	Deal or No Deal?
1	$100,000	5	5/20 = .25 = 25%	No Deal

After each offer from the bank, calculate your chances of getting a better deal by continuing to play. In the above example, 6 out of 26 total briefcases are opened in the first round, leaving 20 unopened. If there were only 5 unopened cases containing more than $100,000, the chances of getting a better deal was 5 out of 20, which can be written as 5/20, .25, or 25%.

If there is only a 25% chance that the player will win more than the $100,000 offer shouldn't we say Deal?

That makes sense mathematically, but not in the context of playing the game. First, if it's only the first round of the game, you can't expect anyone to say "deal" no matter the odds. Secondly, players usually make their decisions based on their chances of getting the million dollar briefcase. The way this game works, your probability of getting a better deal by playing can actually increase as the game goes on, because the offers are random (and thus may decrease).

Don't the offers play into our decisions?

The offers absolutely play into decisions, because in the card game, the offer is randomly drawn from a deck or written by the Host. So the offers don't always make sense (as they would during the real game), which helps extend the game time as students rarely get a good deal.

If students got an offer of $10 with $1, $5 and $1,000,000 on the board, they would only have a 33 1/3% chance of getting a better deal. Mathematically speaking, it's not a great deal, but just like the earlier discussion about not taking the best *mathematical* deal, not taking the chance that late in the game just isn't any fun in the context of the game.

Also, keep in mind that the students are not bound by probability, it's meant to be an advisory. If they want to take the deal at any point, even with a small chance of getting the big money, they can and most likely will. The idea is to show them exactly how slim those chances are, and that games like these are rarely skewed in their favor.

In the end, the math shouldn't trump the fun of the game, of taking a chance at some point.

Playing the Game

You can magnets to hold the briefcase cards and cash cards underneath on the board (you could also use a hanging pocket display with clear pockets, the kind you often see in elementary classrooms). The teacher can play Host Howie, there won't be any models to open the cases, and the class will play as a whole group. After picking a student to start you off by claiming "our" case, have students pick each other "popcorn style" to choose the briefcases to open each round, or to eliminate confusion establish and order and use it each round. When it comes time for the bank offer, the Host can pretend to get calls and text messages from the bank on a cell phone. Students and Host will then figure out the probability, fill in the graphic organizer like the example above, and decide whether to take the deal.

If students start to argue over taking the deal or not (especially once the million dollars comes off the board, have students vote.

Students only need their graphic organizers and a calculator to help convert fractions to decimals and percents (since probability is shown in all three ways).

At lower levels, students should be learning (or have learned) converting between fractions, decimals and percents, regardless of the probability aspect. You may want to give them some problems before then to gauge their ability, and if they don't seem ready, you can downplay the conversion part of it. You might just ask them to consider if each fraction is more or less than half, which is an easier way to conceptualize it and to help them decide to take the deal or not.

Extensions:

Have students create their own probability game, or adapt an existing game to include probability calculations. This would encourage higher order thinking and make it more memorable for the long term, as well as provide a game they could later play for review.

Play the game Deal or No Deal and have students calculate their chances of winning using probability and the expected value calculation sheet. Can they beat the mean?

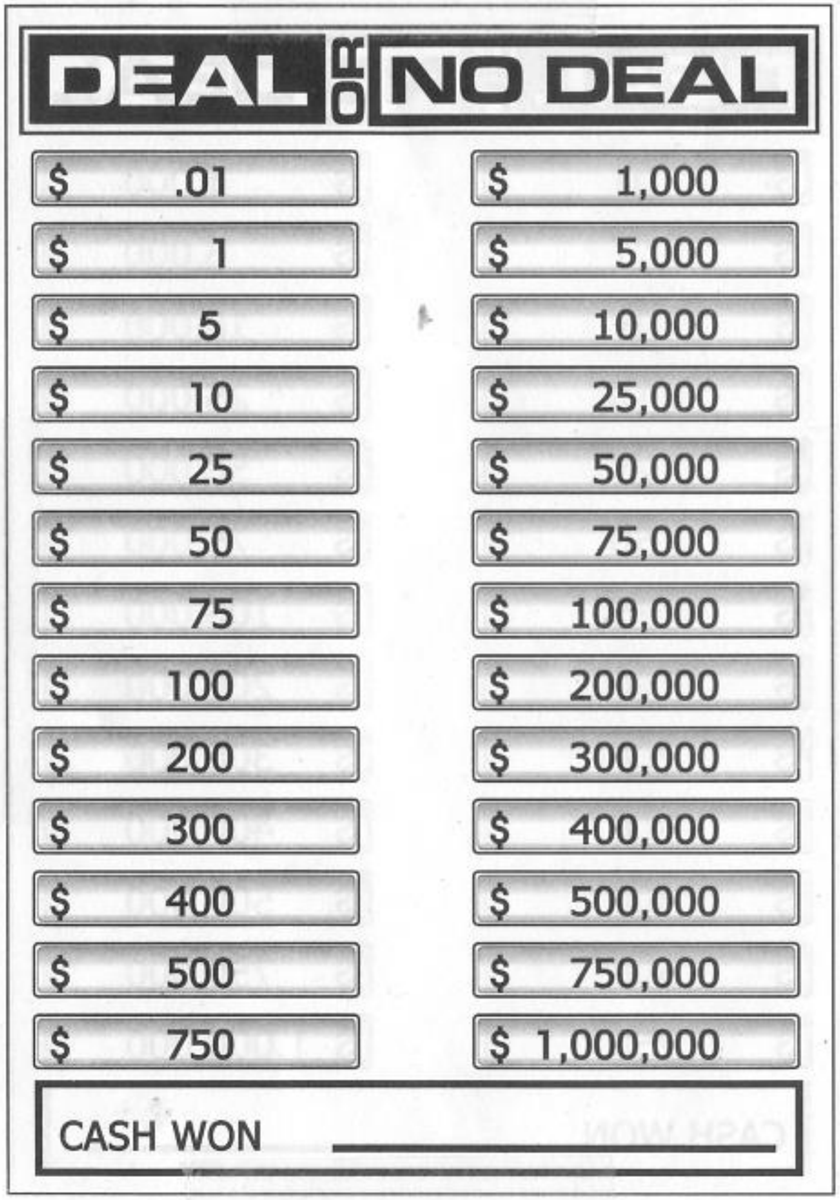
Name: ____

DEAL OR NO DEAL

$ .01	$ 1,000
$ 1	$ 5,000
$ 5	$ 10,000
$ 10	$ 25,000
$ 25	$ 50,000
$ 50	$ 75,000
$ 75	$ 100,000
$ 100	$ 200,000
$ 200	$ 300,000
$ 300	$ 400,000
$ 400	$ 500,000
$ 500	$ 750,000
$ 750	$ 1,000,000

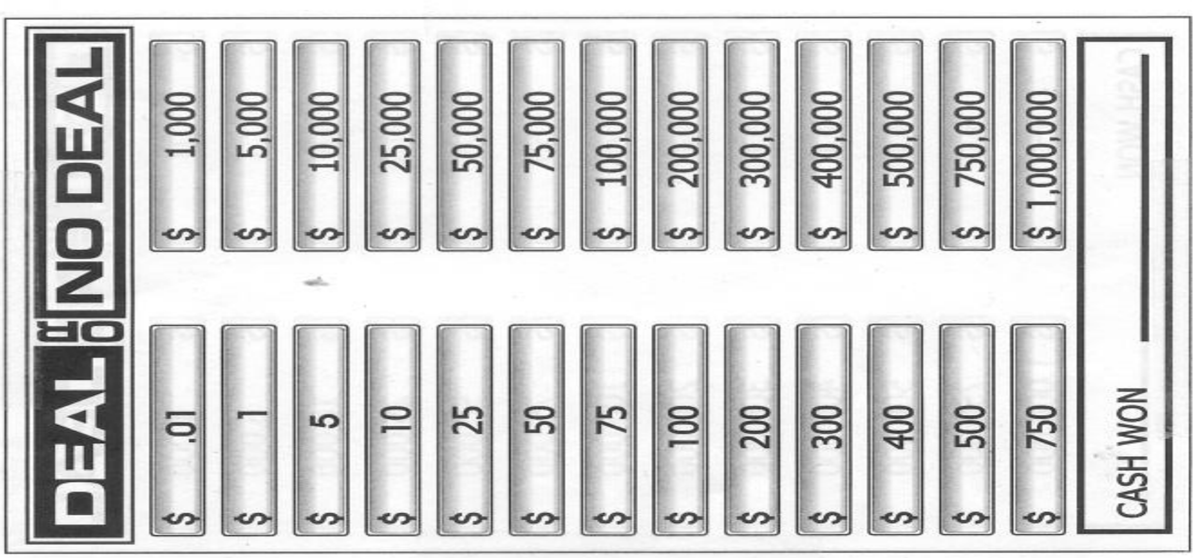
CASH WON ______________________

NAME: PERIOD:



Round	Bank Offer	# of briefcases left with more money than Bank Offer	Probability of winning more than Bank Offer	Deal or No Deal?
1				
2				
3				
4				
5				
6				
7				
8				
9				

Round	Bank Offer Amount	Number of Briefcases Left	Number of Briefcases Left with More Money than Bank Offer	Probability of Winning More than Amount of Bank Offer	Expected Value (Mean) of Remaining Briefcases	Deal or No Deal ?
1						
2						
3						
4						
5						
6						
7						
8						
9						




1

2

3

4

5

6


7


8


9


10


11


12


13

14

15

16

17

18


19

20

21

22

23

24


25


26


DEAL!


NO DEAL!

$0.1

$5

$10

$25

$50

$75

$100

$200

$300

$400

$500

$750

$1,000

$5,000

$10,000

$25,000

$50,000

$75,000

$100,000

$200,000

$300,000

$400,000

$500,000

$750,000

$1,000,000

$1

Bank Offer!

$20

Bank Offer!

$1,000

Bank Offer!

$10

Bank Offer!

$11,750

Bank Offer!

$200,000

Bank Offer!

$500

Bank Offer!

$2,500

Bank Offer!

$.50

Bank Offer!

$90,000

Bank Offer!

$45,000

Bank Offer!

$12,000

Bank Offer!

$500,000

Bank Offer!

$25,00

Bank Offer!

$32,975

Bank Offer!

$45

Bank Offer!

$85,630

Bank Offer!

$

Bank Offer!

$

Bank Offer!

$

Bank Offer!

$

Bank Offer!

$

Bank Offer!

$