Name:_____ Date:_____ Period:_____

Building a Winning Die

For this activity, you will need a partner and a die. You will be having a "roll-off" competition. You both roll your die at the same time. The person with the larger number gets a point. If you have the same number, record this as a tie. Keep track of how many points each of you have, as well as how many ties there are on the table below. Roll a total of 36 times. The person who has more points at the end will move up towards the winners table, and the player who lost will stay at his/her table.

Game 1:

My Wins	Partner Wins	Ties

Game 2:

My Wins	Partner Wins	Ties

Was this game fair? Why or why not?

_____

_____

_____

_____

Task 2: Analyzing the Competition

To determine if this was a "fair" competition, fill in the chart of all possible match-ups between the two dice, A and B. In each box, record which die will win by writing A or B, or if it's a tie, write T for tie.

Die A

Die B # on die	1	2	3	4	5	6
1						
2						
3						
4						
5						
6						

1. How many times should die A win? _____
2. How many times should die B win? _____

3. Does one person have a greater chance (probability) of winning than the other in this competition?

_____

4. Why did some students win twice if everyone had an equal chance of winning?

_____

Name:_____ Date:_____ Period:_____

Task 3: Strategizing to Win

We will be having a new tournament with the same rules as before. This time, however, you make your own die. Your die may have any digit from 0 to 6 on each face, but the sum of the six numbers on the faces must be 21.

Competing in the Tournament: The tournament runs the same way as above: each round consists of 36 rolls. For each student you compete against, use tally marks to record you wins, your partner's wins and ties. Then, analyze who *should* have won by completing the table and calculating the probability of each person winning.

Game 3:

My Wins	Partner Wins	Ties

#'s						

What is the probability that your die would win on a single roll? _____

What is the probability that your partner's die would win? _____

Which die would win more often in the long run? _____

Game 4:

My Wins	Partner Wins	Ties

#'s						

What is the probability that your die would win on a single roll? _____

What is the probability that your partner's die would win? _____

Which die would win more often in the long run? _____

Name:_____ Date:_____ Period:_____

Game 5:
My Wins Partner Wins Ties

#'s						

What is the probability that your die would win on a single roll? _____

What is the probability that your partner's die would win? _____

Which die would win more often in the long run? _____

Task 4: Analysis

1. Does the person with the greater probability of winning always win when you play? Why or why not?

_____

_____

2. What is the difference between *experimental probability* and *theoretical probability*?

3. How did the difference impact you in the games?

Challenge/Extension:

4. Write down the digits of the person who won the most in the class. Did he/she have the best die? Use the table below to compare your two dice and determine if you had a greater theoretical probability of winning. Winning Digits: _____

#'s						

Name:_____ Date:_____ Period:_____

5. Could you design a die (that still uses only the digits 0-6 and has a sum of 21) to BEAT the best die? Use the tables below to help you plan how to build a die to be the winner.

#'s						

#'s						

Teacher Directions

Objective
Students will compete in rolling a standard die to determine who has the larger number more often. They will analyze the game to determine if it was fair. They will then create their own die with a sum of 21 and compete against other students' dice to compare and understand the concept of experimental and theoretical probability.

Materials
- 6-Sided Die - 1 per person
- 1-Inch Colored Cubes - 1 per student
- Circle Sticky Dots - 6 per student

Activity Notes
Set up the classroom for tables of 4. Within each group of 4, have students decide who they will be playing against (each student needs one partner to play against). Pass out the activity sheet to each student. Explain the directions and ask clarifying questions to ensure that students understand that they will have to complete 36 rolls, each time recording a tally mark for the person who had the larger number.

Pass out a die to each student (and if needed, show them how to set up a "goal" to roll into). Set the timer for 90 seconds for students to complete their 36 rolls. Ask each pair to determine who won. Now, explain how the competition will work. You need to determine the flow of tables in your classroom so that there is a progression from the "losers or bottom" up to the winners table. Everyone who won needs to raise their hand and then take their paper, pencil and die and move UP to the next table; however if the student who is at the very top table wins, they will stay, but if they lose, they will move down one table.

Note: Two people should be moving from each table! Once everyone has moved, have them repeat the exact same game with a new partner.

After the second game, have the students think about and then answer the question, "Was this game fair?" Call on a few students to share their thinking.

Analyzing the Competition
Explain how the table works to show all possible outcomes (which will allow us to "prove" if the game was fair, as you did with the tree diagram in the activity *2 Coins, 3 People*). Ask what the result is if Die A is a 1 and Die B is also a 1. Record a T in that box to represent a Tie. Then ask what happens in Die A is a 2 and Die B is a 1. Record a B in that box to show that B would have won. Have the students continue in this process to complete the table.

Note: Many students will notice patterns for completing this table; encourage them to share once all have completed!

Ask the students to use the table to determine the probability of Die A and Die B winning. Give them 2 minutes to complete the questions at the bottom of page 1. Once you agree that the game is fair in that each person has an equal chance of winning, make sure students can explain why some students still won instead of coming to a tie. Write the term *Experimental Probability* on the board as well as *Theoretical Probability*. Guide the students to see that while they **should** have tied (theoretically, on paper), experimentally, some people win. If you want, use this opportunity to explain why Las Vegas and places like it make money!

Teacher Directions

Strategizing to Win
Now that everyone agrees you all have an equal probability of winning, the game is less fun, so explain that they will get a chance to make their own die. Explain the rules. They can use any digit from 0 to 6, but the SUM must be 21. Pass out sticky dots and blank cubes and allow each student 5 minutes to plan and make their die.

Repeat the same process of competing, but this time students will use their own die. **Before starting, have each student check to ensure their partner's die has a sum of 21.** After EACH competition, they need to use the table to compare who *should* have won (this practice also helps them analyze two dice!). Have the students compete two more times, stopping after each game to have the experimental winners move up.

Once you have completed the 5 games, give the students 5 minutes to complete analysis questions 1-3.

Challenge/Extension
Find a student at the top who won all 3 times with their created die. List the digits of this die for the class to see, and ask the if they think this person *should* have won or if this person got lucky. To know the answer, have each student compare their die to these 6 digits using the table.

Record a few sets of numbers that *theoretically* should have won. Ask the students if these numbers represent the best die. Have them either compare theirs to one of these OR try to create a die to "beat" this one.

There does NOT exist a best die, but you can always build a die to tie or beat the "winning" die.
See how well your students are doing with this activity. If they are keeping up and interested, create a diagram to show which numbers are beating which other sets and have them try to create (in theory) a die to beat each winner. Show them how the *transitive property* does NOT hold in this case: just because A beats B and B beats C does NOT mean A will beat C.