Games with Dice

Dice Opening Game:
In the opening game students are grouped in three groups. Group one scores one point when a sum of 2-5 is rolled. Students in group two score one point when a sum of 6-8 is rolled. Group 3 score one point when a sum of 9-12 is rolled. Use the table below to keep track of who scores on each roll.

	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15	R16	R17
2 - 5																	
6 - 8																	
9 - 12																	

How did the game go? Does it seem fair? If not, who has the advantage? Why?

Experiment:
Your group task is to roll two different colored dice as many times as you can for about ten minutes. You should be able to do over 100 rolls. As your group rolls the dice make sure to correctly record each combination on the record sheet (separate document). You might want to make tally marks in the corresponding box for each combination. Then add up your tally marks after all of your rolls.

1. Complete the table to give the total times each combination was rolled. Then find the percent of times that each combination was rolled.

Sum:	2	3	4	5	6	7	8	9	10	11	12
Rolls:											
Percent:											

2. To get another look at the data we can create a frequency distribution for rolling two dice. Each cell is worth 2%. Shade vertically to represent the percent of times each sum occurred (4 % would be two shaded cells).

2	3	4	5	6	7	8	9	10	11	12

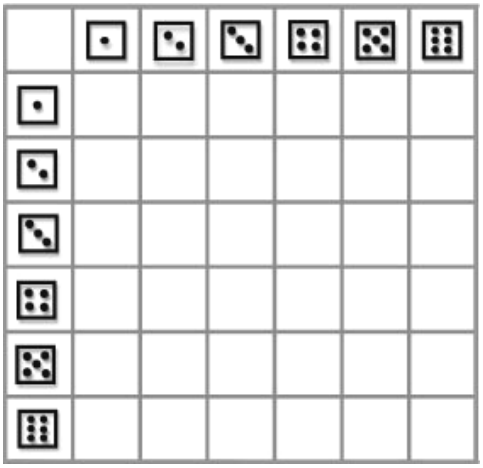
3. What are you observations? Which combinations were rolled most often? Which were rolled the least? What patterns do you see in the data?

4. Some people think a ten will be rolled as often as six. What does our data tell us about the accuracy of that statement? Can you mathematically explain why this is or is not true?

5. When we use experimental data to answer probability questions we refer to it as **experimental probability**. Answer the following questions based on our experimental probability (percentages).

a. What is the experimental probability of rolling a seven?

b. According to our experimental probability, what chance do we have to roll doubles?



6. Lets examine what should have happened according to **theoretical probability**. Complete the table by finding the number of ways each sum can occur, the probability that sum would occur as a fraction and finally the percent of times that we would expect that sum to occur. You might use your record sheet (pictured to the left) from your experiment in problem one to help you think about this question.

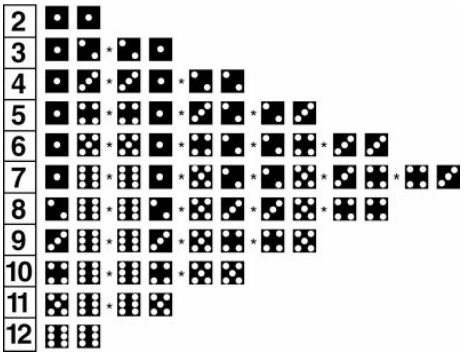
Sum:	2	3	4	5	6	7	8	9	10	11	12
Possible ways to roll sum											
Probability as a fraction:											
Probability as a percent:											

7. Lets think back to our opening activity. Why do numbers like a 6, 7 and 8 come up more often than sums such as 2, 3, 11, or 12?

2	3	4	5	6	7	8	9	10	11	12

8. We will now create an additional frequency distribution to compare how our experimental and **theoretical probabilities** for each sum compare. Each vertical line is worth 2%. Shade in the theoretical probability for each sum.

9. How does this picture relate to your frequency distribution? How does it relate to your record sheet from problem one?



10. Use your two frequency distributions (from problem two and problem eight) to compare your experimental probability with the theoretical probability for each sum.

11. Often a small amount of data will not reflect theoretical probabilities. How would you change this experiment so that our experimental probability is closer to actual theoretical probabilities?

12. In the popular casino game of Craps these bets have the following payoffs:

Roll and Bet	Payout	Fair Payout
Any Craps (2, 3 or 12)	7 to 1	
Seven	4 to 1	
Hard way (doubles making 4, 6, 8, or 10)	7 to 1	
2	30 to 1	
3	15 to 1	
11	15 to 1	
12	30 to 1	

Analyze each bet in the table. Does the payoff for each bet seem fair? What would you expect to be paid for rolling a 4? There are three out of 36 ways to roll a four. It would make sense that over the long run you would win 3 out of 36 times or 1 out of 12 times. With that reasoning, to keep it fair you should be paid $12 on a $1 bet each time you roll a four. Of course the casinos don't typically pay out on the odds correctly, since this is how they make their money. Analyze each of the bets in the table and determine what the fair payoff should be. Enter those fair payouts in the right column of the table.

13. How do think casinos make money on such small advantages in their casino games? How does this relate to the big idea of data and probability?

14. A student rolled two dice about 30 times. One sum came up about 17% of the time. What could that sum be? Does it have to be the sum with a theoretical probability of roughly 17%?

15. The entire school rolled two dice all day and tracked the results. They had around 42,000 rolls. One sum came up about 17% of the time. What sum is this most likely to be? Can we have more confidence that it was this particular sum?

EXTENSIONS:
Another dice game is the game of SKUNK. Do a web search for skunk dice game and you will see a lot of information on the game. There is a good deal of info on the game of SKUNK at:
http://illuminations.nctm.org/LessonDetail.aspx?id=L248

Check the game out and play it as a class.

16. What is the probability of rolling a one in the game of Skunk?

17. In the game of SKUNK, on scoring rolls, what score are you most likely to roll?

18. After about how many rolls should you expect to roll a one with either of the dice?

19. Use your answers to questions 17, 18, 19 to think about a good SKUNK game play strategy. About how many rolls should you participate in during each round? About how points should you expect to score in each round and for the entire game?