

Using Simulations to Estimate p

Name: _____ Class: _____ Date: _____

PURPOSE: This exploration allows you to explore approximating a probability that will be used to estimate the value of p .

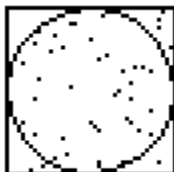
MATERIALS NEEDED: TI-83 Calculator
PI program for TI-83
This worksheet

GOAL: Upon completion of this exploration, you should be able to

1. understand and explain how a simulation can be used to approximate probabilities.
2. explain how a probability approximation can be used to estimate p .

PART ONE

1. Imagine that you have a square dartboard with an inscribed circle.
2. You are to throw darts at the board and every point on the board has an equally likely chance of being hit by your darts.
3. **QUESTION 1:** What is the probability of a dart landing inside the circle given that it has landed inside the square? (Compute this theoretically.)
4. Have your teacher check your work. When your teacher is satisfied with your calculations, he or she will let you download the program PI to your calculator (TI-83).
5. Run PI. You will have to input how many darts are to be thrown in each run of the simulation. The program knows that you are an expert dart thrower, so all of your darts land inside the square.
6. For the darts inside the square, what fraction (or proportion) of them also land inside the circle?



7. Run PI ten times and complete the entries required in the table below.

Run	# of Darts Thrown	# of Darts Inside Circle	Percent of Darts in Circle	Estimate of p
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				

8. **QUESTION 2:** Are the values for the percents of darts in the circle close to the theoretical probability value that you calculated in step 3? Explain why they are or why they are not.
9. Think of the darts as random points that either fall inside the circle or outside the circle (but still inside the square).
10. We can use the proportion of the random points that fall inside the circle to estimate the value of p .
11. You first need to recall the meaning of expected value. **Write your understanding of what expected value means.**
12. **QUESTION 3:** You found the theoretical probability of having a dart land inside the circle in step 3. The proportion of darts that landed inside the circle for each of your runs directly leads to an estimate of p . The proportion of darts that land inside the circle is an estimate of $\frac{1}{4}$ the value of p .

19. Try it.

Run	# of Darts Thrown	# of Darts Inside Circle	Percent of Darts in Circle	Estimate of p
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				

20. **QUESTION 8:** Describe the new distribution of the 10 estimates of p . How close is the mean of the 10 new estimates to p ? What is the spread of the new estimates? What is the standard deviation of the new estimates?

21. **QUESTION 9:** Does the length of the side of the square (diameter of the circle) make a difference in this simulation process? Could the same results be gotten if the square were half the size in the program? Twice the size?

22. **QUESTION 10:** If the shape inside the square dartboard were something other than a circle, how could you use this simulation process to approximate the area of that shape?