

EXPLORATION 7.9 **Pig**

We will play a variation of a famous dice game that many teachers use to help their students learn probability and statistics concepts. The rules of the game are simple:

You roll a standard die as many times as you want and add the numbers from each roll. However, if you roll a 1, then you get 0 points for your entire turn. For example, if you roll 6, 6, 3, 4, and 2 (and then stop), your score is 21. However, if you roll 6, 6, 3, 4, 2, and 1, your turn ends and your score is 0. You can see where the name *Pig* comes from! Each game consists of 10 turns. See how many points you can get from 10 turns.

Part 1: Making and testing hypotheses

1. Play the game alone for 5 to 10 minutes to get a sense of what strategies you would like to test. In other words, what do you think will be the best strategy? After this time, take a minute to note your present thinking.
2. Meet with your group and share ideas.
 - a. Each group will now select two or more strategies to test. Justify your reasons for selecting these strategies.
 - b. Play several games and record the results.
 - c. At this point, do you think one of the strategies you are testing is the best strategy, do you think you need more information, or have you come up with a new strategy that you think is even better? Briefly explain your reasoning.
3. After discussing strategies with the whole class, respond to the following questions.
 - a. Which of the strategies discussed in class do you think will produce the highest score over time? Why?
 - b. How might we gather and analyze data to find the “best” strategy for winning?

Part 2: Gathering and analyzing data

This part of the exploration models many real-life situations in which we do some research on the topic. That is, we are not immediately going to play more games to compare two or more strategies. Instead, we are going to gather and analyze data on two questions:

- On average, how many times can we roll the die before a 1 occurs?
 - On average, how many points will we accumulate before a 1 occurs?
1. Discuss your initial predictions for these two questions in your group. Write down and briefly justify your

predictions.

2. Discuss how we might collect and record the data on these questions.
3. As a group, take a certain number of turns, but let each turn continue until you roll a 1. Count the number of rolls in each of these turns, not including the roll that turned up the 1. Also, calculate the number of points accumulated in each of these turns before the 1 turned up. Make tables like the ones below to tally your data.

Number of rolls before a 1 occurs	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	etc.
--	---	---	---	---	---	---	---	---	---	---	----	----	----	----	----	----	------

Frequency

Accumulated points before a 1 occurs	0	1	2	3	4	5	6	7	8	9	10	11	12	etc.
---	---	---	---	---	---	---	---	---	---	---	----	----	----	------

Frequency

4. In Step 5, we will record the data from the whole class. However, before we do, predict what the distributions will look like—will they be uniform, normal, bimodal, skewed to the right or left, or random? Explain your reasoning.
5. Now record the data from the whole class in tables like those below, and make two histograms.

Number of rolls before a 1 occurs	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	etc.
--	---	---	---	---	---	---	---	---	---	---	----	----	----	----	----	----	------

Frequency

Accumulated points before a 1 occurs	0	1	2	3	4	5	6	7	8	9	10	11	12	etc.
---	---	---	---	---	---	---	---	---	---	---	----	----	----	------

Frequency

6. The modes are immediately apparent. Before you compute them, predict the means and the medians. Briefly explain your reasoning. Then determine the means and medians.
7. Compare your empirical findings with your prediction in Step 1. If the results are different from your

prediction, can you explain the observed average?

8. Now discuss these two sets of data in your group. Does either set of data support your favorite strategy, or do they suggest a new strategy? Briefly explain your reasoning.

Part 3: Comparing different strategies

1. We will compare the following strategies: “stop after 4 rolls,” “stop after 5 rolls,” and “stop after 6 rolls.”
 - a. Which one do you think will win? Why?
 - b. Decide how you might gather the data most effectively.
 - c. Collect the data for 50 games. Which strategy results in the most points after 50 games? If we programmed a computer to play the game, would this strategy result in the most points after 1,000 games—yes, no, or not sure? Explain your choice.
 - d. If we look at only those turns in which points were scored—that is, if we put aside the losing rounds, what do you think will be the average score *per turn* for the “stop after 4” strategy, the “stop after 5” strategy, and the “stop after 6” strategy? Explain your reasoning.
2. We will now analyze the data for each of the three strategies.
 - a. Make a histogram and compute the mean and standard deviation (use a calculator or computer). Write a short paragraph explaining what the histogram, mean, and standard deviation tell us about the three strategies.
 - b. Make a boxplot for each of the three strategies. Write a short paragraph explaining what the boxplot tells us about the three strategies.
 - c. Summarize the pros and cons of the two analyses—that is, the histogram, mean, and standard deviation versus the boxplot.
3. Now analyze another strategy.
 - a. Predict the histogram, mean, standard deviation, and boxplot for the “stop after 7” strategy.
 - b. Collect the data for the “stop after 7” strategy and make the histogram, mean, standard deviation, and boxplot. Discuss the match between your predictions and the results.

