

S.IC.4 The Marble Jar

Task

Sometimes hotels, malls, banks, and other businesses will present a display of a large, clear container holding a large number of items and ask customers to estimate some aspect of the items in the container as a contest. In some cases, contestants are allowed to sample items from the jar; but usually, contestants simply have to estimate based on visual inspection of the jar. A local bank is running such a contest, but one of the bank employees is concerned.

The bank has placed 1,500 marbles in a very large, clear jar near the customer entrance. Since the bank's logo's colors are blue and white, some of the 1,500 marbles are blue and the rest are white. In order to enter the contest, a customer must fill in an entry form with his/her estimate for the percentage of blue marbles in the jar and then place the entry form in a ballot box. A random drawing will be held and the first entry drawn that correctly estimates the percentage of blue marbles in the whole jar will receive a \$100 gift certificate. The entry form says the following:

Name: _____ Phone: _____

I think that 1 out of every _____ marbles in this jar is blue.

(Fill in the blank with a "2", "3", "4", "5", or "6".)

Note that for the ease of the contestants, the estimate is to be stated as "1 out of every 2" instead of "50%," "1 out of every 3" instead of "33.3%," and so on.

Now the concerned employee is fairly confident that the true proportion of blue marbles is 25% (1 out of every 4), but he has heard other employees (some of whom are responsible for the contest) state a true proportion value that is different. The employee is worried enough that he wants to investigate but he certainly does not want to empty the jar and inspect all 1,500 marbles! He decides to select a random sample

of marbles from the jar and calculate the percentage of blue marbles in his sample. The percentage of blue marbles in the random sample will be his estimate for the actual percentage of blue marbles in the jar.

He selects a random sample of 5 marbles, and only 1 of the marbles is blue. Based on this sample which gives him an estimate of 20% (1 out of 5) blue marbles, the employee is concerned, but he decides to stick with his original claim of 25% blue marbles in the jar. However, he is now inspired to take even larger samples. He records his results in the table below (additional spaces will be filled in eventually).

Sample Number	Sample Size	Total Number of Blue Marbles in Sample	Percentage of Blue Marbles in Sample
1	5	1	$\frac{1}{5} = 20\%$
2	12	2	$\frac{2}{12} =$
3	20	5	
4		32	
5			
6			
7			
8			
9			

a. His second random sample consists of 12 marbles. Only 2 of the marbles are blue. (This is recorded in the table above.) Compute the sample percentage of blue marbles for this sample and record it in the table. Based on this sample, do you think the employee should stick with his original claim of 25% blue marbles in the jar, or should he come up with a different estimate? Explain why you think this.

b. He then takes a random sample of 20 marbles (Sample 3). Five of the 20 marbles are blue. Compute the sample percentage of blue marbles for this sample and record it in the table. Based on this sample, do you think the employee should stick with his original claim of 25% blue marbles in the jar, or should he come up with a different

estimate? Explain why you think this.

c. He then takes a random sample of 32 marbles (Sample 4). Eight of the marbles are blue. Enter this information on the table, and compute the sample percentage of blue marbles for this sample. Based on this sample, do you think the employee should stick with his original claim of 25% blue marbles in the jar, or should he come up with a different estimate? Explain why you think this.

At this point, the employee feels compelled to talk to the bank manager who is responsible for the contest. The bank manager is a little surprised by the results, but she is not overly concerned. She is quite confident that the true proportion of blue marbles is 33.3%, or 1 in every 3 (i.e., 5,000 blue, 10,000 white marbles), and she asks the concerned employee to go back and look at an even larger random sample of marbles.

d. He then takes a random sample of 40 marbles (Sample 5) and 13 of the marbles are blue. Add this information to the table. Based on this sample, and mindful that the correct, true proportion of blue marbles in the jar is 1 in 2, or 1 in 3, or 1 in 4, etc., do you think the employee should challenge the bank manager's claim that 1 in every 3 marbles is blue? Explain why you think this.

e. Here are the results of some additional random samples. Record each of these in the table and compute the blue marble percentage for each sample.

Sample 6, sample size = 55, 17 blue.

Sample 7, sample size = 65, 21 blue.

Sample 8, sample size = 75, 24 blue.

Sample 9, sample size = 85, 27 blue.

f. Based on the random sample of 85 marbles, and mindful that the correct, true proportion of blue marbles in the jar is 1 in 2, or 1 in 3, or 1 in 4, etc., do you think that the employee should challenge the bank manager's claim that 1 in every 3 marbles is blue? Explain why you think this.

g. Keeping in mind that the samples were random samples, and assuming that the bank manager's claim is correct that the true proportion of blue marbles is 33.3% (1 in every 3), did the employee get more accurate estimates from the small samples or from the large samples?



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