below, we rewrite the formula for the mean of a frequency table so that it applies to a population. In the fraction f/N, the value of f is the frequency with which the value x occurs and N is the population size, so f/N is the probability for the value of x. When we replace f/N with $P(x)$, we make the transition from relative frequency based on a limited number of observations to probability based on infinitely many trials. This result shows why Formula 5-1 is as given earlier in this section.

$$\mu = \frac{\Sigma(f \cdot x)}{N} = \Sigma\left[\frac{f \cdot x}{N}\right] = \Sigma\left[x \cdot \frac{f}{N}\right] = \Sigma[x \cdot P(x)]$$

Similar reasoning enables us to take the variance formula from Chapter 3 and apply it to a random variable for a probability distribution; the result is Formula 5-2. Formula 5-3 is a shortcut version that will always produce the same result as Formula 5-2. Although Formula 5-3 is usually easier to work with, Formula 5-2 is easier to understand directly. Based on Formula 5-2, we can express the standard deviation as

$$\sigma = \sqrt{\Sigma[(x - \mu)^2 \cdot P(x)]}$$

or as the equivalent form given in Formula 5-4.

5-2 Basic Skills and Concepts

Statistical Literacy and Critical Thinking

1. Random Variable Table 5-7 lists probabilities for the corresponding numbers of girls in three births. What is the random variable, what are its possible values, and are its values numerical?

2. Discrete or Continuous? Is the random variable given in Table 5-7 discrete or continuous? Explain.

3. Probability Distribution Does Table 5-7 describe a probability distribution? Show how the requirements are satisfied or are not satisfied.

4. Unusual For 200 births, the probability of exactly 90 girls is 0.0208 and the probability of 90 or fewer girls is 0.089.

Table 5-7 Number of Girls in Three Births

Number of Girls x	$P(x)$
0	0.125
1	0.375
2	0.375
3	0.125

a. Is exactly 90 girls in 200 births unlikely?

b. Among 200 births, is 90 girls an unusually low number of girls?

Identifying Discrete and Continuous Random Variables. ***In Exercises 5 and 6, identify the given values as a* discrete random variable, continuous random variable, *or* not a random variable.**

5. a. Exact weights of quarters now in circulation in the United States

b. Numbers of tosses of quarters required to get heads

c. Responses to the survey question "Did you smoke at least one cigarette in the last week?"

d. Numbers of spins of roulette wheels required to get the number 7