Population, Sample, Parameters & Statistics

Statistics Worksheet · Grade 9–12

Name: ________________________________ Date: ________________

Learning Objectives

- Distinguish between a population and a sample, and identify parameters versus statistics
- Use correct notation (μ, σ, p vs. x■, s, p■) for population and sample measures
- Understand and apply the Central Limit Theorem to sampling distributions

Problems

1. Identify whether each measurement is a parameter or a statistic: (a) The average age of ALL students enrolled in a school district. (b) The average age of 30 randomly selected students from that district.

2. Match each symbol to its correct meaning by filling in the blank: (a) μ = ___ (b) σ = ___ (c) p = ___ (d) x■ = ___ (e) s = ___ (f) p■ = ___

$$\mu,\ \sigma,\ p,\ \bar{x},\ s,\ \hat{p}$$

3. A researcher records the favorite sport of every person in a town of 5,000 people and finds that 60% prefer soccer. Then she surveys 200 residents and finds that 58% prefer soccer. Complete the table by labeling each value as Parameter or Statistic and writing the correct symbol.

Description	Value	Parameter or Statistic	Symbol
Proportion of all 5,000 who prefer soccer	60%		
Proportion of 200 surveyed who prefer soccer	58%		

4. A school principal wants to know the mean GPA of all 1,200 students in her school. She randomly selects 80 students and finds their mean GPA is 3.2. (a) What is the population? (b) What is the sample? (c) Is 3.2 a parameter or a statistic? (d) Write the correct symbol for 3.2.

$$\bar{x} = 3.2$$

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5. Explain in your own words why population parameters are described as 'unknown and unknowable.' Use the example of finding the average height of all adult males in the United States to support your explanation.

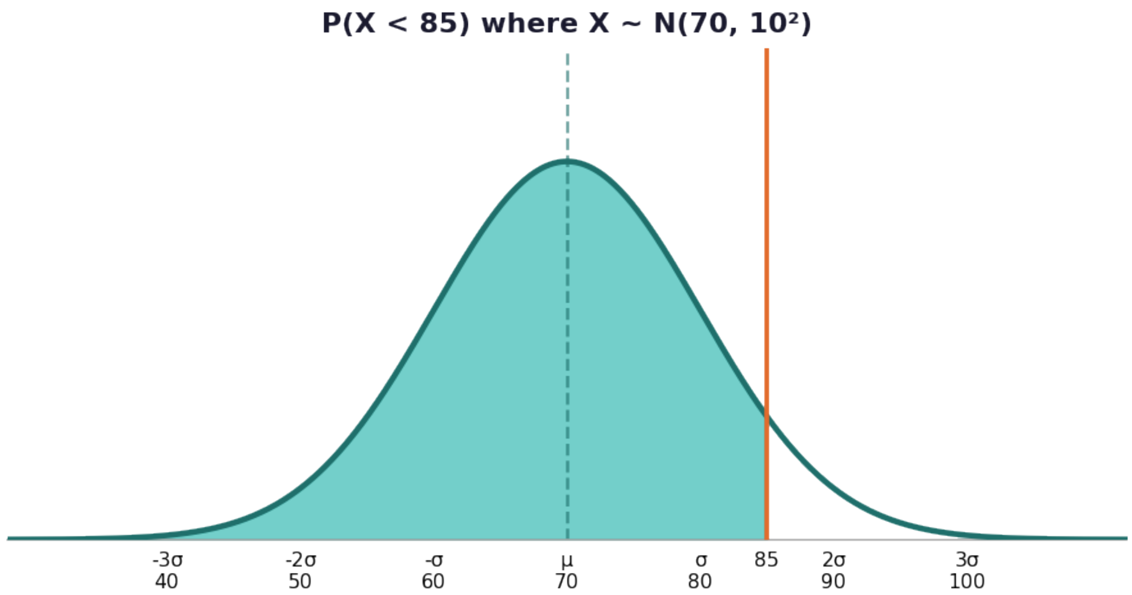
6. A biologist weighs 20 rabbits, then 200 rabbits, then 2,000 rabbits and records the distributions. According to the Central Limit Theorem, describe what happens to (a) the shape of the distribution and (b) the variability (spread) as the sample size increases.

$$n = 20,\ 200,\ 2000$$

7. The heights of adult women in a city are normally distributed with a population mean of 64 inches and a population standard deviation of 3 inches. A random sample of 36 women is selected. What is the mean and standard error of the sampling distribution of the sample mean?

$$\mu = 64,\ \sigma = 3,\ n = 36$$

8. Scores on a standardized exam are normally distributed with a mean of 70 and a standard deviation of 10. Find the probability that a randomly chosen student scores less than 85.



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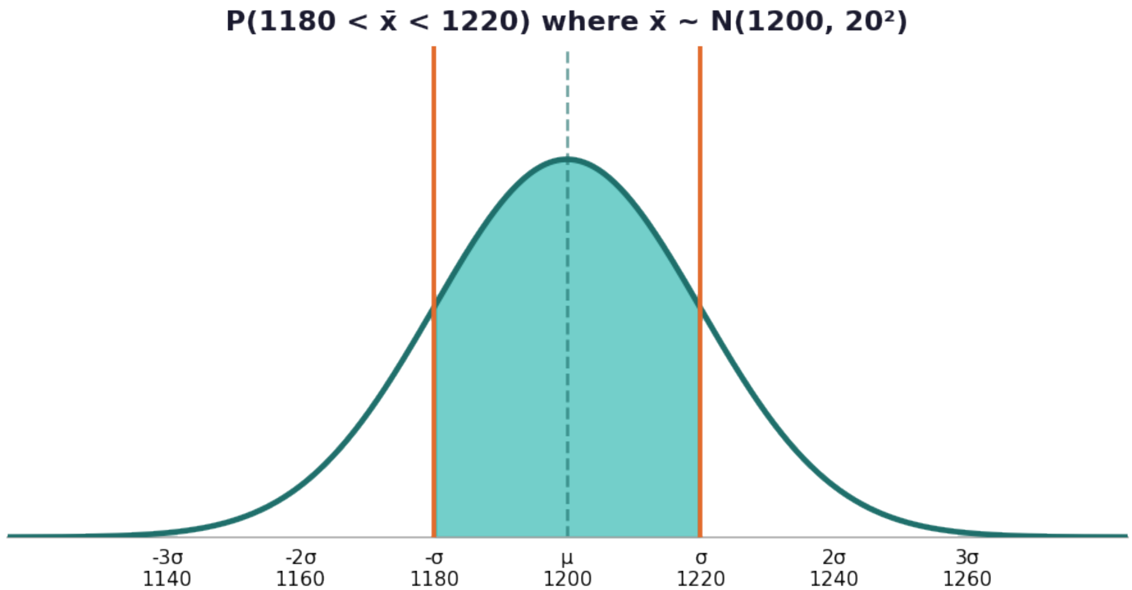
9. A polling agency surveys a random sample of 500 registered voters and finds that 54% support a new education bill. The true population proportion is unknown. (a) Identify the population and the sample. (b) Write the statistic using correct notation. (c) If repeated samples of size 500 were taken, what does the Central Limit Theorem say about the distribution of sample proportions? (d) Calculate the standard error of the proportion if the true proportion is assumed to be 0.54.

$$SE = \sqrt{\frac{p(1-p)}{n}}$$

10. The lifespans of a certain brand of light bulb are normally distributed with a mean of 1,200 hours and a standard deviation of 100 hours. A quality control inspector randomly selects 25 bulbs. (a) Describe the sampling distribution of the sample mean. (b) Find the probability that the sample mean lifespan is between 1,180 and 1,220 hours. (c) Would it be unusual to observe a sample mean below 1,150 hours? Justify using a z-score.



Population, Sample, Parameters & Statistics — Answer Key

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Answer Key

1. Answer: (a) Parameter — it describes the entire population. (b) Statistic — it is computed from a sample.

- A parameter describes an entire population; a statistic is computed from a sample.
- (a) 'ALL students enrolled' refers to the full population → Parameter.
- (b) '30 randomly selected students' is a subset of the population → Statistic.

2. Answer: (a) population mean (b) population standard deviation (c) population proportion (d) sample mean (e) sample standard deviation (f) sample proportion

- Greek letters denote population parameters: μ (mean), σ (standard deviation), p (proportion).
- Roman/modified letters denote sample statistics: x■ (mean), s (standard deviation), p■ (proportion).

3. Answer: Row 1: Parameter, p. Row 2: Statistic, p■.

Description	Value	Parameter or Statistic	Symbol
Proportion of all 5,000 who prefer soccer	60%	Parameter	p
Proportion of 200 surveyed who prefer soccer	58%	Statistic	$\hat{p}$

- 60% comes from all 5,000 people (entire population) → Parameter, symbol p.
- 58% comes from only 200 people (a sample) → Statistic, symbol p■.

4. Answer: (a) All 1,200 students (b) The 80 randomly selected students (c) Statistic (d) x■

- (a) The population is all 1,200 students in the school.
- (b) The sample is the 80 randomly selected students.
- (c) Since 3.2 is computed from a sample of 80, it is a statistic.
- (d) The sample mean is denoted x■, so x■ = 3.2.

5. Answer: It is practically impossible to measure every individual in a large population, so the true parameter can never be exactly determined. We instead use sample statistics to estimate it.

- There are hundreds of millions of adult males in the U.S. — measuring each one is impossible.
- Because we cannot collect data from every member, the true population mean (μ) can never be precisely known.
- Instead, researchers take a representative sample and compute x■ to estimate μ.

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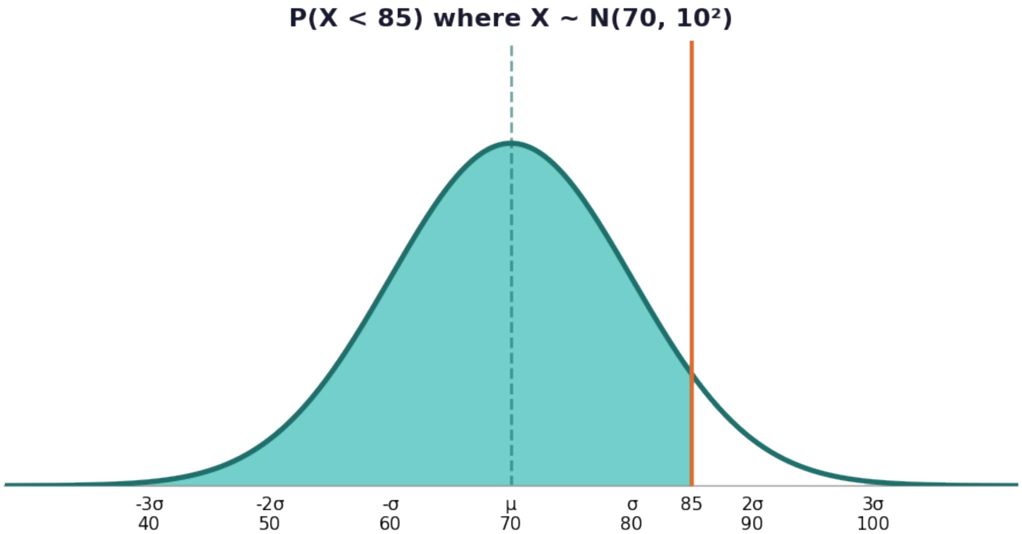
6. Answer: (a) The distribution approaches a normal (bell-shaped) distribution. (b) The variability (spread) decreases.

- The Central Limit Theorem states: as sample size n increases, the sampling distribution of the sample mean approaches a normal distribution.
- With $n = 20$, the distribution has high spread and may not look normal.
- With $n = 2{,}000$, the distribution is much narrower and closely resembles a normal curve.
- Variability of the sampling distribution is measured by the standard error: $\sigma / \sqrt{n}$, which decreases as n increases.

7. Answer: Mean of sampling distribution = 64 inches; Standard Error = 0.5 inches

- The mean of the sampling distribution equals the population mean: μ_x■ = μ = 64 inches.
- The standard error (SE) = $\sigma / \sqrt{n} = 3 / \sqrt{36} = 3 / 6 = 0.5$ inches.
- So the sampling distribution of x■ ~ $N(64, 0.5^2)$.

8. Answer: P ≈ 0.9332 (93.32%)

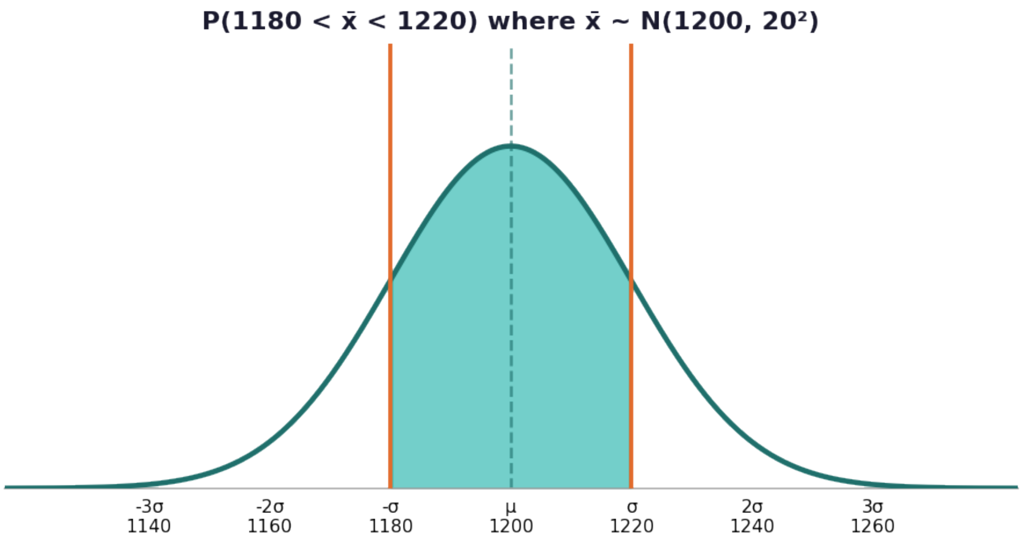


- Compute the z-score: $z = (85 - 70) / 10 = 15 / 10 = 1.5$
- Look up $P(Z < 1.5)$ in the standard normal table.
- $P(Z < 1.5) \approx 0.9332$
- Therefore, about 93.32% of students score less than 85.

9. Answer: (a) Population: all registered voters; Sample: the 500 surveyed (b) p■ = 0.54 (c) The distribution of p■ approaches normal (d) SE ≈ 0.0223

- (a) Population = all registered voters; Sample = the 500 randomly selected voters.
- (b) The sample proportion is written as p■ = 0.54.
- (c) By the CLT, as n increases the sampling distribution of p■ approaches a normal distribution centered at p.
- (d) $SE = \sqrt{(0.54 \times 0.46 / 500)} = \sqrt{(0.2484 / 500)} = \sqrt{(0.0004968)} \approx 0.0223$.

10. Answer: (a) x■ ~ $N(1200, 20^2)$ (b) P ≈ 0.6827 (68.27%) (c) z = –2.5; yes, unusual since |z| > 2



- (a) By CLT, x■ ~ N(μ, σ^2/n) = N(1200, $100^2/25$) = N(1200, 20^2). The standard error = 100/√25 = 20.
- (b) z for 1180: z = (1180 – 1200)/20 = –1. z for 1220: z = (1220 – 1200)/20 = 1.
- P(–1 < Z < 1) ≈ 0.6827, so about 68.27% of samples would have a mean between 1,180 and 1,220 hours.
- (c) z = (1150 – 1200)/20 = –50/20 = –2.5. P(Z < –2.5) ≈ 0.0062 (0.62%).
- Since the probability is less than 5%, a sample mean below 1,150 hours would be considered unusual.

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