

## Module 7 Statistical Reasoning in Everyday Life page 56

Why do we need statistics?

Descriptive Statistics – Numerical data used to measure and describe characteristics of groups. Includes measures of central tendency and measures of variation.

Measures of Central Tendency – **mode**: the most frequently occurring score in a distribution.

**Mean**: The arithmetic average of a distribution, obtained by adding the scores and then dividing by the number of scores.

**Median**: The middle score in a distribution; half the scores are above it and half are below it.

Sometimes outliers can skew data. Look at figure 7.2 page 58.

**Range**: the difference between the highest and the lowest scores in a distribution.

**Standard Deviation**: A computed measure of how much scores vary around the mean score.

Look at figure 7.3, page 59.

**What is a range, a variance, and a standard deviation?**

Range = the difference between the highest and lowest numbers

Variance = how spread out (far away) a number is from the mean

Standard Deviation = loosely defined as the average amount a number differs from the mean

**Find the mean, median, mode, and range for the following list of values.**

13, 18, 13, 14, 13, 16, 14, 21, 13

**The mean is the usual average, so I'll add and then divide:**

$$(13 + 18 + 13 + 14 + 13 + 16 + 14 + 21 + 13) \div 9 = 15$$

Note that the mean, in this case, isn't a value from the original list. This is a common result. You should not assume that your mean will be one of your original numbers.

**The median is the middle value, so first I'll have to rewrite the list in numerical order:**

13, 13, 13, 13, 14, 14, 16, 18, 21

**There are nine numbers in the list, so the middle one will be the  $(9 + 1) \div 2 = 10 \div 2 = 5$ th number:**

13, 13, 13, 13, 14, 14, 16, 18, 21

So the median is 14.

The mode is the number that is repeated more often than any other, so 13 is the mode.

The largest value in the list is 21, and the smallest is 13, so the range is  $21 - 13 = 8$ .

mean: 15

median: 14

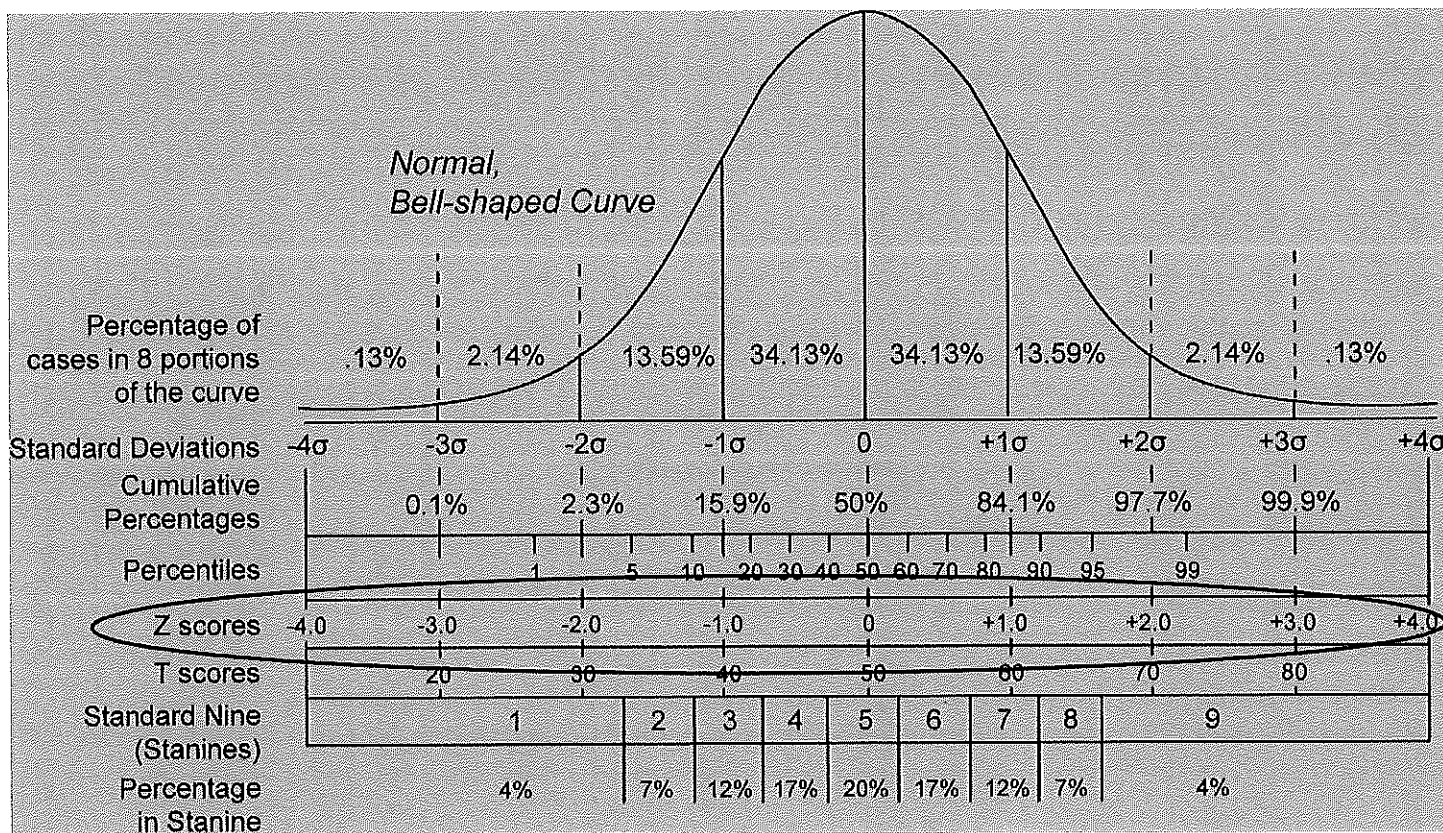
mode: 13

range: 8

Note: The formula for the place to find the median is " $([\text{the number of data points}] + 1) \div 2$ ", but you don't have to use this formula. You can just count in from both ends of the list until you meet in the middle, if you prefer, especially if your list is short. Either way will work.

### What Is a Z-Score?

A Z-score is a numerical measurement that describes a value's relationship to the mean of a group of values. Z-score is measured in terms of standard deviations from the mean. If a Z-score is 0, it indicates that the data point's score is identical to the mean score. A Z-score of 1.0 would indicate a value that is one standard deviation from the mean. Z-scores may be positive or negative, with a positive value indicating the score is above the mean and a negative score indicating it is below the mean.



## What Is P-Value?

In statistics, the p-value is the probability of obtaining results at least as extreme as the observed results of a statistical hypothesis test, assuming that the null hypothesis is correct. The p-value is used as an alternative to rejection points to provide the smallest level of significance at which the null hypothesis would be rejected. A smaller p-value means that there is stronger evidence in favor of the alternative hypothesis.

- A p-value is a measure of the probability that an observed difference could have occurred just by random chance.
- The lower the p-value, the greater the statistical significance of the observed difference.
- P-value can be used as an alternative to or in addition to pre-selected confidence levels for hypothesis testing.

## Explain statistical significance.

Null Hypothesis - The **null hypothesis** states that there is no relationship between the two variables being studied (one variable does not affect the other). It states results are due to chance and are not significant in terms of supporting the idea being investigated. In the **example**, Susie's **null hypothesis** would be something like this: There is no statistically significant relationship between the type of water I feed the flowers and growth of the flowers.

Alternative Hypothesis - The **alternative hypothesis** states that there is a relationship between the two variables being studied (one variable has an effect on the other). It states that the results are not due to chance and that they are significant in terms of supporting the theory being investigated.

What Are **Examples** of a **Hypothesis**? ... The **alternative hypothesis** states that students will recall significantly more information on a Monday morning than on a Friday afternoon. The **null hypothesis** states that there will be no significant difference in the amount recalled on a Monday morning compared to a Friday afternoon.

Statistical Significance - **Statistical significance** is the term used by research **psychologists** to indicate whether or not the difference between groups can be attributed to chance or if the difference is likely the result of experimental influences.

The null hypothesis states that there is no relationship between the two variables being studied (one variable does not affect the other). It states the results are due to chance and are not significant in terms of supporting the idea being investigated. Thus, the null hypothesis assumes that whatever you are trying to prove did not happen.

The purpose is **to prove whether or not the test is supported, which is separated from the investigator's own values and decisions**. They also provide direction to the research. The null hypothesis is generally denoted as  $H_0$ . It states the exact opposite of what an investigator or an experimenter predicts or expects.

The alternative hypothesis is the one you would believe if the null hypothesis is concluded to be untrue.

The alternative hypothesis states that the independent variable did affect the dependent variable, and the results are significant in terms of supporting the theory being investigated (i.e. not due to chance).

A p-value, or probability value, is a number describing how likely it is that your data would have occurred by random chance (i.e. that the null hypothesis is true).

The level of statistical significance is often expressed as a p-value between 0 and 1. The smaller the p-value, the stronger the evidence that you should reject the null hypothesis.

- A  $p$ -value less than 0.05 (typically  $\leq 0.05$ ) is statistically significant. It indicates strong evidence against the null hypothesis, as there is less than a 5% probability the null is correct (and the results are random). Therefore, we reject the null hypothesis, and accept the alternative hypothesis.

However, if the  $p$ -value is below your threshold of significance (typically  $p < 0.05$ ), you can reject the null hypothesis, but this does not mean that there is a 95% probability that the alternative hypothesis is true. The  $p$ -value is conditional upon the null hypothesis being true, but is unrelated to the truth or falsity of the alternative hypothesis.

- A  $p$ -value higher than 0.05 ( $> 0.05$ ) is not statistically significant and indicates strong evidence for the null hypothesis. This means we retain the null hypothesis and reject the alternative hypothesis. You should note that you cannot accept the null hypothesis, we can only reject the null or fail to reject it.

A statistically significant result cannot prove that a research hypothesis is correct (as this implies 100% certainty).

Instead, we may state our results “provide support for” or “give evidence for” our research hypothesis (as there is still a slight probability that the results occurred by chance and the null hypothesis was correct – e.g. less than 5%).

## AP Psychology Stats for Smarties

**Measures of Central Tendency** – the AP will likely use this term. It looks at stats (mean, median, and mode, specifically) that tell you where data falls in a distribution of scores. (For this “cheat sheet” let’s use test averages on an AP Psychology test as our example or means of reference.)

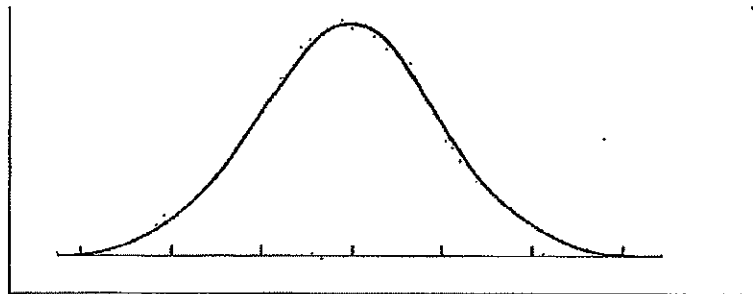
- Mean – the arithmetic average
  - Remember, VERY HIGH or VERY LOW scores can skew (or distort) the mean!
- Median – the middle score in a distribution (half scores fall above, half fall below)
- Mode – the number occurring most frequently

**Measures of Variability** – These scores look at how much variation there is to your data, or how spread out they are.

- Range – the range is the difference between the HIGHEST and the LOWEST numbers.
  - If my high score on the last test was 100/100, and the low score was 65/100, the range would be 35.
- Standard Deviation – the standard deviation is average difference between each individual score and the mean of all the scores. Another way to describe standard deviation is how far on average each of the individual scores in a data set varies from the mean. (Or, the average of each score from the average.)
  - A **LARGE** standard deviation means a lot of variation in scores. (Students with very high and very low scores.)
  - A **SMALL** standard deviation indicates little variance in scores.
- Variance – the average of a distribution is called the variance. On average, how much the scores vary.

### Normal Distribution

- If the mean, median, and mode are all equal and located at the center of the distribution, the result is called a normal distribution or a normal curve. It is the “bell shaped curve” that test designers love.

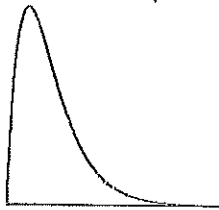


- A normal curve says (on an AP Psych test, let’s say) that some kids blew it off and didn’t study and didn’t know anything. They failed. (Left side) Some kids studied their butt’s off and lived-ate-breathed psychology for a week before the test and totally rocked it. (Right side) MOST kids, on average, were somewhere inbetween those two extremes. They knew much of the material, but got some questions wrong.

- In a normal distribution, the rule is 68-95-99. That means that MOST of the scores, 68% fall in ONE standard deviation from the average. 95% of people scored in 2 standard deviations from the mean. 99% of scores are within 3 standard deviations from the mean.
  - (Just remember a 6 and an 8 year old steal a car and hit Highway I-95 going 99 miles per hour and get busted by a police officer.)
  - This rule allows us to comprehend that most people fall within an average. Few people on an AP Psych test will score 100%, as few will score in the 40%...or IQ. We have, statistically, few geniuses and few people with severe cognitive impairment.

### Skews

- When a set of data is skewed, it is not “normal”. See above.
- Positive Skew – this means most of the scores are low, and the skew points to the right (or towards positive on a number line.)
  - This likely means the test was very hard, too hard maybe.



- Negative Skew – this means the scores on a test are very high, the tail points to the left (or negative on a number line.)



### Inferential Statistics

- Can we make assumptions based off of our data? Are they significant enough to be applied to a whole high school? A whole nation?
- Statistical Significance – when data is statistically significant, it means that this information is *not likely* to be happenstance (or chance).
  - There is a high probability that the the IV caused the DV
  - We can reject the null hypothesis
  - The probability value (or p value) is  $p < .05$ 
    - There is a 95% chance that the IV caused the DV
    - A p value can never be 0%
    - *The lower the p value, the better the data, you always want less chance and more statistical evidence when presenting data!!!!*