☺ 2.2 – Measures of Spread ☺

Objectives:

1. Develop a concept of spread
2. Understand deviation from the mean.
3. Define standard deviation.
4. Understand formula for standard deviation.
5. Find the standard deviation of a data set.

Investigation of spread:
Measure ½ cup of noodles five times with each measuring cup and record the numbers below.

	Number of shells in ½ cup measured with a Dry ½ cup Measuring Cup	Calculate the **Deviation** from the Mean for each value	Number of shells Liquid Measuring Cup	Calculate the **Deviation** from the Mean for each value
Trial 1	41	.6	85 43	-2.4 3.2
Trial 2	40	-.4	89 37	1.6 -2.8
Trial 3	40	-.4	91 45	3.6 5.2
Trial 4	41	.6	82 38	-5.4 -1.8
Trial 5	40	-.4	90 36	2.6 -3.8
Sum	122	0	437 199	0 0
Mean	40.4	0	87.4 39.8	0 0

Please note that the sum of the Deviations is 0 for both measuring cups.

Standard Deviation

The **standard deviation,** s, is a measure of the spread of a data set.

$$s = \sqrt{\frac{\sum_{i=1}^{n}(x_i - \bar{x})^2}{n-1}}$$

where x_i represents the individual data values, n is the number of values, and $\bar{x}$ is the mean. The standard deviation has the same units as the data.

Number of shells in ½ cup measured with a Dry ½ cup Measuring Cup	Deviation	$(\text{Deviation})^2$	Number of shells Liquid Measuring Cup	Deviation	$(\text{Deviation})^2$
41	.6	.36	85 43	-2.4 3.2	5.76 10.24
40	-.4	.16	89 37	1.6 -2.8	2.56 7.84
40	-.4	.16	91 45	3.6 5.2	12.96 27.04
41	.6	.36	82 38	-5.4 -1.8	29.16 3.24
40	-.4	.16	90 36	2.6 -3.8	6.76 14.44

Sum of the $(\text{Deviation})^2$= 1.2	Sum of the $(\text{Deviation})^2$= 57.2 62.8
Variance $\frac{\text{Sum of the (Deviation)}^2}{\cancel{5}\ 4} =$ .3	Variance $\frac{\text{Sum of the (Deviation)}^2}{\cancel{5}\ 4} =$ 14.3 15.7
Standard Deviation $\sqrt{\frac{\text{\textit{Sum} of the (Deviation)}^2}{\cancel{5}\ 4}} =$ .548	Standard Deviation $\sqrt{\frac{\text{\textit{Sum} of the (Deviation)}^2}{\cancel{5}\ 4}} =$ 3.782 3.962

	Standard Deviation for dry measuring cup	Standard Deviation for liquid measuring cup
Group 1		
Group 2		
Group 3		
Group 4		
Group 5		
Group 6		
Group 7		
Group 8		
Average		

Discuss the results found and possible reasons for the results found.

EXAMPLE This table gives the student-to-teacher ratios for public elementary and secondary schools in the United States.

Student-to-Teacher Ratios for Public Elementary and Secondary Schools (2003–2004 School Year)

State	AK	AL	AR	AZ	CA	CO	CT	DE	FL	GA	HI	IA	ID
Ratio	17.2	12.6	14.7	21.3	21.1	16.9	13.6	15.2	17.9	15.7	16.5	13.8	17.9

State	IL	IN	KS	KY	LA	MA	MD	ME	MI	MN	MO	MS	MT
Ratio	16.5	16.9	14.4	16.1	16.6	13.6	15.8	11.5	18.1	16.3	13.9	15.1	14.4

State	NC	ND	NE	NH	NJ	NM	NV	NY	OH	OK	OR	PA	RI
Ratio	15.1	12.7	13.6	13.7	12.7	15.0	19.0	13.3	15.2	16.0	20.6	15.2	13.4

State	SC	SD	TN	TX	UT	VA	VT	WA	WI	WV	WY
Ratio	15.3	13.6	15.7	15.0	22.4	13.2	11.3	19.3	15.1	14.0	13.3

(U.S. Department of Education, National Center for Education Statistics)

STAT - CALC - 1 VAR STATS

$\bar{x} = 15.546$

$s = 2.48$ ← sample s.d.

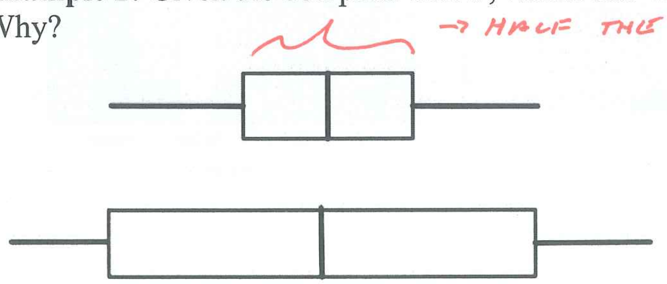
a. Calculate the mean and the standard deviation. What do the statistics tell you about the spread of the student-to-teacher ratios? More than half of the ratios are within 2.48 students of the mean.

b. Identify any values that are more than two standard deviations from the mean. What percentage of all values are more than two standard deviations from the mean? $15.55 - 2(2.48) = 10.58$ NONE

$15.55 + 2(2.48) = 20.51$ OR CA AZ UT $\frac{4}{50} = 8\%$

20.6 21.1 21.3 22.4

Example 2: Given the box plots below, which one would have a smaller standard of deviation? Why? → HALF THE VALUES CLOSER TO MEAN



Example 3: Sally and Jake's Algebra class both averaged a 14 out of 20 on their quiz this week. However, Sally's class had a standard deviation of 1.2 while Jake's class had a standard deviation of 4.5. What does this tell you about each class' scores?

Sally's class had half of its students within 1.2 of the mean, which indicates their scores were similar. Jake's class had half within 4.5 of the mean, which means there was more variance.