III. Two-tail testing of 2 sample medians from independent populations using the Mann-Whitney test

A. This hypothesis test is used when populations are not symmetrical and do not have equal variances.

B. Data must be at least ordinal in nature.

C. Procedures

1. Data from 2 samples will be combined into an ordered array. Sample size may differ.
2. Beginning with the number 1, data will be ranked. Equal data, called ties, will be given their averaged rank.
3. Ranks will be assigned to their respective sample and the mean rank of each sample calculated.
4. If population medians are equal, there will be little difference between the mean rank of each sample.
5. Either mean calculation, U_1 or U_2, may be used.
6. The sampling distribution of U will be approximately normal provided both samples n_1 and n_2 are ≥ 10.
7. Special procedures, not covered in **Quick Notes Statistics**, are used when either n is less than 10.

D. Twenty-three employees were randomly assigned to training method A or B. Distribution shapes are not known. Linda wants to determine the equality of training methods at the .05 level of significance.

n_1 is sample size #1.	n_2 is sample size #2.	$U = U_1$ or U_2
R_1 is sample 1's rank.	R_2 is sample 2's rank.	

Method Score A	Method Score B	Rank Ordered Array and Method			Ranked Scores Method A	Ranked Scores Method B
14	12	1.	12	B		1
17	21	2.	13	A	2	
27	28	3.	14	A	4	
19	16	4.	14	B		4
13	30	5.	14	B		4
32	26	6.	16	B		6
22	14	7.	17	A	7	
25	18	8.	18	A	8.5	
18	28	9.	18	B		8.5
30	22	10.	19	A	10	
24	14	11.	21	B		11
33		12.	22	A	12.5	
		13.	22	B		12.5
		14.	24	A	14	
		15.	25	A	15	
		16.	26	B		16
		17.	27	A	17	
		18.	28	B		18.5
		19.	28	B		18.5
		20.	30	A	20.5	
		21.	30	B		20.5
		22.	32	A	22	
		23.	33	A	23	
		Totals		R =	155.5	or 120.5

H_o : Median$_1$ = Median$_2$ H_1 : Median$_1$ ≠ Median$_2$

$$z = \frac{U - \mu_U}{\sigma_U}$$

U is the test statistic. If z from the test statistic is beyond the critical value of z, H_0 will be rejected. That is, the medians are not equal.

$$U_1 = n_1 n_2 + \frac{n_1(n_1+1)}{2} - R_1$$

or

$$U_2 = n_1 n_2 + \frac{n_2(n_2+1)}{2} - R_2$$

R_1 has been calculated using the chart.

$$\mu_U = \frac{n_1 n_2}{2}$$

$$\sigma_U = \sqrt{\frac{n_1 n_2(n_1+n_2+1)}{12}}$$

$$U_1 = n_1 n_2 + \frac{n_1(n_1+1)}{2} - R_1 = 12(11) + \frac{12(12+1)}{2} - 155.5 = 132 + 78 - 155.5 = 54.5$$

$$\mu_U = \frac{n_1 n_2}{2} = \frac{12(11)}{2} = 66$$

$$\sigma_U = \sqrt{\frac{n_1 n_2(n_1+n_2+1)}{12}} = \sqrt{\frac{12(11)(12+11+1)}{12}} = \sqrt{\frac{3{,}168}{12}} = 16.248$$

$$z = \frac{U - \mu_U}{\sigma_U} = \frac{54.5 - 66.0}{16.248} = -.71$$

This two-tail .05 test has a z of ±1.96. Accept H_0 because z of -.71 from the test statistic is not beyond - 1.96. There is not a difference between these median scores.