Ch2 Lab Results - Hypothesis Testing

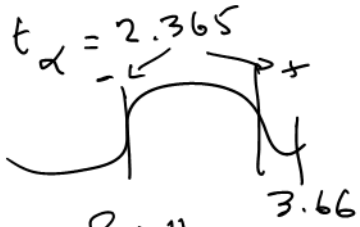
***1. What conclusions are warranted about the life satisfaction scores of 4100 students relative to**
*** UW students at large assuming researchers had no expectation about the results?**

$H_0: \mu = 15$
$H_a: \mu \neq 15$

$t = \frac{17.875 - 15}{2.416/\sqrt{8}} = \frac{2.875}{.854} = 3.66$

$df = 8 - 1 = 7$

$t_\alpha = 2.365$



Rej H_0
Acc H_a

```
DATA LIST FREE / sat.
BEGIN DATA
20 17 19 15 19 18 14 21
END DATA.

DESCR /VARI = sat.
```

	N	Minimum	Maximum	Mean	Std. Deviation
sat	8	14.000	21.000	17.87500	2.416461
Valid N (listwise)	8				

***2. Use SPSS's TTEST command to perform the preceding analysis.**

μ_0

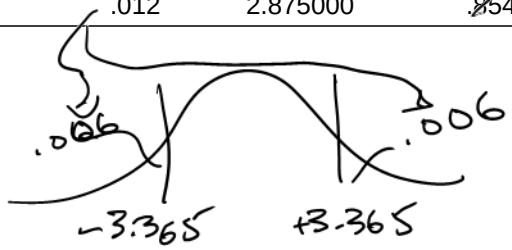
```
TTEST /TESTVALUE = 15 /VARI = sat.
```

$\frac{2.416}{\sqrt{8}}$

	N	$\bar{Y}$ Mean	Std. Deviation	Std. Error Mean
sat	8	17.87500	s 2.416461	.854348

	Test Value = 15					
					95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
sat	3.365	7	.012	2.875000	.85479	4.89521

$n-1$



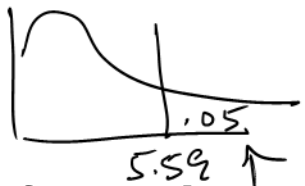
```
*3. Perform an equivalent test using MANOVA and GLM.
*    Show correspondences to the TTEST results.

COMPUTE sat0 = sat-15.
MANOVA sat0 /PRINT = CELL.
```

$H_0: \mu = 0$

$F = \frac{8(2.875-0)^2}{2.416^2} = 11.32$

$df = 1, 7$

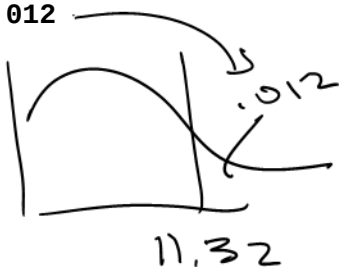
$F_{crit} = 5.59$



11.32 Rej H_0

	Mean	Std. Dev.	N	95 percent Conf. Interval	
For entire sample	2.875	2.416	8	.855	4.895

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN CELLS	40.88	7	5.84		
CONSTANT	66.13	1	66.13	11.32	.012




```
GLM sat0 /PRINT = DESCR.
```

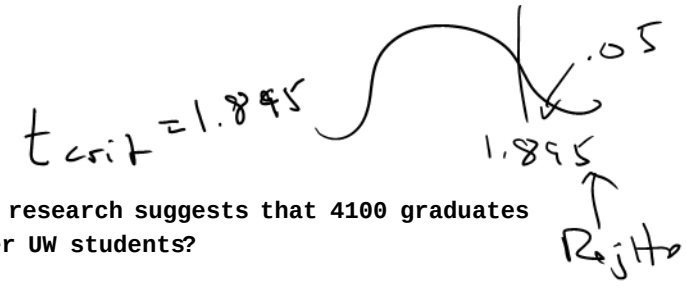
Dependent Variable: sat0

Mean	Std. Deviation	N
2.87500	2.416461	8

Dependent Variable: sat0

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	.000[a]	0	.	.	.
Intercept	66.125	1	66.125	11.32	.012
Error	40.875	7	5.839		
Total	107.000	8			
Corrected Total	40.875	7			

a. R Squared = .000 (Adjusted R Squared = .000)



***4. What conclusion would be appropriate if prior research suggests that 4100 graduates**
*** are more satisfied with their lives than other UW students?**

***5. A comparison group of 8 general UW students completed the UTLS: MN=14.75, SD=4.367.**
*** Determine whether the two groups differ significantly in life satisfaction.**

***6. Copy and run the following commands to enter the data in SPSS.**
*** Perform the analysis corresponding to that completed in #5.**

$H_0: \mu_1 = \mu_2$
$H_a: \mu_1 \neq \mu_2$

$t = \frac{(17.875 - 14.75) - 0}{\sqrt{12.455\left(\frac{1}{8} + \frac{1}{8}\right)}}$

$= \frac{3.125}{1.765} = 1.77$

$s_p^2 = \frac{40.875 + 133.49}{8+8-2}$

$= 12.455$

$SS_2 = (8-1)4.367^2$

$= 133.49$

$df = 14$

$t_{crit} = 2.145$


```
DATA LIST FREE / grp sat.
BEGIN DATA
1 17 1 12 1 16 1 12 1 18 1 22 1 13 1 8
2 20 2 17 2 19 2 15 2 19 2 18 2 14 2 21
END DATA.

TTEST /GROUP = grp /VARI = sat.
```

	grp	N	Mean	Std. Deviation	Std. Error Mean
sat	1.000	8	14.75000	4.367085	1.543998
	2.000	8	17.87500	2.416461	.854348

		Levene's Test for Equality of Variances		t-test for Equality of Means			
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference
sat	Equal variances assumed	3.007	.105	-1.771	14	.098	-3.125000
	Equal variances not assumed			-1.771	10.919	.104	-3.125000

−1.77 +1.77

8+8−2

		t-test for Equality of Means		
		Std. Error Difference	95% Confidence Interval of the Difference	
			Lower	Upper
sat	Equal variances assumed	1.764607	-6.909706	.659706
	Equal variances not assumed	1.764607	-7.012388	.762388

Dev.

```
*7. Use GLM to perform same analysis and obtain descriptive statistics.
*    Perform the analysis by hand and compare to the SPSS output.
```

```
GLM sat BY grp /PRINT = DESCR.
```

Dependent Variable: sat

grp	Mean	Std. Deviation	N
1.000	14.75000	4.367085	8
2.000	17.87500	2.416461	8
Total	16.31250	3.772157	16

$\bar{Y}$ $\bar{Y}_G$ $\bar{Y} - \bar{Y}_G$ $(\bar{Y} - \bar{Y}_G)^2$

-1.5625

$+1.5625$

$8 \times \Sigma = 39.06$

$df = 2 - 1 = 1$

Dependent Variable: sat

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	39.063[a]	1	39.063	3.136	.098
Intercept	4257.563	1	4257.563	341.826	.000
grp	39.063	1	39.063	3.136	.098
Error	174.375	14	12.455		
Total	4471.000	16			
Corrected Total	213.438	15			

Redundant

F_{crit} 4.6

Num

Den

s_p^2

$\frac{39.06}{12.455}$

0

3.136 DNR

a. R Squared = .183 (Adjusted R Squared = .125)

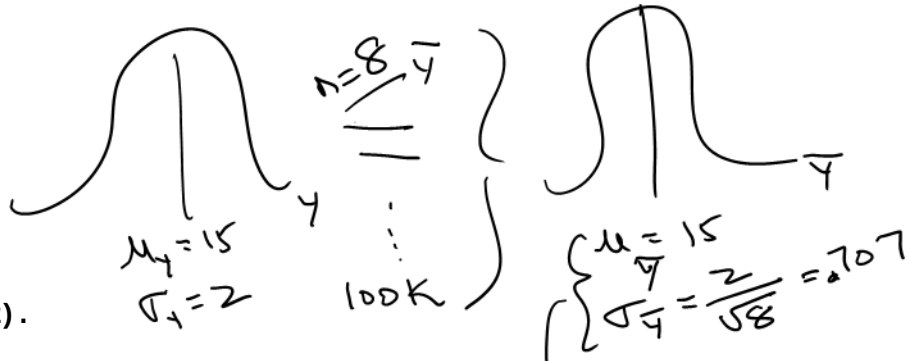
```
MANOVA sat BY grp(1 2) /PRINT = CELL.
```

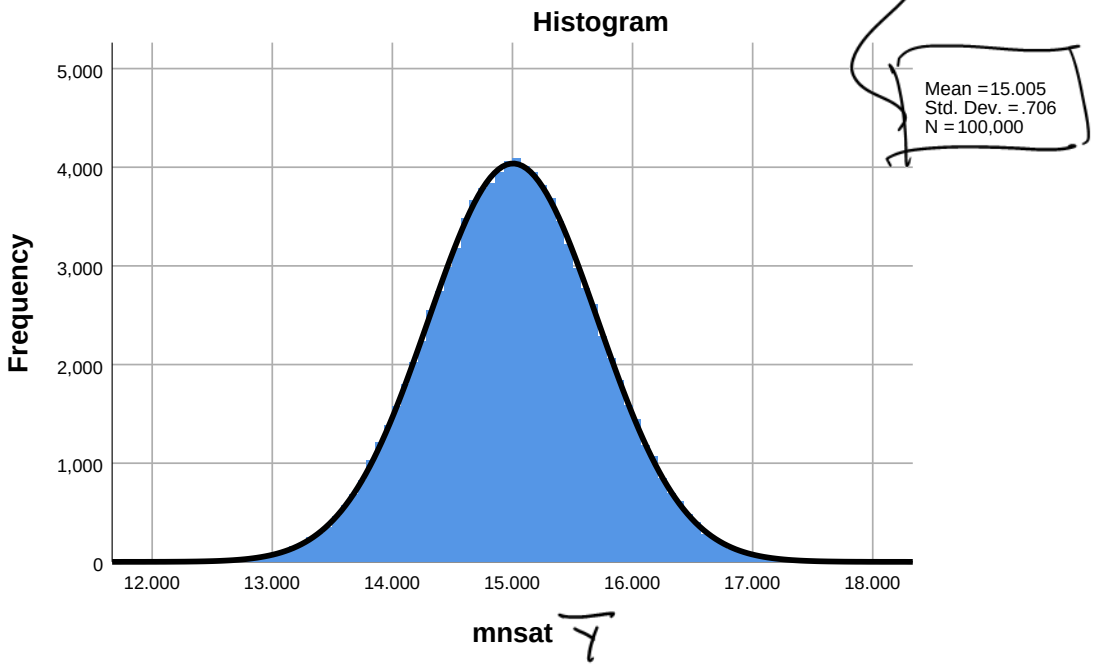
FACTOR	CODE	Mean	Std. Dev.	N
grp	1	14.750	4.367	8
grp	2	17.875	2.416	8
For entire sample		16.313	3.772	16

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN CELLS	174.38	14	12.46		
grp	39.06	1	39.06	3.14	.098
(Model)	39.06	1	39.06	3.14	.098
(Total)	213.44	15	14.23		

R-Squared = .183 Adjusted R-Squared = .125

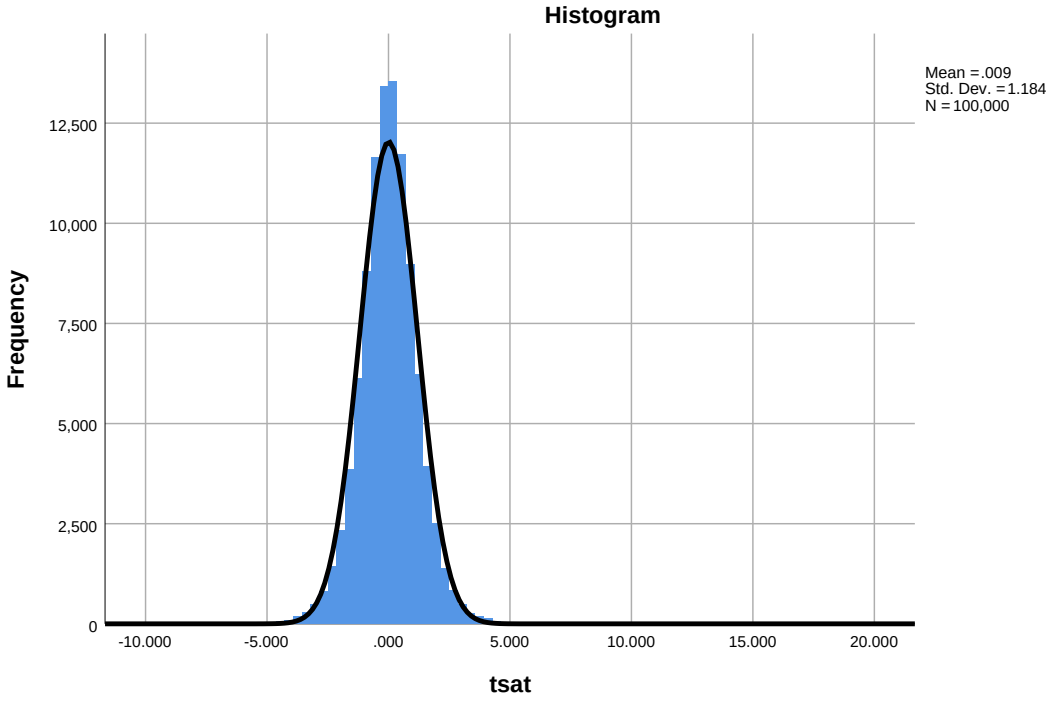
```
 SET SEED = 457102234.
INPUT PROGRAM.
LOOP s = 1 to 100000.
END CASE.
END LOOP.
END FILE.
END INPUT PROGRAM.
DO REPEAT y = s1 TO s8.
COMPUTE y = RV.NORM(15,2).
END REPEAT.
COMPUTE mnsat = MEAN(s1 TO s8).
COMPUTE sdsat = SD(s1 TO s8).

FREQ mnsat /FORM = NOTABLE /HIST NORM.
```





```
COMPUTE tsat = (mnsat-15)/(sdsat/SQRT(8)).
FREQ tsat /FORM = NOTABLE /HIST NORM.
```

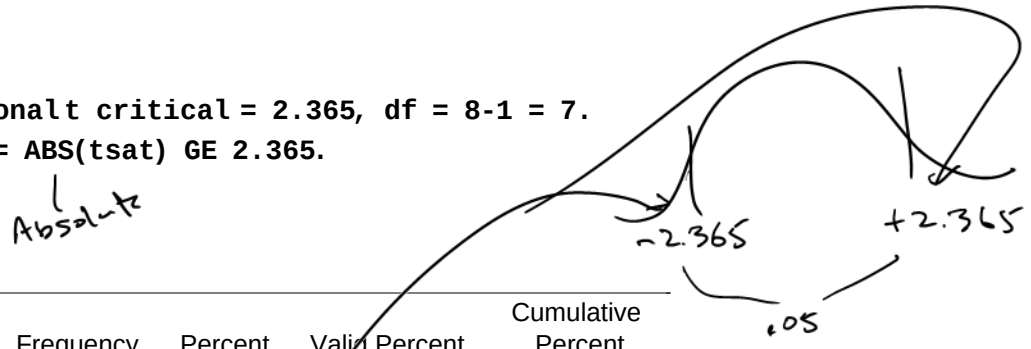
$$t = \frac{\bar{y} - 15}{s/\sqrt{8}}$$



```
*non-directional t critical = 2.365, df = 8-1 = 7.
COMPUTE tsig = ABS(tsat) GE 2.365.
FREQ tsig.
```

tsig

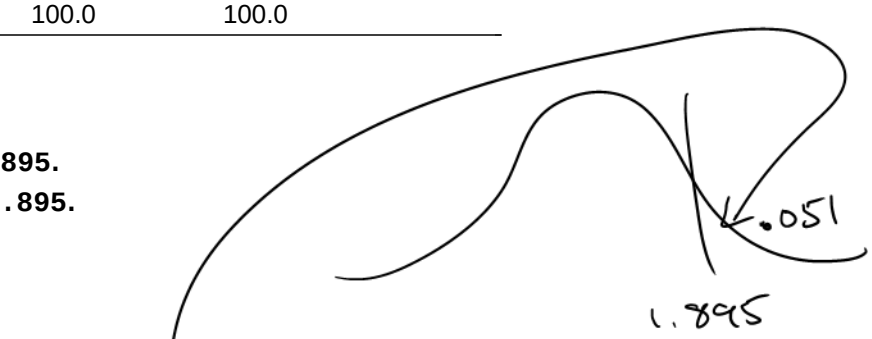
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	.000	95044	95.0	95.0	95.0
	1.000	4956	5.0	5.0	100.0
	Total	100000	100.0	100.0	




```
*direct t critical = 1.895.
COMPUTE tsig = tsat GE 1.895.
FREQ tsig.
```

tsig

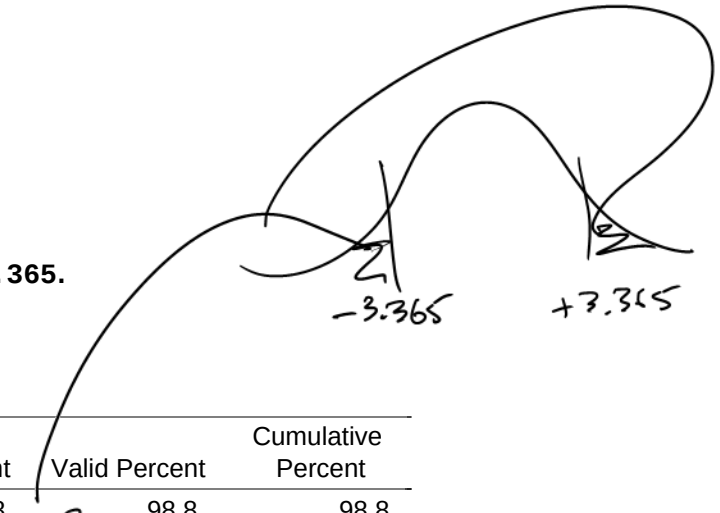
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	.000	94915	94.9	94.9	94.9
	1.000	5085	5.1	5.1	100.0
	Total	100000	100.0	100.0	



```
*obs t 3.365 non-directional
COMPUTE prob = ABS(tsat) GE 3.365.
FREQ prob.
```

prob

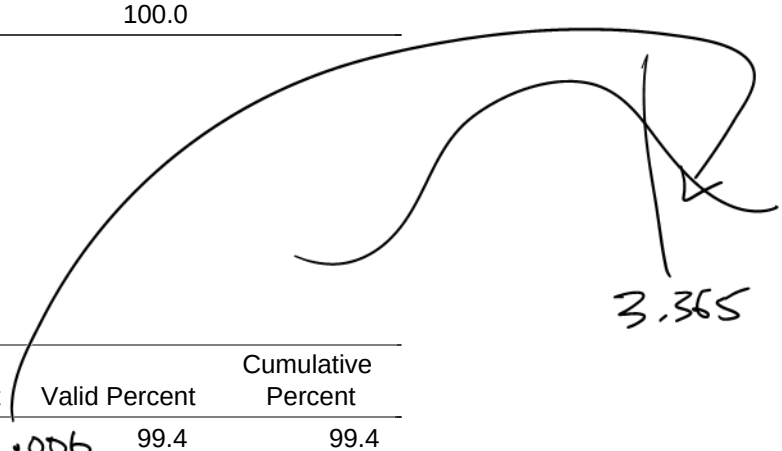
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	.000	98786	98.8	98.8	98.8
	1.000	1214	1.2	1.2	100.0
	Total	100000	100.0	100.0	




```
*obs t 3.365 directional
COMPUTE prob = tsat GE 3.365.
FREQ prob.
```

prob

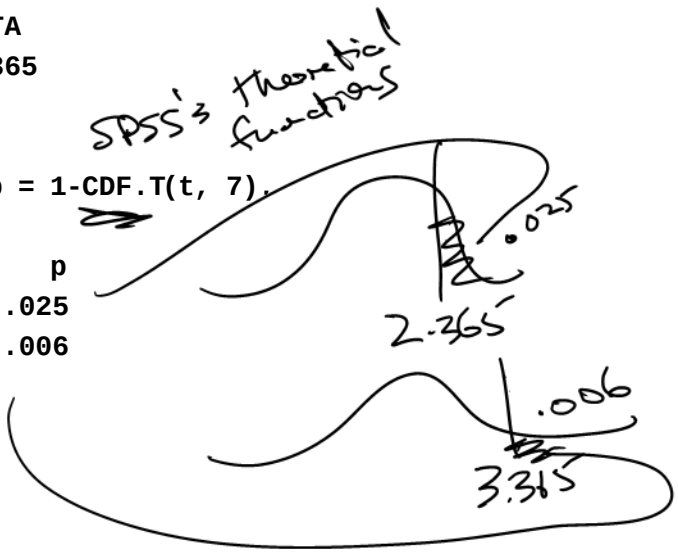
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	.000	99383	99.4	99.4	99.4
	1.000	617	.6	.6	100.0
	Total	100000	100.0	100.0	



Statistics

prob		
N	Valid	100000
	Missing	0

```
DATA LIST FREE / t.
BEGIN DATA
2.365 3.365
END DATA.

COMPUTE p = 1-CDF.T(t, 7).
LIST.
     t      p
 2.365   .025
 3.365   .006
```



Lab 1:2 - Hypothesis Testing

$\mu = 15.0$ $\sigma = 2.0$

$\bar{Y} = 17.875$ $S_y = 2.416 \rightarrow (2.416)^2 = 5.839 = s^2$ $n = 8$

---

1. "What conclusions are warranted?" - Hypothesis test

"no expectation" - non-directional $H_0: \mu = \mu_0$ $H_a: \mu \neq \mu_0$

2 means (population + sample) - t-test: line 2 of formula sheet

$$t = \frac{\bar{Y} - \mu_0}{s_y / \sqrt{n}}$$

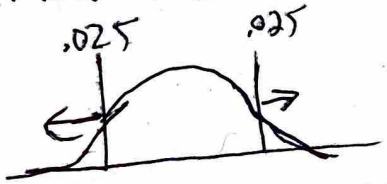
numerator: systematic variance: How much do groups differ from each other?

denominator: random variance: How much variance do we expect on average, based on how data is spread out and sample size

$\alpha = .05$ ← 5% chance of making a Type I error

non-directional hypothesis, so .05 probability is spread on both ends of the distribution (2-tailed)

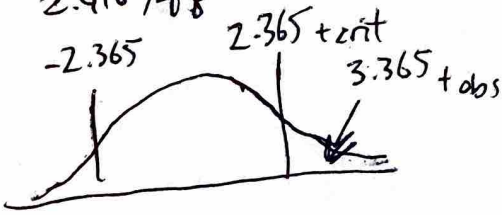
Appendix T - crit for df = 7, .025 is 2.365



So: $\bar{Y} = 17.875$ $\mu = 15$ $s_y = 2.416$ $n = 8$

$$t = \frac{17.875 - 15}{2.416/\sqrt{8}} = \frac{2.875}{0.8543} = 3.365 > 2.365 \text{ t-crit}$$

∴ reject H_0



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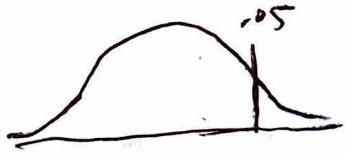
4. Expectation: 4100 students more satisfied → directional hypothesis

$H_0: \mu = \mu_0$ $H_a: \mu > \mu_0$



all of α at one end of distribution (one-tailed)

Appendix T - crit for df = 7, .05 is 1.895

3.365 > 1.895, reject H_0

5. "comparison group of 8 general UW students" - not related, independent groups t-test

"Determine whether the two groups differ" - non-directional / 2-tailed

$H_0: \mu_1 = \mu_2 \quad H_a: \mu_1 \neq \mu_2$

line 3 Formula sheet $t = \dfrac{(\bar{Y}_1 - \bar{Y}_2) - 0}{S_p\sqrt{\frac{1}{n_1} + \frac{1}{n_2}}}$

$S^2_p = \dfrac{SS_1 + SS_2}{n_1 + n_2 - 2}$ ← line 3 formula $\qquad SS = (n-1)s^2$ ← line 1 Formula

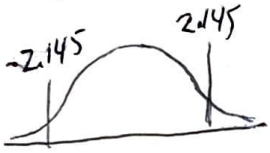
$\bar{Y}_1 = 17.875 \quad S_1 = 2.416 \quad n_1 = 8$

$\bar{Y}_2 = 14.75 \quad S_2 = 4.367 \quad n_2 = 8$

$SS_1 = (8-1)(2.416)^2 = 40.86 \quad S^2_p = \dfrac{40.86 + 133.49}{8 + 8 - 2} = 12.45$

$SS_2 = (8-1)(4.367)^2 = 133.49$

$dF = (n_1 - 1) + (n_2 - 1) = n_1 + n_2 - 2 = 14 \quad \alpha = .05/2 \quad t\text{-crit} = 2.145$



$t = \dfrac{(17.875 - 14.75) - 0}{(12.45)\sqrt{\frac{1}{8} + \frac{1}{8}}} = \dfrac{3.125}{1.765} = 1.77 < 2.145 \quad \therefore$ do not reject H_0.

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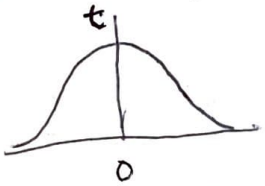
7. "Perform the analysis by hand" - F-test

$df_{numerator} = k - 1 = 2 - 1 = 1$ Appendix T. 3 F_{crit} at .10 = 3.59 → $\sqrt{3.59} = 1.895$

$df_{denominator} = n - 1 = 8 - 1 = 7$ F_{crit} at .05 = 5.59 → $\sqrt{5.59} = 2.365$ t-crit



$F = t^2$

Formula sheet line 2

$F = \dfrac{n(\bar{Y} - \mu_0)^2}{s^2_Y} \quad n = 8 \quad \bar{Y} = 17.875 \quad \mu_0 = 15 \quad s^2_Y = 5.839$

$F = \dfrac{8(17.875 - 15)^2}{5.839} = \dfrac{66.125}{5.839} = 11.324 \rightarrow (3.365)^2$

F t

$F_{obs}(11.324) > F_{crit}(5.59)$, reject H_0