

Quick Questions 19 Two-Factor Analysis of Variance

I. Use the symbols to the right to complete the following ANOVA summary chart.

Variance Analysis Summary Table				
Variance Sources	df	Sum of the Squares	Mean Squares	ANOVA
Between Treatments	$t - 1$	SS_T	$MS_T = \frac{SS_T}{t-1}$	$F = \frac{MS_T}{MS_E}$
Block	$b - 1$	SS_B	$MS_B = \frac{SS_B}{b-1}$	
Within Treatments (error)	$(t - 1)(b - 1)$	SS_E	$MS_E = \frac{SS_E}{(t-1)(b-1)}$	$F = \frac{MS_B}{MS_E}$
Total Variance	$N - 1 =$	SS_{TOTAL}		

SS_T	$F = \frac{MS_T}{MS_E}$
$(t - 1)(b - 1)$	SS_{TOTAL}
$MS_T = \frac{SS_T}{t-1}$	$t - 1$
$MS_B = \frac{SS_B}{b-1}$	SS_E
$MS_E = \frac{SS_E}{(t-1)(b-1)}$	
$b - 1$	SS_B
$F = \frac{MS_B}{MS_E}$	$N - 1$

II. The analysis in the last set of Quick Questions will be expanded by rearranging the data in each row so it is based upon the amount of time students spend studying. Complete the following ANOVA study concerning college grades and study times collected by a local college. Begin by completing this chart. Those using statistics software should skip to part C.

Analysis of College Grades Based Upon High School Grades and Time Spent Studying While in College						Row Totals Required for Calculations			
College Study Time	High H.S. Grades T_1		Medium H.S. Grades T_2		Low H.S. Grades T_3		$\sum X_B$	$(\sum X_B)^2$	$\frac{(\sum X_B)^2}{t}$
	College Grades(X_1)	X_1^2	College Grades(X_2)	X_2^2	College Grades(X_3)	X_3^2			
High	3.5	12.25	3.2	10.24	2.7	7.29	9.4	88.36	29.45
Medium	3.4	11.56	3.0	9.00	2.5	6.25	8.9	79.21	26.40
Low	3.1	9.61	2.8	7.84	2.1	4.41	8.0	64.00	21.33
							26.3 = $\sum x$	$\sum \left[\frac{(\sum X_B)^2}{t} \right] = 77.18$	
$\sum X_T$	10		9		7.3		26.3 = $\sum x$		
$(\sum X_T)^2$	100		81		53.29				
b	3		3		3		N = 9		
$\frac{(\sum X_T)^2}{b}$	33.33		27		17.76		$\sum \left[\frac{(\sum X_T)^2}{b} \right] = 78.09$		
$\sum X_T^2$		33.42		27.08		17.95	$\sum x^2 = 78.45$		

A. Using this chart, calculate the following values.

$$\begin{aligned}
 SS_T &= \sum \left[\frac{(\sum X_T)^2}{b} \right] - \frac{(\sum X)^2}{N} \\
 &= 78.09 - \frac{26.3^2}{9} \\
 &= 78.09 - 76.85 = 1.24
 \end{aligned}$$

$$\begin{aligned}
 SS_B &= \sum \left[\frac{(\sum X_B)^2}{t} \right] - \frac{(\sum X)^2}{N} \\
 &= 77.18 - 76.85 \\
 &= .33
 \end{aligned}$$

$$\begin{aligned}
 SS_{TOTAL} &= \sum x^2 - \frac{(\sum x)^2}{N} \\
 &= 78.45 - 76.85 \\
 &= 1.60
 \end{aligned}$$