Question 3.2

Results shown in Table 1. R code to make calculations are shown in an appendix (note, however, that you are not expected to make these calculations in R).

Table 1. Completed analysis of variance table for learning methods data.

	df	SS	MS	F	p
Among	3	1510.2	503.4	2.58	0.0579
Instructor	1	114.0	114.0	0.58	0.4464
Method	1	1363.5	1363.5	6.99	0.0096
Interaction	1	32.8	32.8	0.17	0.6827
Within	96	18717.1	195.0		
Total	99	20227.3			

Notes from Professor

- The key to this problem is to construct a table of treatment, level, and grand means similar to what is shown in Table 2. Then $SS_{instructor}$, SS_{method} and SS_{among} are computed by following the SS_{row}, SS_{column} and SS_{among} formulas from the book. The $SS_{interaction}$ is then found from these SS and SS_{total} by subtraction. All of the degrees-of-freedom are found by formulas supplied in the book and realizing that $r = 2$, $c = 2$ and $n = 25$. The MS and F are found as usual and the p-values are found with `distrib()`.

Table 2. Means table for learning methods data.

	Lecture	Self	mean
A	75.45	83.98	79.72
B	74.46	80.70	77.58
mean	74.95	82.34	78.65

R Commands

```
> tmns <- matrix(c(75.45,83.98,74.46,80.70),byrow=TRUE,nrow=2)
> colnames(tmns) <- c("Lecture","Self")
> rownames(tmns) <- c("A","B")
> mns <- addmargins(tmns,FUN=mean)
> r <- c <- 2
> n <- 25
> ssins <- r*n*sum((mns[1:2,3]-mns[3,3])^2)
> ssmeth <- r*n*sum((mns[3,1:2]-mns[3,3])^2)
> ssamong <- n*sum((mns[1:2,1:2]-mns[3,3])^2)
> ssint <- ssamong-ssins-ssmeth
> sstotal <- 20227.3
> sswithin <- sstotal-ssamong
> dfamong <- r*c-1
> dfins <- r-1
> dfmeth <- c-1
> dfint <- dfamong-dfins-dfmeth
> dftotal <- r*c*n-1
> dfwithin <- dftotal-dfamong
> ss <- c(ssamong,ssins,ssmeth,ssint,sswithin)
> df <- c(dfamong,dfins,dfmeth,dfint,dfwithin)
> ms <- ss/df
> f <- ms[-length(ms)]/ms[length(ms)]
> p <- pf(f,df1=df[-length(df)],df2=df[length(df)],lower.tail=FALSE)
> tbl <- cbind(c(df,dftotal),c(ss,sstotal),c(ms,NA),c(f,NA,NA),c(p,NA,NA))
```

```
> colnames(tbl) <- c("df","SS","MS","F","p")
> rownames(tbl) <- c("Among","Instructor","Method","Interaction","Within","Total")
```