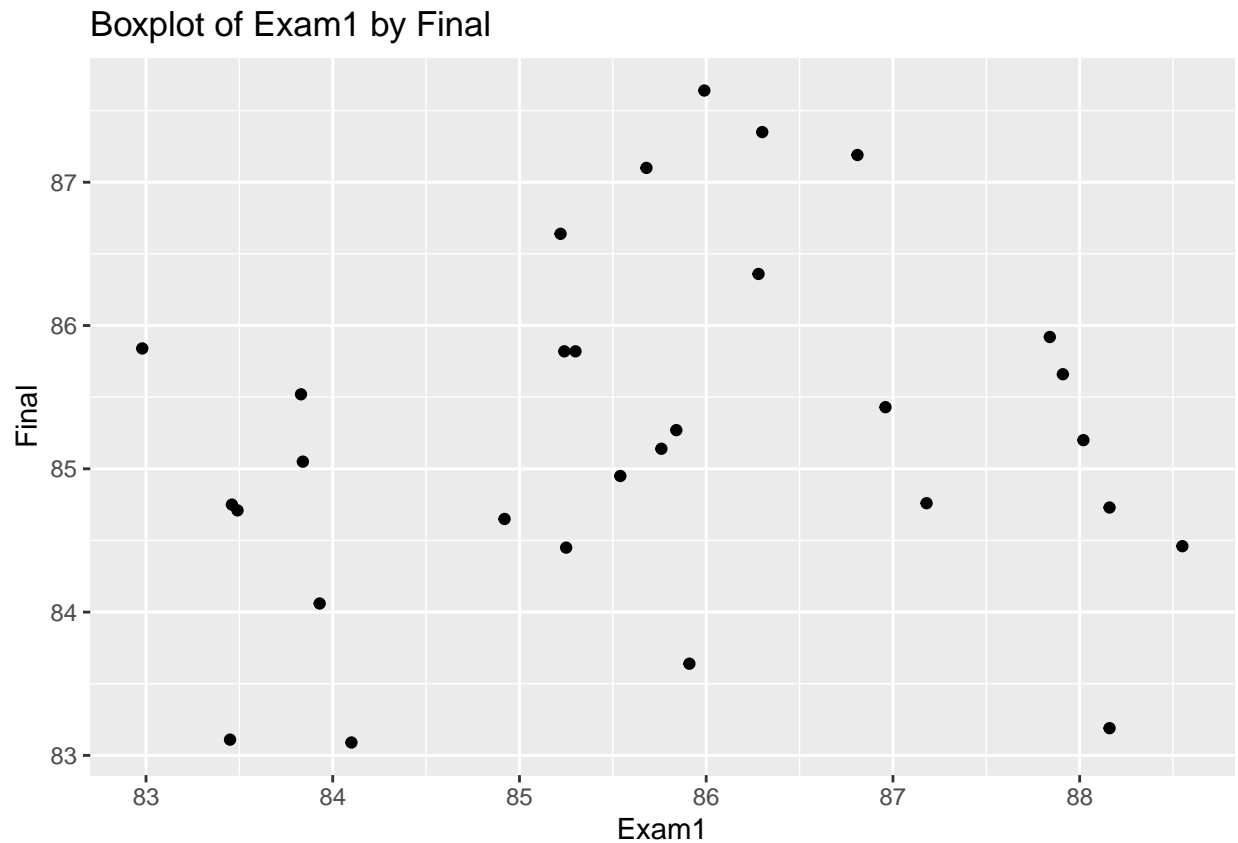


# Pedagogy

Joshua Cabrera

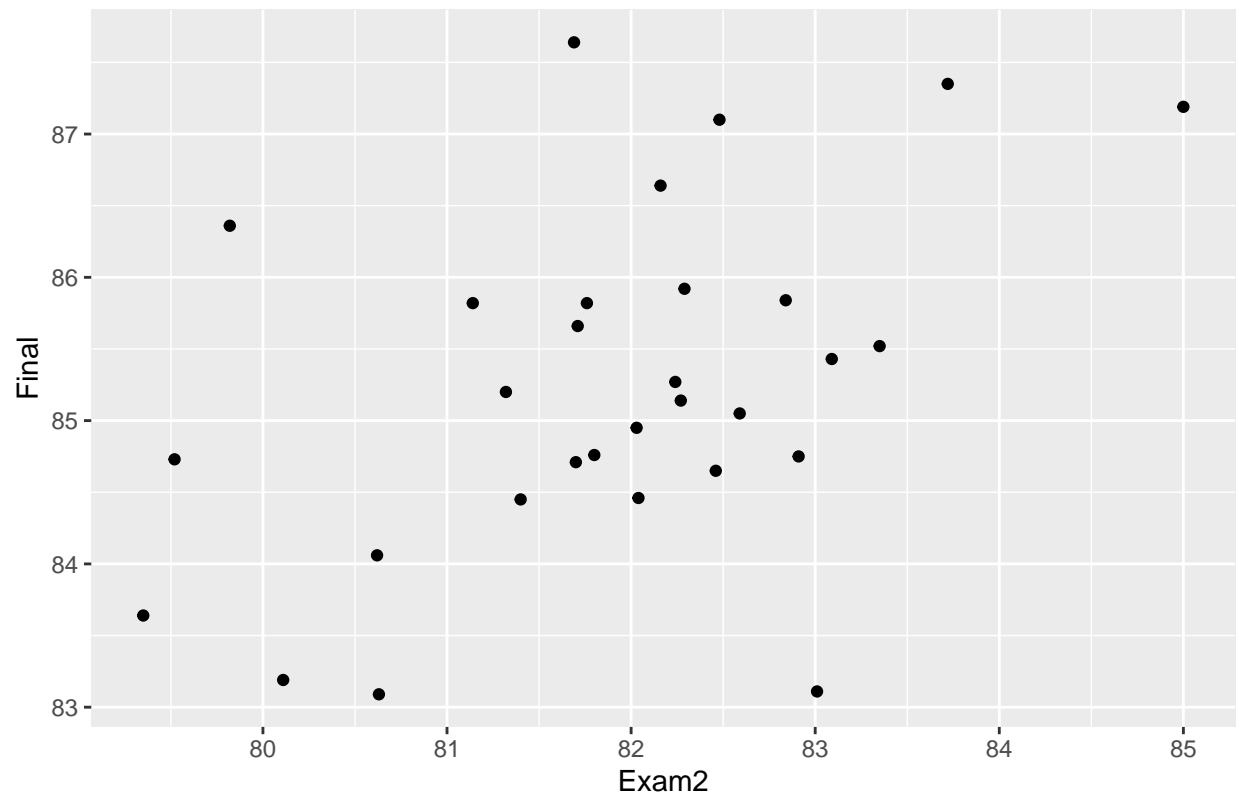
2024-02-14

```
ggplot(data = data, mapping = aes(x = Exam1, y = Final)) +  
  geom_point()+  
  # geom_smooth( se = FALSE)+  
  labs(title = "Boxplot of Exam1 by Final",  
        x = "Exam1",  
        y = "Final")
```



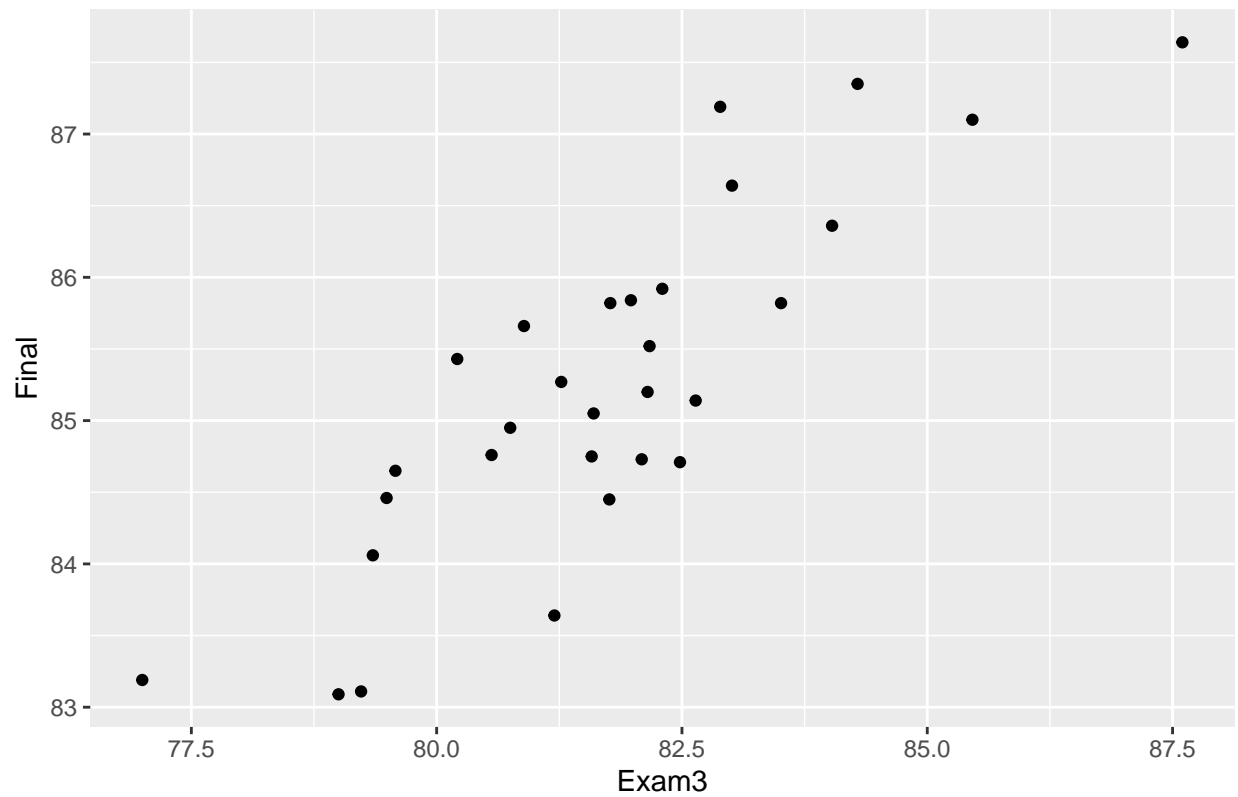
```
ggplot(data = data, mapping = aes(x = Exam2, y = Final)) +  
  geom_point()+  
  # geom_smooth( se = FALSE)+  
  labs(title = "Boxplot of Exam2 by Final",  
        x = "Exam2",  
        y = "Final")
```

Boxplot of Exam2 by Final



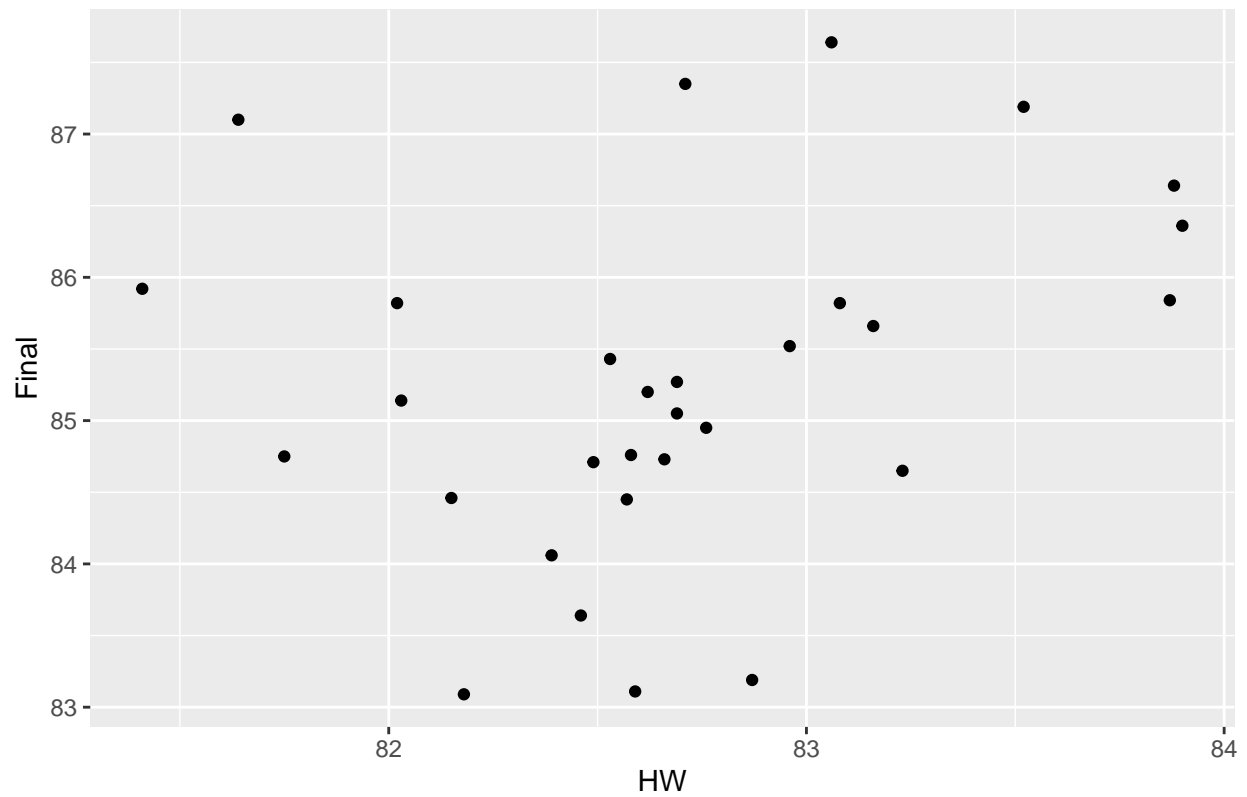
```
ggplot(data = data, mapping = aes(x = Exam3, y = Final)) +  
  geom_point() +  
  # geom_smooth( se = FALSE) +  
  labs(title = "Boxplot of Exam3 by Final",  
        x = "Exam3",  
        y = "Final")
```

Boxplot of Exam3 by Final



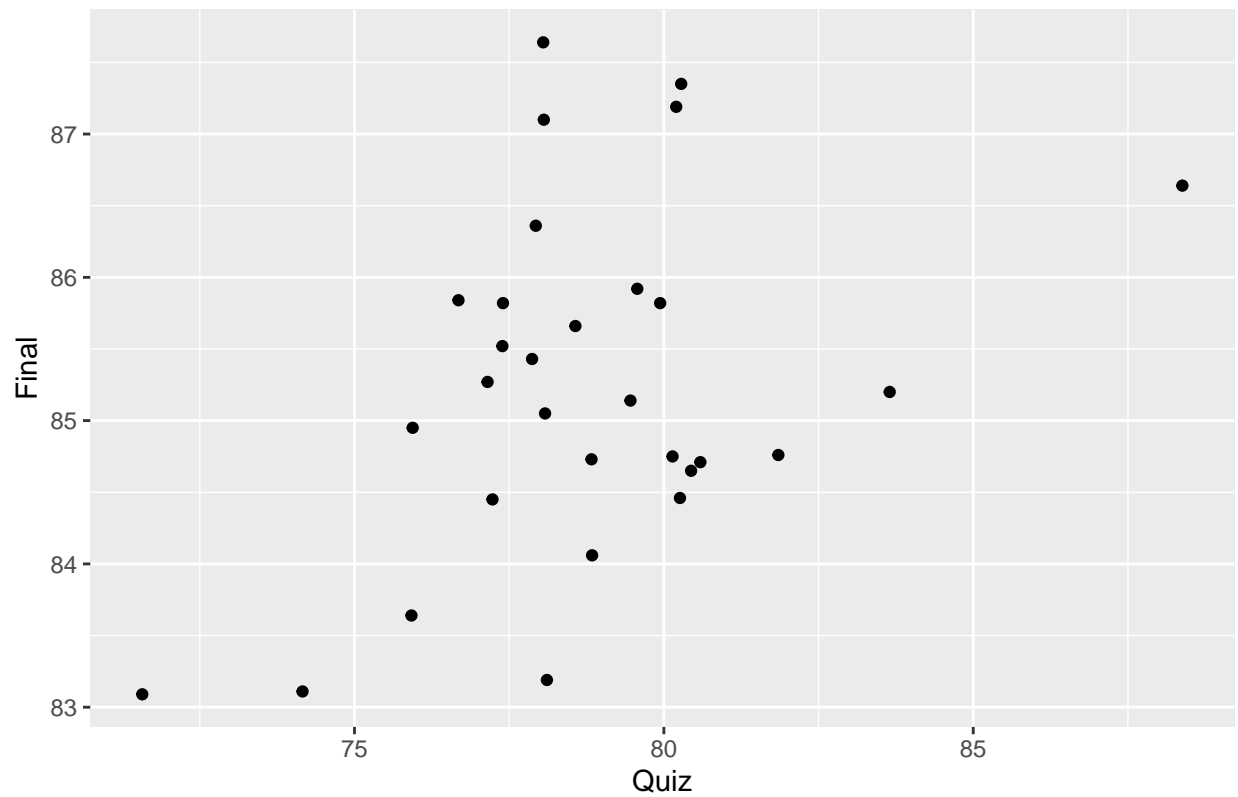
```
ggplot(data = data, mapping = aes(x = HW, y = Final)) +  
  geom_point() +  
  # geom_smooth( se = FALSE) +  
  labs(title = "Boxplot of HW by Final",  
        x = "HW",  
        y = "Final")
```

Boxplot of HW by Final



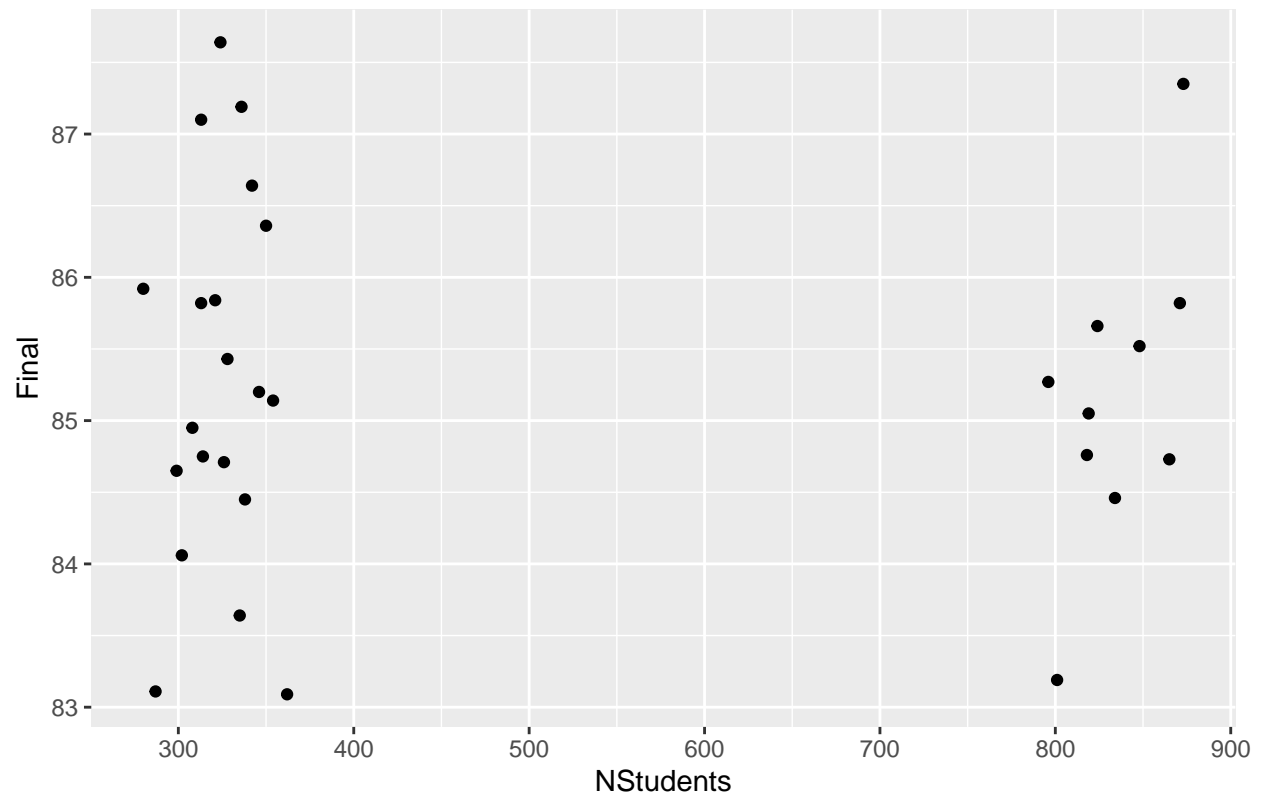
```
ggplot(data = data, mapping = aes(x = Quiz, y = Final)) +  
  geom_point() +  
  # geom_smooth( se = FALSE) +  
  labs(title = "Boxplot of Quiz by Final",  
        x = "Quiz",  
        y = "Final")
```

Boxplot of Quiz by Final



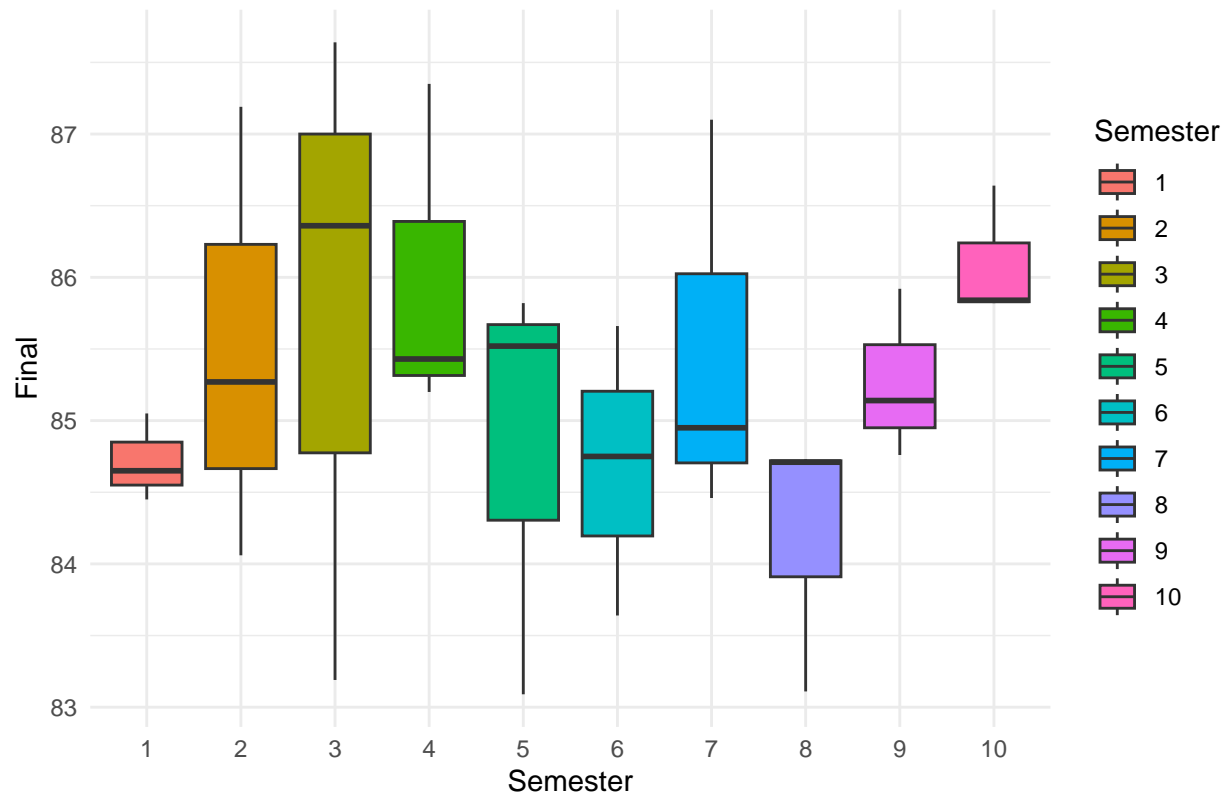
```
ggplot(data = data, mapping = aes(x = NStudents, y = Final)) +  
  geom_point() +  
  # geom_smooth( se = FALSE) +  
  labs(title = "Boxplot of NStudents by Final",  
        x = "NStudents",  
        y = "Final")
```

Boxplot of NStudents by Final



```
ggplot(data, aes(x = Semester, y = Final, fill = Semester)) +  
  geom_boxplot() +  
  labs(x = "Semester", y = "Final", title = "Box Plot Example") +  
  theme_minimal()
```

## Box Plot Example



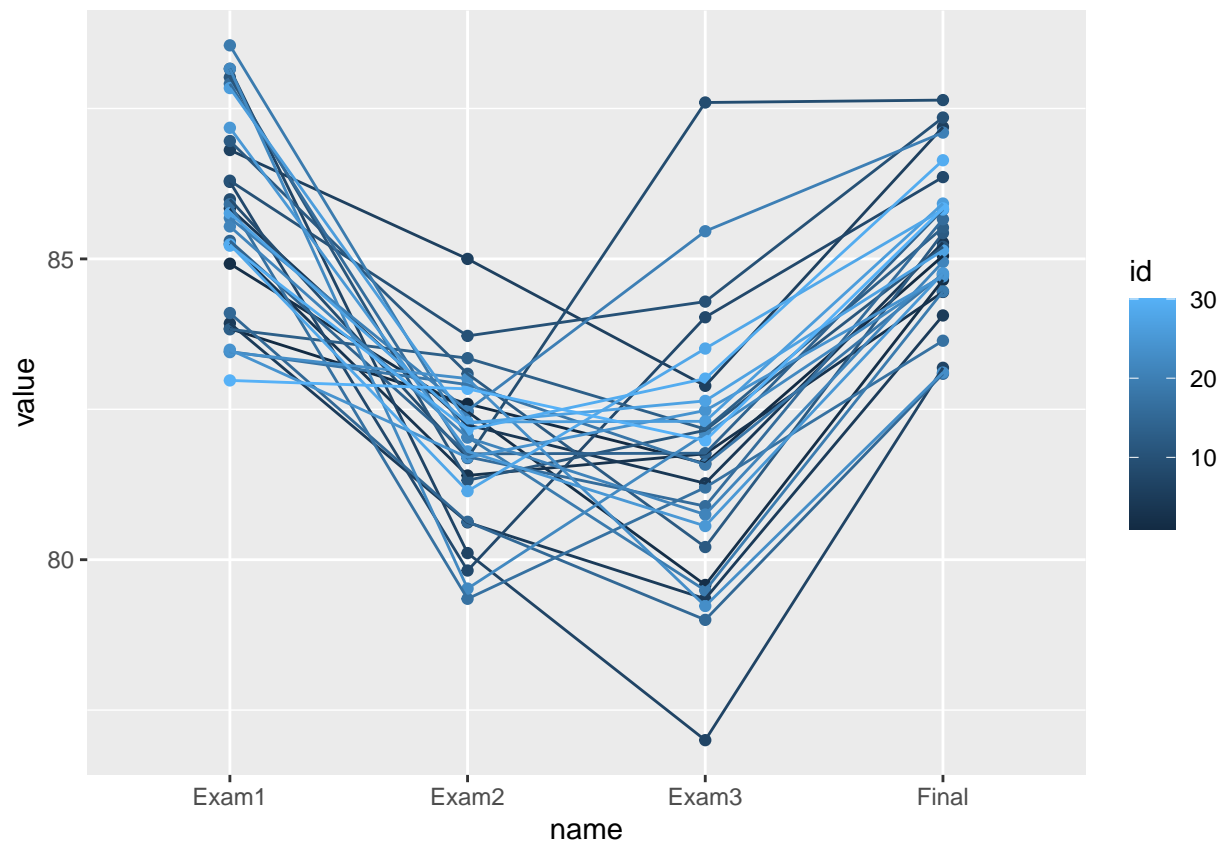
```
data$id <- 1:30
```

```
data_long <- data %>%
  pivot_longer(
    cols = c(Exam1, Exam2, Exam3, Final) )
```

```
head(data_long)
```

```
## # A tibble: 6 x 7
##   Semester NStudents   HW Quiz   id name  value
##   <fct>      <dbl> <dbl> <dbl> <int> <chr> <dbl>
## 1 1          819  82.7  78.1     1 Exam1  83.8
## 2 1          819  82.7  78.1     1 Exam2  82.6
## 3 1          819  82.7  78.1     1 Exam3  81.6
## 4 1          819  82.7  78.1     1 Final  85.0
## 5 1          299  83.2  80.4     2 Exam1  84.9
## 6 1          299  83.2  80.4     2 Exam2  82.5
```

```
ggplot(data_long, aes(x = name, y = value, group = id, colour = id))+
  geom_point()+
  geom_line()
```



```
# summary(data)

#Checking if our model should use NStudents
Pedagogy_lm <- lm(Final ~ ., data = data)
Pedagogy_lm_reduced <- lm(Final ~ Exam1+Exam2+Exam3+HW+Quiz, data = data)

summary(Pedagogy_lm)
```

```
##
## Call:
## lm(formula = Final ~ ., data = data)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.60595 -0.20300  0.04756  0.20767  0.39744
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept) -1.689e+01  1.484e+01  -1.138  0.27559
## Semester2    9.352e-01  6.532e-01   1.432  0.17582
## Semester3    1.289e+00  1.229e+00   1.049  0.31335
## Semester4    1.805e+00  1.778e+00   1.015  0.32848
## Semester5    2.427e+00  2.296e+00   1.057  0.30977
## Semester6    2.739e+00  2.887e+00   0.949  0.36015
## Semester7    3.472e+00  3.436e+00   1.011  0.33064
```



```
## Semester8      3.348e+00  4.014e+00  0.834  0.41933
## Semester9      4.317e+00  4.597e+00  0.939  0.36488
## Semester10     5.279e+00  5.170e+00  1.021  0.32589
## NStudents      -4.411e-04  6.343e-04 -0.695  0.49905
## Exam1           1.624e-01  7.578e-02  2.143  0.05158 .
## Exam2           3.173e-01  8.222e-02  3.859  0.00198 **
## Exam3           4.383e-01  4.095e-02 10.703  8.14e-08 ***
## HW              3.065e-01  1.740e-01  1.761  0.10166
## Quiz            1.885e-02  3.427e-02  0.550  0.59175
## id              -1.780e-01  1.899e-01 -0.937  0.36581
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.4025 on 13 degrees of freedom
## Multiple R-squared:  0.9504, Adjusted R-squared:  0.8895
## F-statistic: 15.58 on 16 and 13 DF, p-value: 5.938e-06
```

```
anova(Pedagogy_lm_reduced,Pedagogy_lm)
```

```
## Analysis of Variance Table
##
## Model 1: Final ~ Exam1 + Exam2 + Exam3 + HW + Quiz
## Model 2: Final ~ Semester + NStudents + Exam1 + Exam2 + Exam3 + HW + Quiz +
##          id
##   Res.Df    RSS Df Sum of Sq    F Pr(>F)
## 1      24 3.7553
## 2      13 2.1064 11    1.6489 0.9251 0.5458
```

```
data$fittedVals <- Pedagogy_lm$fitted.values
data$Residuals <- Pedagogy_lm$residuals

write.csv(data, file = "ClassAssessment_copy.txt", row.names =T)

anova_result <- aov(lm(Final ~ Semester, data = data))
anova_result
```

```
## Call:
##   aov(formula = lm(Final ~ Semester, data = data))
##
## Terms:
##              Semester Residuals
## Sum of Squares 10.71893 31.79187
## Deg. of Freedom      9      20
##
## Residual standard error: 1.260791
## Estimated effects may be unbalanced
```

```
summary(anova_result)
```

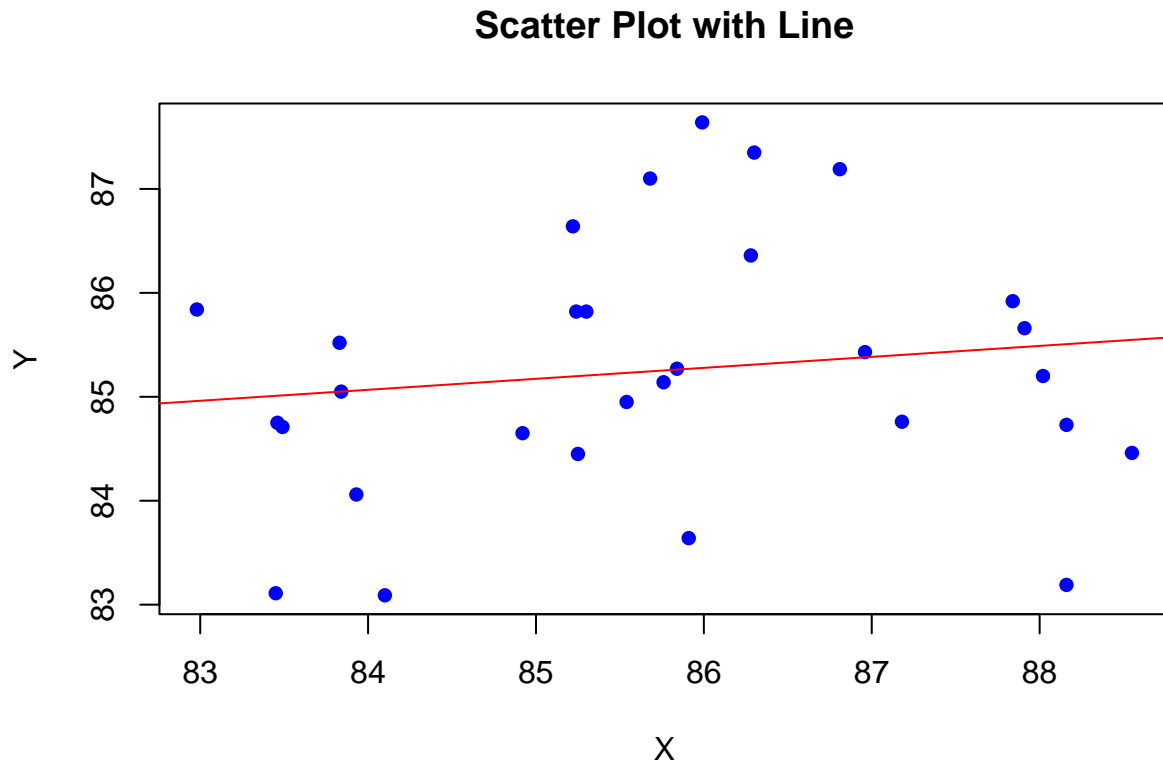
```
##              Df Sum Sq Mean Sq F value Pr(>F)
## Semester      9  10.72   1.191   0.749  0.662
## Residuals    20  31.79   1.590
```

```
# anova_result <- anova(lm(value ~ group, data = df))
```

```
Pedagogy_lm <- lm(Final ~ ., data = data)
bptest(Pedagogy_lm)
```

```
##
## studentized Breusch-Pagan test
##
## data: Pedagogy_lm
## BP = 25.378, df = 17, p-value = 0.08656
```

```
plot(data$Exam1, data$Final, type = "p", pch = 16, col = "blue", xlab = "X", ylab = "Y", main = "Scatter Plot with Line")
# Add a line
abline(lm(Final ~ Exam1, data = data), col = "red")
```



## GLS model

```
Pedagogy_gls <- gls(model= Final ~ Semester + NStudents + Exam1 + Exam2 + Exam3 + HW + Quiz, data= data)
summary(Pedagogy_gls)
```

```

## Generalized least squares fit by maximum likelihood
## Model: Final ~ Semester + NStudents + Exam1 + Exam2 + Exam3 + HW + Quiz
## Data: data
##      AIC      BIC    logLik
## 37.48776 61.30811 -1.743879
##
## Variance function:
## Structure: fixed weights
## Formula: ~1/NStudents
##
## Coefficients:
##              Value Std.Error   t-value p-value
## (Intercept) -20.678894 14.106414 -1.465921 0.1648
## Semester2    0.314248  0.312913  1.004268 0.3323
## Semester3    0.135855  0.358230  0.379239 0.7102
## Semester4    0.217420  0.362182  0.600304 0.5579
## Semester5    0.153728  0.296367  0.518709 0.6121
## Semester6    0.142737  0.322422  0.442702 0.6647
## Semester7    0.123949  0.378959  0.327079 0.7484
## Semester8   -0.376932  0.323211 -1.166208 0.2630
## Semester9   -0.048025  0.366645 -0.130986 0.8977
## Semester10   0.414087  0.304966  1.357815 0.1960
## NStudents    0.000084  0.000301  0.279317 0.7841
## Exam1        0.174047  0.072629  2.396391 0.0311
## Exam2        0.298527  0.081761  3.651215 0.0026
## Exam3        0.444123  0.036699 12.101756 0.0000
## HW          0.347460  0.165549  2.098834 0.0545
## Quiz        0.017499  0.033726  0.518872 0.6120
##
## Correlation:
##      (Intr) Smstr2 Smstr3 Smstr4 Smstr5 Smstr6 Smstr7 Smstr8 Smstr9
## Semester2  0.168
## Semester3  0.238  0.485
## Semester4  0.189  0.556  0.435
## Semester5  0.057  0.473  0.424  0.369
## Semester6  0.105  0.543  0.577  0.548  0.449
## Semester7  0.024  0.547  0.452  0.658  0.356  0.571
## Semester8 -0.009  0.480  0.585  0.462  0.442  0.564  0.486
## Semester9 -0.049  0.518  0.426  0.645  0.333  0.549  0.669  0.491
## Semester10 -0.008  0.431  0.457  0.414  0.453  0.463  0.362  0.513  0.410
## NStudents  0.137  0.180  0.181  0.235 -0.021  0.197  0.305  0.097  0.258
## Exam1      -0.441 -0.336 -0.353 -0.528 -0.012 -0.381 -0.572 -0.229 -0.464
## Exam2      -0.319 -0.203  0.209 -0.352 -0.018 -0.018 -0.301  0.205 -0.218
## Exam3      -0.211 -0.033 -0.140 -0.187 -0.029 -0.087 -0.046 -0.168 -0.060
## HW         -0.696  0.048 -0.208  0.251 -0.087  0.058  0.372  0.028  0.398
## Quiz       0.335  0.121  0.195 -0.038  0.202  0.103  0.024  0.046 -0.165
##
##      Smst10 NStdnt Exam1 Exam2 Exam3 HW
## Semester2
## Semester3
## Semester4
## Semester5
## Semester6
## Semester7
## Semester8

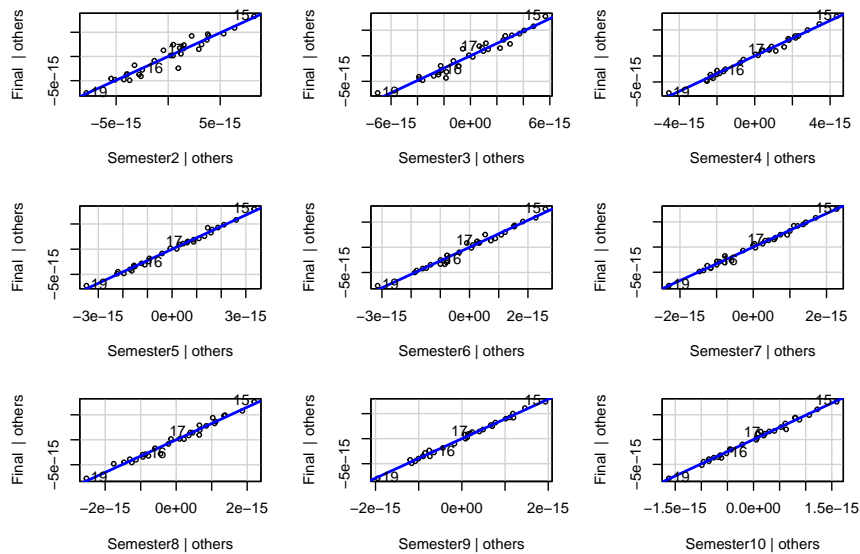
```

```
## Semester9
## Semester10
## NStudents -0.056
## Exam1 0.018 -0.509
## Exam2 0.184 -0.228 0.465
## Exam3 -0.247 0.045 0.134 -0.172
## HW -0.025 0.155 -0.188 -0.305 0.046
## Quiz -0.111 0.108 -0.289 -0.131 -0.113 -0.321
##
## Standardized residuals:
## Min Q1 Med Q3 Max
## -2.13262212 -0.80200916 0.05282028 0.73675916 1.66980472
##
## Residual standard error: 5.399915
## Degrees of freedom: 30 total; 14 residual
```

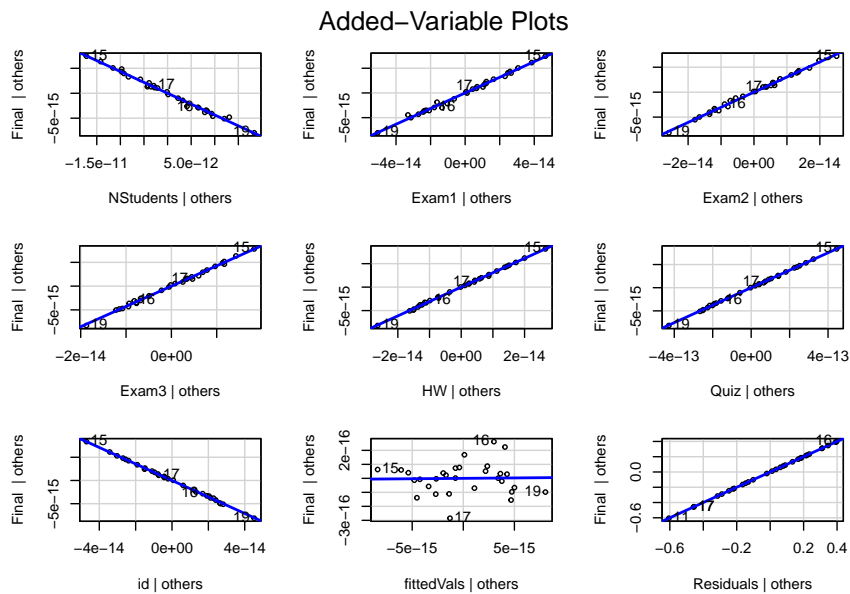
## Section 3: Assumptions

### Linear

```
library(car)
avPlots(Pedagogy_lm,ask=F)
```



```
## Warning in lsfit(mod.mat[, -var], cbind(mod.mat[, var], response), wt = wt, :
## 'X' matrix was collinear
```



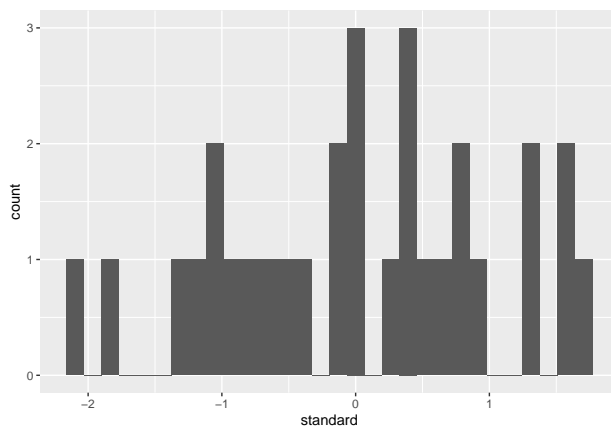
\* Looking at quantitative

variables- approximately linear

Independent

Normal

```
standard <- resid(object=Pedagogy_gls, type="pearson")
ggplot()+geom_histogram(mapping=aes(x=standard))
```



```
ks.test(standard, "pnorm")
```

```
##
## Exact one-sample Kolmogorov-Smirnov test
##
## data: standard
## D = 0.081897, p-value = 0.978
## alternative hypothesis: two-sided
```

- It does appear approximately normal - ish