MLM Nested Main Section B

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Question 0: read data and process missingness

```
dat <- read.dta("classroom.dta")

# construct new outcome math1st
dat <- dat %>%
    mutate(math1st = mathkind + mathgain)

# remove missing data
dat <- dat %>%
    filter(complete.cases(dat))
```

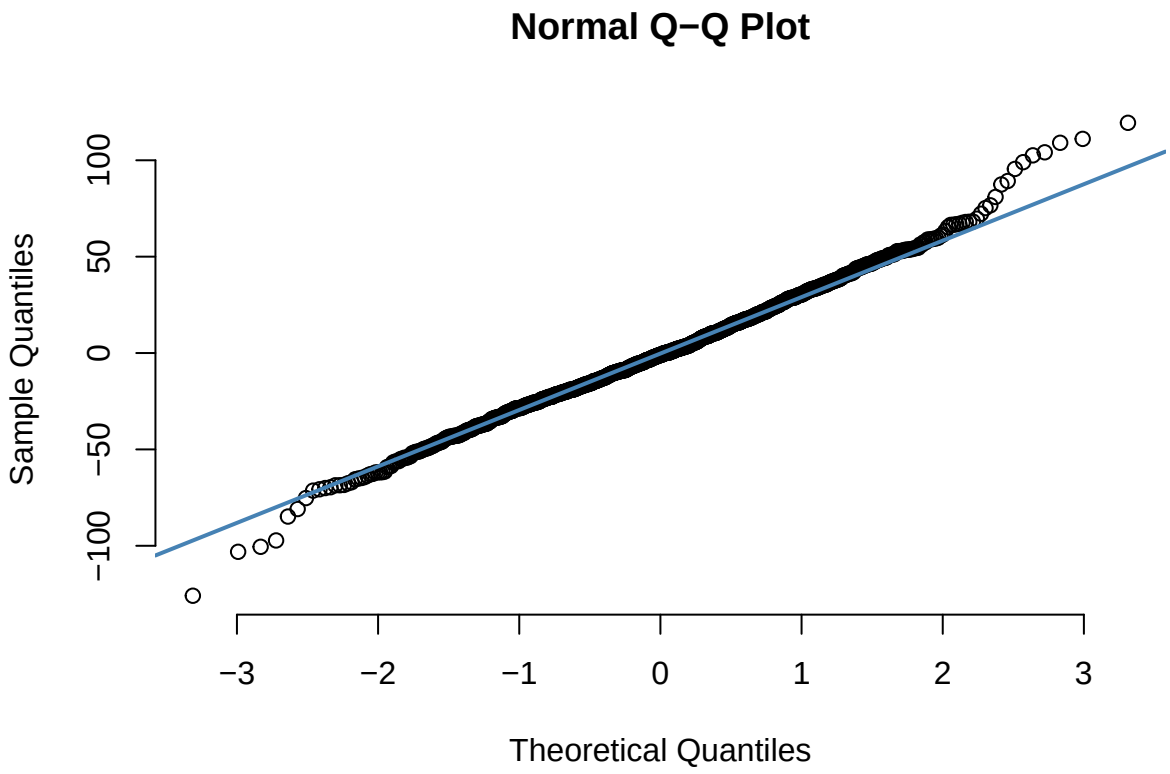
Question 1

```
# fit a model
fit1 <- lmer(math1st ~ housepov + yearstea + mathprep + mathknow + ses + sex + minority +
    (1 | schoolid/classid), data = dat)
summary(fit1)
```

```
## Linear mixed model fit by REML. t-tests use Satterthwaite's method [
## lmerModLmerTest]
## Formula: math1st ~ housepov + yearstea + mathprep + mathknow + ses + sex +
##     minority + (1 | schoolid/classid)
##    Data: dat
##
## REML criterion at convergence: 10729.5
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -3.8581 -0.6134 -0.0321  0.5971  3.6598
##
## Random effects:
##  Groups           Name        Variance Std.Dev.
##  classid:schoolid (Intercept)   93.89   9.689
##  schoolid         (Intercept)  169.45  13.017
##  Residual                      1064.96  32.634
## Number of obs: 1081, groups:  classid:schoolid, 285; schoolid, 105
##
## Fixed effects:
##               Estimate Std. Error         df t value Pr(>|t|)
## (Intercept)  539.63041    5.31209  275.39009 101.585  < 2e-16 ***
## housepov     -17.64850   13.21755  113.87814  -1.335    0.184
```

```
## yearstea       0.01129    0.14141  226.80861   0.080    0.936
## mathprep      -0.27705    1.37583  205.27111  -0.201    0.841
## mathknow       1.35004    1.39168  234.49768   0.970    0.333
## ses           10.05076    1.54485 1066.56211   6.506 1.18e-10 ***
## sex           -1.21419    2.09483 1022.42110  -0.580    0.562
## minority     -16.18676    3.02605  704.47787  -5.349 1.20e-07 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##          (Intr) houspv yearst mthprp mthknw ses    sex
## housepov -0.451
## yearstea -0.259  0.071
## mathprep -0.631  0.038 -0.172
## mathknow -0.083  0.058  0.029  0.004
## ses      -0.121  0.082 -0.028  0.053 -0.007
## sex      -0.190 -0.007  0.016 -0.006  0.007  0.020
## minority -0.320 -0.178  0.024  0.001  0.115  0.162 -0.011
```

```
# plot residuals to test normality assumption
res1 <- residuals(fit1)
qqnorm(res1, pch = 1, frame = FALSE)
qqline(res1, col = "steelblue", lwd = 2)
```



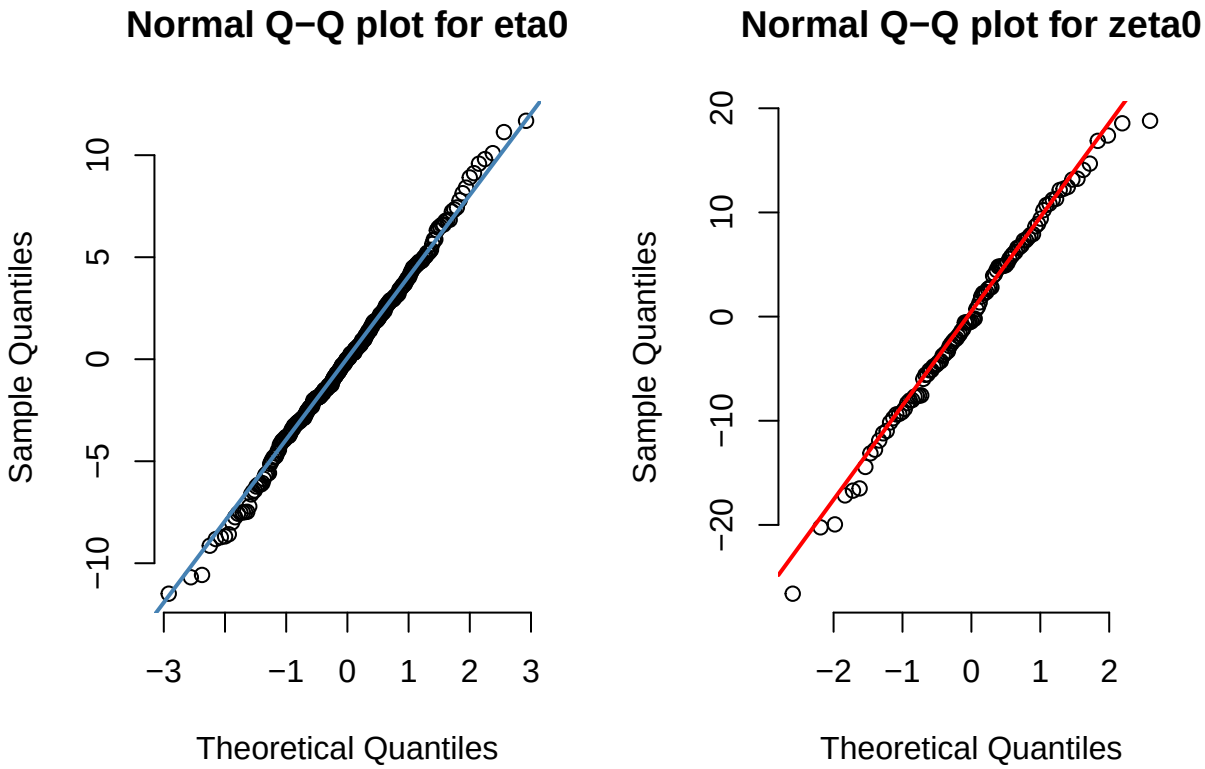
QQ plot shows that points are around the line, and thus we believe the normality assumption holds.

Question 2

```
blups_fit1 <- ranef(fit1)
```

```
par(mfrow = c(1, 2))
# examine normality for eta0 (class-level)
eta0_fit1 <- blups_fit1$`classid:schoolid`$`(Intercept)`
qqnorm(eta0_fit1, pch = 1, frame = FALSE, main = "Normal Q-Q plot for eta0")
qqline(eta0_fit1, col = "steelblue", lwd = 2)

# examine normality for zeta0 (school-level)
zeta0_fit1 <- blups_fit1$schoolid$`(Intercept)`
qqnorm(zeta0_fit1, pch = 1, frame = FALSE, main = "Normal Q-Q plot for zeta0")
qqline(zeta0_fit1, col = "red", lwd = 2)
```




```
par(mfrow = c(1, 1))
```

QQ plot shows that both sets of BLUPs of zeta0 and eta0 are around the line, and thus we believe the normality assumption holds.

Question 3

```
# fit2 <- lmer(mathgain ~ mathkind + ses + minority + yearstea + (yearstea |
# schoolid), data = dat) math1st ~ housepov + yearstea + mathprep + mathknow +
# ses + sex + minority + (minority|schoolid) print(summary(fit3))
```