EDUC 231D: Homework 2

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Scenario

The policy director at a national foundation is concerned about disparities in math scores in early elementary grades. They recently read an article by Dr. Valerie Lee that emphasized the importance of the schooling context for student learning and would like you to investigate whether school size and school resources (as measured by average school socioeconomic status [SES]) are associated with disparities in math scores within elementary schools. In particular, they want to know about math score disparities for students of color (SOC) in relation to white students and for students with different levels of family SES.

To conduct this investigation, the policy director provided you with a data file and a description of the file. The file was uploaded to our BruinLearn site and is named hw2_eclsk11_data.RDS.

Use this data file to answer the following questions for the policy director. Submit your responses as a PDF file by **12PM on February 11**. The file name for the PDF you submit should use the following naming convention:

HW2_[LastName]_[FirstName].pdf

Set Up

To get started, you need to load some R packages and the data file.

> **Note**
>
> If you have not already installed these packages, you will first have to install them before loading the libraries.

```r
# clear the R environment just in case there are things loaded that we don't want
# (start with a clean slate)
rm(list=ls())

# load packages
library("tidyverse") # optional package useful for data processing
library("skimr") # optional package useful for summarizing data file contents
library("flextable") # optional package useful for creating tables
library("table1") # optional package useful for creating cross-tab tables
library("lme4") # the primary package we'll use for estimating multilevel models
library("lmerTest") # package to view p-values for estimates

# load data file: make sure the file path matches where you have the file saved
```

```
hw <- readRDS("/Users/aishuhan/Desktop/EDUC 231D Multilevel Analysis/Assignments/HW2/hw2_eclsk11_c

# set a working directory for where you can save files
setwd("/Users/aishuhan/Desktop/EDUC 231D Multilevel Analysis/Assignments/HW2")
```

Description of the Data File

The data file includes data on 11,116 first grade students from 800 schools. The following variables are included in the file:

- *schid* = unique ID for each school
- *childid* = unique ID for each students
- *g1mscore* = student's math test score from the spring of grade 1
- *bipoc* = indicator for whether the student is a student of color (1) or not (0)
- *bipoc.gpc* = indicator for whether the student is a student of color (1) or not (0); the variable is group-mean centered, so that a value of zero is equal to the proportion of students of color at the school
- *famses* = composite score for the student's family SES
- *famses.gpc* = composite score for the student's family SES; the variable is group-mean centered, so that a value of zero is equal to the school's mean value
- *sector* = indicator for whether the school is a private school (1) or a public school (0)
- *schsizebig* = indicator for whether the school is considered a "big" school (1) or not (0), where big is defined as having a student enrollment of 500 or more students.
- *schses.gdc* = mean family SES for the students in the school; the variable is grand-mean centered, so that a value of zero is equal to the mean for all schools in the study


```r
skim(hw) # get descriptive statistics
```

Table 1: Data summary

Name	hw
Number of rows	11116
Number of columns	10
Column type frequency:	
character	1
numeric	9
Group variables	None

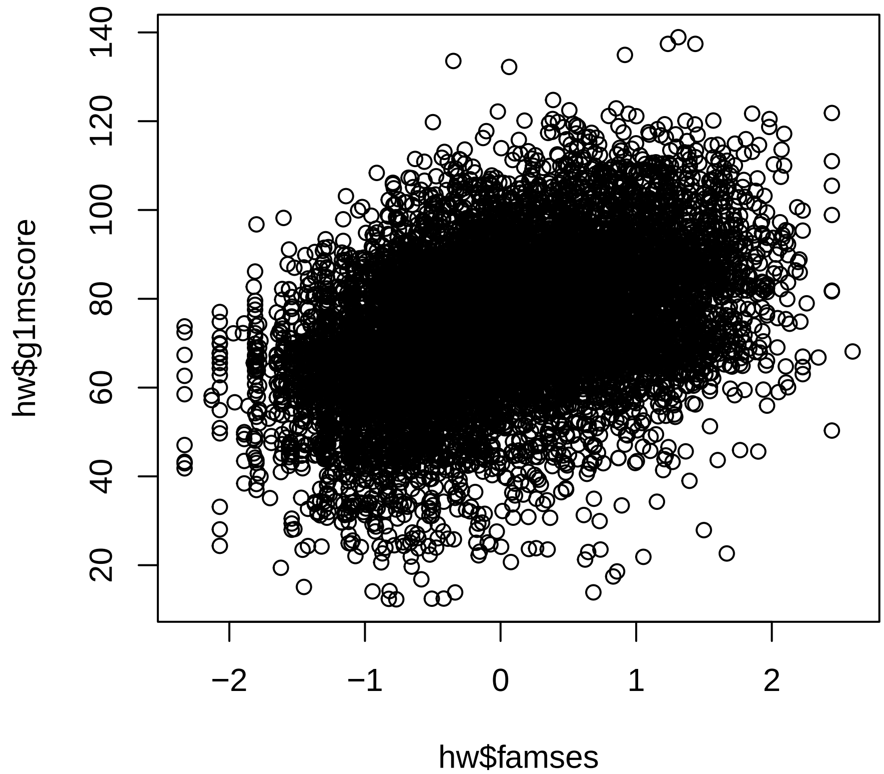
Variable type: character

skim_variable	n_missing	complete_rate	min	max	empty	n_unique	whitespace
schid	0	1	4	4	0	800	0

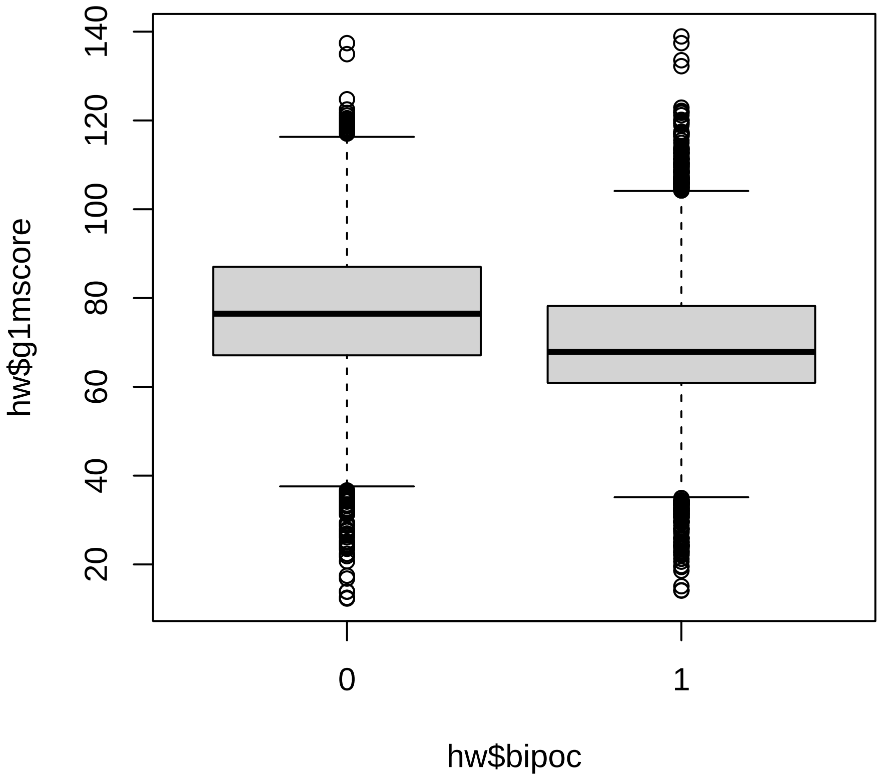
Variable type: numeric

skim_variable	n_missing	complete_rate	mean	sd	p0	p25	p50	p75	p100	hist
childid	0	1	10009107.05	5247.92	1.000e+07	10004617.75	10009055.00	10013688.25	10018176.00	
g1mscore	0	1	73.17	15.70	1.231e+01	64.01	71.23	83.61	138.92	
bipoc	0	1	0.50	0.50	0.000e+00	0.00	0.00	1.00	1.00	
famses	0	1	-0.02	0.82	- 2.330e+00	-0.65	-0.10	0.57	2.60	
bipoc.gpc	0	1	0.00	0.36	-9.500e-01	-0.21	0.00	0.19	0.96	
famses.gpc	0	1	0.00	0.61	- 2.640e+00	-0.41	-0.03	0.39	2.36	
sector	0	1	0.10	0.30	0.000e+00	0.00	0.00	0.00	1.00	
schsizebig	0	1	0.54	0.50	0.000e+00	0.00	1.00	1.00	1.00	
schses.gdc	0	1	0.02	0.54	- 1.230e+00	-0.41	0.02	0.44	1.37	

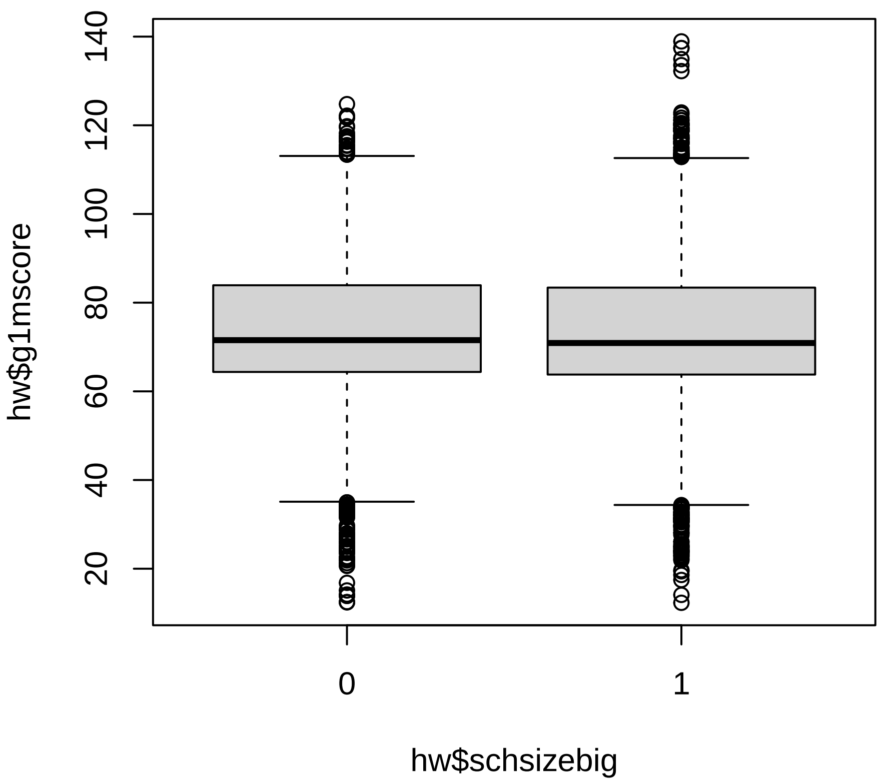
```r
# a quick look at the relationship between SES and Grade 1 math scores
plot(hw$famses, hw$g1mscore)
```




```r
# a quick look at the distribution of math scores by student of color indicator and school size in
boxplot(hw$g1mscore ~ hw$bipoc)
```




```r
boxplot(hw$g1mscore ~ hw$schsizebig)
```



Question 1

Start by fitting the following model for Grade 1 math scores (Model 1):

$Y_{ij} = \beta_{0j} + \beta_{1j}(bipoc.gpc) + r_{ij}$, $r_{ij} \sim N(0, \sigma^2)$

$\beta_{0j} = \gamma_{00} + u_{0j}$, $u_{0j} \sim N(0, \tau_{00})$

$\beta_{1j} = \gamma_{10} + u_{1j}$, $u_{1j} \sim N(0, \tau_{11})$

> Show your work
>
> As part of your response to this question, include any R code and/or output you used to help answer the question.

1.A. Which parameter in this model represents the average SOC math score gap for the population of schools in the study? **Answer:** γ_{10}, it represents the fixed (average) component of the slope across schools.

1.B. Which parameter represents the extent to which the SOC math score gaps vary across schools? **Answer:** τ_{11}, it represents the variance in the SOC math score gaps across schools.

1.C. Based on the model results, what point estimate do you get for the average SOC math score gap for the population of schools in the study? Is this estimate statistically significant? Interpret the meaning of this result for the policy director.

Answer: The point estimate for the average SOC Math Score Gap is -4.55 (0.40). It is statistically significant. On average, being a student of color is associated with a 4.55 point lower math score compared to non-student of color within the school.

```r
model1 <- lmer(g1mscore ~ 1 + bipoc.gpc + (1 + bipoc.gpc| schid), data =hw)
summary(model1)
```

```
Linear mixed model fit by REML. t-tests use Satterthwaite's method [
lmerModLmerTest]
Formula: g1mscore ~ 1 + bipoc.gpc + (1 + bipoc.gpc | schid)
   Data: hw

REML criterion at convergence: 91543.9

Scaled residuals:
    Min      1Q  Median      3Q     Max
-4.5999 -0.5841 -0.0431  0.6079  4.4566

Random effects:
 Groups   Name        Variance Std.Dev. Corr
 schid    (Intercept)  43.49    6.594
          bipoc.gpc    14.82    3.850   0.21
 Residual             198.36   14.084
Number of obs: 11116, groups:  schid, 800

Fixed effects:
            Estimate Std. Error       df t value Pr(>|t|)
(Intercept)  72.9216     0.2712 794.9017  268.89   <2e-16 ***
bipoc.gpc    -4.5465     0.4033 575.6222  -11.27   <2e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Correlation of Fixed Effects:
          (Intr)
bipoc.gpc 0.063
```

1.D. Do SOC math test gaps appear to vary across schools to a substantive or significant degree? What results led you to this conclusion?

Answer: The p-value for the likelihood ratio test shows that adding the random slope for bipoc.gpc significantly improves the model fit (p<.0.001). This demonstrates that SOC math score gaps vary significantly across schools. The variance of the random slope for bipoc.gpc is 14.82, the confident interval of the bipoc.gpc estimate is [-12.09, 3.00], suggesting that SOC math score gaps vary substantively across schools.

```r
model1x <- lmer(g1mscore ~ 1 + bipoc.gpc + (1 | schid), data =hw)
#model1x
anova(model1, model1x, test = "LRT")
```

```
Data: hw
Models:
model1x: g1mscore ~ 1 + bipoc.gpc + (1 | schid)
model1: g1mscore ~ 1 + bipoc.gpc + (1 + bipoc.gpc | schid)
        npar   AIC   BIC logLik deviance  Chisq Df Pr(>Chisq)
model1x    4 91565 91594 -45778    91557
model1     6 91555 91599 -45772    91543 13.824  2  0.0009957 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```r
#plausible values for bipoc.gpc slope
vc <- as.data.frame(VarCorr(model1))
vc
```

```
       grp        var1      var2      vcov     sdcor
1    schid (Intercept)      <NA>  43.48545  6.594350
2    schid   bipoc.gpc      <NA>  14.82151  3.849872
3    schid (Intercept) bipoc.gpc   5.41404  0.213257
4 Residual        <NA>      <NA> 198.36104 14.084070
```

```r
#extract the slope variance
tau_11 <- vc[2, 4]
#extract the point estimate for gamma_10
g_10 <- summary(model1)$coef[2, 1]
g_10.lb <- g_10 - 1.96*sqrt(tau_11)
g_10.ub <- g_10 + 1.96*sqrt(tau_11)
c(g_10.lb, g_10.ub)
```

```
[1] -12.092290   2.999207
```

Question 2

Differences in test scores between SOC and non-SOC first graders in a school may be due in part to differences in SES. To address this concern, fit the following model that includes `famses.gpc` at level 1 and allows for the SES-achievement slope to vary across schools (Model 2):

$Y_{ij} = \beta_{0j} + \beta_{1j}(bipoc.gpc) + \beta_{1j}(famses.gpc) + r_{ij}\ ,\ r_{ij} \sim N(0, \sigma^2)$

$\beta_{0j} = \gamma_{00} + u_{0j}\ ,\ u_{0j} \sim N(0, \tau_{00})$

$\beta_{1j} = \gamma_{10} + u_{1j}\ ,\ u_{1j} \sim N(0, \tau_{11})$

$\beta_{2j} = \gamma_{20} + u_{2j}\ ,\ u_{1j} \sim N(0, \tau_{22})$

Show your work

As part of your response to this question, include any R code and/or output you used to help answer the question.

2.A. Does including SES as a covariate in the level-1 model change the meaning of β_{1j}? How would you now define β_{1j}?

Answer: Yes, it will change the meaning of β_{1j}. In the model1, β_{1j} represented the SOC math test gap within schools without controlling for family SES. Now, in model2, β_{1j} represents the SOC math test gap within schools, after controlling for family SES.

2.B. In what way does adding SES as a covariate in the level-1 model change the meaning of γ_{10} and τ_{11}?

Answer: γ_{10} in model1 means the average SOC math score gap across schools. γ_{10} now in model2 represents the average SOC math score gap across schools after controlling for family SES. τ_{11} in model1 represents the variance in SOC math test gaps across schools, reflecting how much the SOC math test gap varies from school to school, now in model2 means the residual variance in SOC math test gaps across schools after accounting for differences in family SES. The τ_{11} is expected to be smaller in model2 compared to model1.

2.C. How do the results for γ_{10} and τ_{11} based on this model compare with the results for γ_{10} and τ_{11} based on the first model?

Answer: The magnitude of γ_{10} has decreased from -4.55 in model1 to -3.06 in model2. The mean SOC math score gap is smaller after controlling for family SES, indicating that SES explains part of the gap. The τ_{11} has decreased from 14.82 in model1 to 8.095 in model2, indicating that family SES also explains some of the variation in SOC math score gaps across schools.

```r
model2 <- lmer(g1mscore ~ 1 + bipoc.gpc + famses.gpc + (1 + bipoc.gpc + famses.gpc | schid), data
summary(model2)
```

```
Linear mixed model fit by REML. t-tests use Satterthwaite's method [
lmerModLmerTest]
Formula: g1mscore ~ 1 + bipoc.gpc + famses.gpc + (1 + bipoc.gpc + famses.gpc |
    schid)
   Data: hw

REML criterion at convergence: 90800.8

Scaled residuals:
    Min      1Q  Median      3Q     Max 
-4.6558 -0.5903 -0.0276  0.6039  4.2885 

Random effects:
 Groups   Name        Variance Std.Dev. Corr       
 schid    (Intercept)  44.615   6.679              
          bipoc.gpc     8.095   2.845    0.14      
          famses.gpc    3.823   1.955    0.39 -0.26
 Residual             183.868  13.560              
Number of obs: 11116, groups:  schid, 800
```

```
Fixed effects:
            Estimate Std. Error       df t value Pr(>|t|)
(Intercept)  72.9158     0.2713 794.7359  268.78  < 2e-16 ***
bipoc.gpc    -3.0617     0.3799 558.2676   -8.06 4.66e-15 ***
famses.gpc    5.7870     0.2271 689.8152   25.48  < 2e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Correlation of Fixed Effects:
           (Intr) bpc.gp
bipoc.gpc  0.034
famses.gpc 0.107  0.103
```

2.D. Based on the model results, how big or small of a SOC math score gap should we expect for a school who's SOC gap is two standard deviations above the average gap? What about for a school who's SOC gap is two standard deviations below the average gap?

Answer: The school with a SOC gap two standard deviations above the average would have an SOC math score gap of 2.63 points, meaning that students of color are expected to score 2.63 points higher than their peers in such schools. In contrast, a school with an SOC gap two standard deviations below the average would have an SOC math score gap of -8.75 points, indicating students of color are expected score 8.75 points lower than their peers in such schools.

```r
vc2 <- as.data.frame(VarCorr(model2))
tau11_model2 <- vc2[2, 4]
g_10_model2 <- summary(model2)$coef[2, 1]
g.10.ub_model2 <- g_10_model2 + 2*sqrt(tau11_model2)
g.10.lb_model2 <- g_10_model2 - 2*sqrt(tau11_model2)
c(g.10.lb_model2, g.10.ub_model2)
```

```
[1] -8.752025  2.628608
```

Question 3

Now fit the following model to test the contextual effect of school size and school-level SES (Model 3):

$Y_{ij} = \beta_{0j} + \beta_{1j}(bipoc.gpc) + \beta_{1j}(famses.gpc) + r_{ij}\ ,\ r_{ij} \sim N(0, \sigma^2)$

$\beta_{0j} = \gamma_{00} + \gamma_{01}(schsizebig) + \gamma_{02}(schses.gdc) + u_{0j}\ ,\ u_{0j} \sim N(0, \tau_{00})$

$\beta_{1j} = \gamma_{10} + \gamma_{11}(schsizebig) + \gamma_{12}(schses.gdc) + u_{1j}\ ,\ u_{1j} \sim N(0, \tau_{11})$

$\beta_{2j} = \gamma_{20} + \gamma_{21}(schsizebig) + \gamma_{22}(schses.gdc) + u_{2j}\ ,\ u_{1j} \sim N(0, \tau_{22})$

> Show your work
>
> As part of your response to this question, include any R code and/or output you used to help answer the question.

3.A. What do the parameters γ_{10}, γ_{11}, γ_{12}, and τ_{11} represent? Explain them using language the policy director should be able to understand.

Answer: - γ_{10} represents the average SOC math score gap across all schools, after controlling for family SES, school size and school-level SES. Or it represents the average SOC math score for the small size schools with average school SES after controlling for family SES. - γ_{11} represents the differentiating effect of school size on the SOC math score gaps, after controlling for family SES and accounting for the school-level SES. - γ_{12} represents the differentiating effect of school-level SES on the SOC math score gaps after controlling for family SES and accounting for the effect of school size. - τ_{11} represents the residual variance in the SOC math score gaps across schools, after accounting for family SES, school size and school-level SES. It reflects how much the SOC math score gaps vary between schools after controlling for these factors.

3.B. Based on the model results, is there evidence that the SOC math score gap is smaller or bigger in larger schools than smaller schools? As part of your answer, comment on whether the estimated difference in the SOC gap between larger and smaller schools is statistically significant. And report the expected SOC test score gap for a large school with average school SES and the expected SOC test score gap for a small school with average school SES.

Answer: There is no statistically significant evidence that the SOC math score gaps differ between larger and smaller schools. Although the estimated SOC math score gap is -2.90 in small schools and -3.25 in large schools (-2.90 - 0.345 = - 3.25), this difference is not statistically significant ($p > 0.05$). Therefore, while the point estimates suggest that the gap might be slightly larger in larger schools, we cannot conclude that school size meaningfully moderates the SOC math score gap when school SES is average.

```r
model3 <- lmer(g1mscore ~ 1 + bipoc.gpc + famses.gpc + schsizebig + schses.gdc +
               bipoc.gpc:schsizebig + bipoc.gpc:schses.gdc +
               famses.gpc:schsizebig + famses.gpc:schses.gdc +
               (1 + bipoc.gpc + famses.gpc | schid), data = hw)

summary(model3)
```

```
Linear mixed model fit by REML. t-tests use Satterthwaite's method [
lmerModLmerTest]
Formula: g1mscore ~ 1 + bipoc.gpc + famses.gpc + schsizebig + schses.gdc +
    bipoc.gpc:schsizebig + bipoc.gpc:schses.gdc + famses.gpc:schsizebig +
    famses.gpc:schses.gdc + (1 + bipoc.gpc + famses.gpc | schid)
   Data: hw

REML criterion at convergence: 90157.3

Scaled residuals:
    Min      1Q  Median      3Q     Max
-4.5751 -0.6003 -0.0186  0.6103  4.1780

Random effects:
 Groups   Name        Variance Std.Dev. Corr
 schid    (Intercept)  12.772   3.574
          bipoc.gpc     8.139   2.853   -0.16
          famses.gpc    3.989   1.997    0.69 -0.26
 Residual             183.830  13.558
Number of obs: 11116, groups:  schid, 800
```

```
Fixed effects:
                       Estimate Std. Error       df t value Pr(>|t|)    
(Intercept)             72.5013     0.2700 776.1786 268.502  < 2e-16 ***
bipoc.gpc               -2.9036     0.5806 599.7589  -5.001 7.51e-07 ***
famses.gpc               5.7108     0.3402 704.7962  16.785  < 2e-16 ***
schsizebig               0.7019     0.3671 771.1788   1.912   0.0563 .  
schses.gdc              10.3958     0.3361 780.8194  30.932  < 2e-16 ***
bipoc.gpc:schsizebig    -0.3453     0.7651 558.0734  -0.451   0.6519    
bipoc.gpc:schses.gdc     1.4893     0.7389 553.5092   2.015   0.0443 *  
famses.gpc:schsizebig    0.2426     0.4576 683.6092   0.530   0.5962    
famses.gpc:schses.gdc   -0.1321     0.4456 860.1865  -0.296   0.7670    
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Correlation of Fixed Effects:
            (Intr) bpc.gp fmss.g schszb schss. bpc.g: bpc.:. fmss.:
bipoc.gpc   -0.028                                                 
famses.gpc   0.154  0.089                                          
schsizebig  -0.738  0.021 -0.114                                   
schses.gdc  -0.078  0.002 -0.010  0.085                            
bpc.gpc:sch  0.021 -0.737 -0.056 -0.029 -0.002                     
bpc.gpc:sc.  0.002 -0.199 -0.054 -0.002 -0.028  0.047              
fmss.gpc:sc -0.115 -0.055 -0.733  0.156  0.014  0.097 -0.007       
fmss.gpc:s. -0.010 -0.055 -0.173  0.013  0.145 -0.002  0.072  0.078
```

3.C. Based on the model results, is there evidence that the SOC math score gap for a school depends on the school's average SES? As part of your answer, comment on whether the relationship between a school's SOC gap and a school's average SES is positive or negative and whether it is statistically significant. Interpret the meaning of this relationship (magnitude and direction) using language the policy director should be able to understand.

Answers: The coefficient for the interaction between SOC status and school SES (bipoc.gpc:schses.gdc) is +1.49, with a p-value of 0.044, indicating that this relationship is statistically significant. This means that for every one-unit increase in a school's average SES, the SOC math score gap decreases by approximately 1.49 points. In other words, the gap becomes smaller in schools with higher SES.

3.D. What proportion of the between-school variance in the SOC gap is accounted for by including the school size and school average SES measures in the model? Hint: compare the SOC gap residual parameter variance estimate from Model 3 to the same parameter estimate from Model 2

Answer: [SOMETHING WENT WRONG HERE, CALCULATION PROPORTION IS NEGATIVE, IGNORE THE Q&A]

```r
vc3 <- as.data.frame(VarCorr(model3))
vc3
```

```
        grp        var1       var2      vcov     sdcor
1     schid (Intercept)       <NA> 12.771570 3.5737334
2     schid   bipoc.gpc       <NA>  8.139477 2.8529769
3     schid  famses.gpc       <NA>  3.989420 1.9973533
```

```
4    schid (Intercept)  bipoc.gpc  -1.589720 -0.1559195
5    schid (Intercept) famses.gpc   4.923548  0.6897650
6    schid   bipoc.gpc famses.gpc  -1.488610 -0.2612329
7 Residual        <NA>       <NA> 183.830124 13.5583968
```

```r
tau11_model3 <- vc3[2, 4]
tau11_model3
```

```
[1] 8.139477
```

```r
tau11_model2
```

```
[1] 8.094926
```

```r
#proportion of SOC gap variance explained
(tau11_model2 - tau11_model3) / tau11_model2
```

```
[1] -0.005503571
```

```r
AIC(model2, model3)
```

```
       df      AIC
model2 10 90820.75
model3 16 90189.26
```

```r
BIC(model2, model3)
```

```
       df      BIC
model2 10 90893.92
model3 16 90306.32
```

3.E. Based on the model's results, report the expect math test score for the following students:

```r
# define the estimated coefficients from Model3
int          <- 72.5013
beta_bipoc   <- -2.9036
beta_schsize <- 0.7019
beta_schses  <- 10.3958
beta_bipoc_schsize <- -0.3453
beta_bipoc_schses  <- 1.4893

# create a function that computes the expected score
expected_score <- function(bipoc, schsize, schses) {
  int +
    beta_bipoc * bipoc +
    beta_schsize * schsize +
```

```r
    beta_schses * schses +
    beta_bipoc_schsize * (bipoc * schsize) +
    beta_bipoc_schses * (bipoc * schses)
}

# 3.E.1: Student of color, large school, school SES = -1
score_3E1 <- expected_score(bipoc = 1, schsize = 1, schses = -1)

# 3.E.2: Not of color, large school, school SES = -1
score_3E2 <- expected_score(bipoc = 0, schsize = 1, schses = -1)

# 3.E.3: Student of color, large school, school SES = +1
score_3E3 <- expected_score(bipoc = 1, schsize = 1, schses = +1)

# 3.E.4: Not of color, large school, school SES = +1
score_3E4 <- expected_score(bipoc = 0, schsize = 1, schses = +1)

# 3.E.5: Student of color, small school, school SES = -1
score_3E5 <- expected_score(bipoc = 1, schsize = 0, schses = -1)

# 3.E.6: Not of color, small school, school SES = -1
score_3E6 <- expected_score(bipoc = 0, schsize = 0, schses = -1)

# 3.E.7: Student of color, small school, school SES = +1
score_3E7 <- expected_score(bipoc = 1, schsize = 0, schses = +1)

# 3.E.8: Not of color, small school, school SES = +1
score_3E8 <- expected_score(bipoc = 0, schsize = 0, schses = +1)

# Print the results
cat("3.E.1 Expected Score:", round(score_3E1, 2), "\n")
```

```
3.E.1 Expected Score: 58.07
```

```r
cat("3.E.2 Expected Score:", round(score_3E2, 2), "\n")
```

```
3.E.2 Expected Score: 62.81
```

```r
cat("3.E.3 Expected Score:", round(score_3E3, 2), "\n")
```

```
3.E.3 Expected Score: 81.84
```

```r
cat("3.E.4 Expected Score:", round(score_3E4, 2), "\n")
```

```
3.E.4 Expected Score: 83.6
```

```r
cat("3.E.5 Expected Score:", round(score_3E5, 2), "\n")
```

```
3.E.5 Expected Score: 57.71
```

```r
cat("3.E.6 Expected Score:", round(score_3E6, 2), "\n")
```

```
3.E.6 Expected Score: 62.11
```

```r
cat("3.E.7 Expected Score:", round(score_3E7, 2), "\n")
```

```
3.E.7 Expected Score: 81.48
```

```r
cat("3.E.8 Expected Score:", round(score_3E8, 2), "\n")
```

```
3.E.8 Expected Score: 82.9
```

- 3.E.1. A student of color in a *large* school, where the student's family SES is average for their school but the school's average SES is 1 unit *below* the sample mean **Answer:** 58.07
- 3.E.2. A student who's *not* of color in a *large* school, where the student's family SES is average for their school but the school's average SES is 1 unit *below* the sample mean **Answer:** 62.81
- 3.E.3. A student of color in a *large* school, where the student's family SES is average for their school but the school's average SES is 1 unit *above* the sample mean **Answer:** 81.84
- 3.E.4. A student who's *not* of color in a *large* school, where the student's family SES is average for their school but the school's average SES is 1 unit *above* the sample mean **Answer:** 83.6
- 3.E.5. A student of color in a *small* school, where the student's family SES is average for their school but the school's average SES is 1 unit *below* the sample mean **Answer:** 57.71
- 3.E.6. A student who's *not* of color in a *small* school, where the student's family SES is average for their school but the school's average SES is 1 unit *below* the sample mean **Answer:** 62.11
- 3.E.7. A student of color in a *small* school, where the student's family SES is average for their school but the school's average SES is 1 unit *above* the sample mean **Answer:** 81.48
- 3.E.8. A student who's *not* of color in a *small* school, where the student's family SES is average for their school but the school's average SES is 1 unit *above* the sample mean **Answer:** 82.90