R Notebook

dat<-read.csv("../classroom.csv")  
attach(dat)  
dat$math1st <- mathkind + mathgain

## UMM MODEL

require(lme4)  
require(lmerTest)  
umm.1 <- lmer(math1st ~ (1|schoolid/classid), data =dat)  
summary(umm.1)

## Linear mixed model fit by REML ['lmerMod']  
## Formula: math1st ~ (1 | schoolid/classid)  
## Data: dat  
##   
## REML criterion at convergence: 11944.6  
##   
## Scaled residuals:   
## Min 1Q Median 3Q Max   
## -5.1872 -0.6174 -0.0204 0.5821 3.8339   
##   
## Random effects:  
## Groups Name Variance Std.Dev.  
## classid:schoolid (Intercept) 85.46 9.244   
## schoolid (Intercept) 280.68 16.754   
## Residual 1146.80 33.864   
## Number of obs: 1190, groups: classid:schoolid, 312; schoolid, 107  
##   
## Fixed effects:  
## Estimate Std. Error t value  
## (Intercept) 522.540 2.037 256.6

With ~ N(0,), ~ N(0,), and ~ N(0,), independent of one another.

#### ICC

## Add school level predictors (HOUSEPOV)

lme1<-lmer(math1st~housepov + (1|schoolid/classid),data=dat)  
summary(lme1)

## Linear mixed model fit by REML t-tests use Satterthwaite approximations  
## to degrees of freedom [lmerMod]  
## Formula: math1st ~ housepov + (1 | schoolid/classid)  
## Data: dat  
##   
## REML criterion at convergence: 11927.4  
##   
## Scaled residuals:   
## Min 1Q Median 3Q Max   
## -5.1142 -0.6011 -0.0350 0.5600 3.8154   
##   
## Random effects:  
## Groups Name Variance Std.Dev.  
## classid:schoolid (Intercept) 82.36 9.075   
## schoolid (Intercept) 250.93 15.841   
## Residual 1146.95 33.867   
## Number of obs: 1190, groups: classid:schoolid, 312; schoolid, 107  
##   
## Fixed effects:  
## Estimate Std. Error df t value Pr(>|t|)   
## (Intercept) 531.294 3.341 102.810 159.024 <2e-16 \*\*\*  
## housepov -45.783 14.236 111.060 -3.216 0.0017 \*\*   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Correlation of Fixed Effects:  
## (Intr)  
## housepov -0.810

anova(lme1,umm.1)

## refitting model(s) with ML (instead of REML)

## Data: dat  
## Models:  
## ..1: math1st ~ (1 | schoolid/classid)  
## object: math1st ~ housepov + (1 | schoolid/classid)  
## Df AIC BIC logLik deviance Chisq Chi Df Pr(>Chisq)   
## ..1 4 11956 11976 -5973.9 11948   
## object 5 11948 11973 -5968.8 11938 10.125 1 0.001463 \*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

Adding the school-level predictor is statistically significant, and an improvement from the UMM model.

#### Report and

is reduced from 280.68 to 250.93. is reduced from 85.46 to 82.36. The reduction in school variance is expected. The classroom variance is reduced slightly possibly due to aggregate effect, where classroom has both the school level and classroom effect.

## ADD Class level preds & report if justifed.

lme2<-lmer(math1st~housepov + mathknow + mathprep + yearstea + (1|schoolid/classid),data=dat)  
summary(lme2)

## Linear mixed model fit by REML t-tests use Satterthwaite approximations  
## to degrees of freedom [lmerMod]  
## Formula:   
## math1st ~ housepov + mathknow + mathprep + yearstea + (1 | schoolid/classid)  
## Data: dat  
##   
## REML criterion at convergence: 10821  
##   
## Scaled residuals:   
## Min 1Q Median 3Q Max   
## -3.5552 -0.6118 -0.0311 0.5863 3.8315   
##   
## Random effects:  
## Groups Name Variance Std.Dev.  
## classid:schoolid (Intercept) 94.36 9.714   
## schoolid (Intercept) 223.31 14.943   
## Residual 1136.43 33.711   
## Number of obs: 1081, groups: classid:schoolid, 285; schoolid, 105  
##   
## Fixed effects:  
## Estimate Std. Error df t value Pr(>|t|)   
## (Intercept) 532.29853 5.20496 228.86000 102.268 < 2e-16 \*\*\*  
## housepov -41.62116 14.08835 109.83000 -2.954 0.00383 \*\*   
## mathknow 2.55143 1.44530 231.07000 1.765 0.07883 .   
## mathprep -0.75440 1.42809 203.21000 -0.528 0.59790   
## yearstea 0.06193 0.14717 223.77000 0.421 0.67432   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Correlation of Fixed Effects:  
## (Intr) houspv mthknw mthprp  
## housepov -0.568   
## mathknow -0.052 0.082   
## mathprep -0.666 0.032 0.004   
## yearstea -0.264 0.077 0.030 -0.175

None of them are significant except for household poverty.

#### Justified?

#anova(lme1,lme2)

#### Report change to

increased from 82.36 to 94.36.

#### Report change to

decreased from 1146.95 to 1136.43.

#### Hypothesis as to why is reduced.

None of the classroom-level covariates are statistically significant. By adding these variables, it may have increased the uncertainty attributed to the between classroom effect.

## ADD student level preds & report if justifed.

lme3<-lmer(math1st~housepov + mathknow + mathprep + yearstea + sex + minority + ses + (1|schoolid/classid),data=dat)  
summary(lme3)

## Linear mixed model fit by REML t-tests use Satterthwaite approximations  
## to degrees of freedom [lmerMod]  
## Formula:   
## math1st ~ housepov + mathknow + mathprep + yearstea + sex + minority +   
## ses + (1 | schoolid/classid)  
## Data: dat  
##   
## REML criterion at convergence: 10729.5  
##   
## Scaled residuals:   
## Min 1Q Median 3Q Max   
## -3.8580 -0.6134 -0.0321 0.5971 3.6598   
##   
## Random effects:  
## Groups Name Variance Std.Dev.  
## classid:schoolid (Intercept) 93.89 9.69   
## schoolid (Intercept) 169.45 13.02   
## Residual 1064.95 32.63   
## Number of obs: 1081, groups: classid:schoolid, 285; schoolid, 105  
##   
## Fixed effects:  
## Estimate Std. Error df t value Pr(>|t|)   
## (Intercept) 539.63042 5.31210 275.40000 101.585 < 2e-16 \*\*\*  
## housepov -17.64847 13.21757 113.90000 -1.335 0.184   
## mathknow 1.35004 1.39168 234.50000 0.970 0.333   
## mathprep -0.27705 1.37583 205.30000 -0.201 0.841   
## yearstea 0.01129 0.14141 226.80000 0.080 0.936   
## sex -1.21419 2.09483 1022.50000 -0.580 0.562   
## minority -16.18678 3.02605 704.50000 -5.349 1.20e-07 \*\*\*  
## ses 10.05075 1.54484 1066.60000 6.506 1.18e-10 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Correlation of Fixed Effects:  
## (Intr) houspv mthknw mthprp yearst sex minrty  
## housepov -0.451   
## mathknow -0.083 0.058   
## mathprep -0.631 0.038 0.004   
## yearstea -0.259 0.071 0.029 -0.172   
## sex -0.190 -0.007 0.007 -0.006 0.016   
## minority -0.320 -0.178 0.115 0.001 0.024 -0.011   
## ses -0.121 0.082 -0.007 0.053 -0.028 0.020 0.162

anova(lme2,lme3)

## refitting model(s) with ML (instead of REML)

## Data: dat  
## Models:  
## object: math1st ~ housepov + mathknow + mathprep + yearstea + (1 | schoolid/classid)  
## ..1: math1st ~ housepov + mathknow + mathprep + yearstea + sex + minority +   
## ..1: ses + (1 | schoolid/classid)  
## Df AIC BIC logLik deviance Chisq Chi Df Pr(>Chisq)   
## object 8 10850 10890 -5417.1 10834   
## ..1 11 10774 10829 -5376.1 10752 82.017 3 < 2.2e-16 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

The addition of all the student-level predictors is an improvement from the previous model (LRT p-value <0.05).

#### Report change in variance components for all levels; why did school level drop?

drops from 94.36 to 93.89. drops from 223.31 to 169.45. $\sigma}^2\_{\varepsilon}$ drops from 1136.43 to 1064.95.

School-level variance drops possibly due to repartitioning. The variance previously attributed to it were explained with the addition of the fixed school variates.

With ~ N(0,), ~ N(0,), and ~ N(0,), independent of one another.

## ADD a random slope for each teacher level predictor.

#### MATHKNOW

lme4.1<-lmer(math1st~housepov + mathknow + mathprep + yearstea + sex + minority + ses + (0+mathknow|schoolid) + (1|schoolid/classid),data=dat)  
summary(lme4.1)

## Linear mixed model fit by REML t-tests use Satterthwaite approximations  
## to degrees of freedom [lmerMod]  
## Formula:   
## math1st ~ housepov + mathknow + mathprep + yearstea + sex + minority +   
## ses + (0 + mathknow | schoolid) + (1 | schoolid/classid)  
## Data: dat  
##   
## REML criterion at convergence: 10729.5  
##   
## Scaled residuals:   
## Min 1Q Median 3Q Max   
## -3.8580 -0.6134 -0.0321 0.5971 3.6598   
##   
## Random effects:  
## Groups Name Variance Std.Dev.   
## classid.schoolid (Intercept) 9.389e+01 9.690e+00  
## schoolid (Intercept) 1.694e+02 1.302e+01  
## schoolid.1 mathknow 4.260e-11 6.527e-06  
## Residual 1.065e+03 3.263e+01  
## Number of obs: 1081, groups: classid:schoolid, 285; schoolid, 105  
##   
## Fixed effects:  
## Estimate Std. Error df t value Pr(>|t|)   
## (Intercept) 539.63042 5.31210 275.40000 101.585 < 2e-16 \*\*\*  
## housepov -17.64847 13.21757 113.90000 -1.335 0.184   
## mathknow 1.35004 1.39168 234.50000 0.970 0.333   
## mathprep -0.27705 1.37583 205.30000 -0.201 0.841   
## yearstea 0.01129 0.14141 226.80000 0.080 0.936   
## sex -1.21419 2.09483 1022.50000 -0.580 0.562   
## minority -16.18678 3.02605 704.50000 -5.349 1.20e-07 \*\*\*  
## ses 10.05075 1.54484 1066.60000 6.506 1.18e-10 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Correlation of Fixed Effects:  
## (Intr) houspv mthknw mthprp yearst sex minrty  
## housepov -0.451   
## mathknow -0.083 0.058   
## mathprep -0.631 0.038 0.004   
## yearstea -0.259 0.071 0.029 -0.172   
## sex -0.190 -0.007 0.007 -0.006 0.016   
## minority -0.320 -0.178 0.115 0.001 0.024 -0.011   
## ses -0.121 0.082 -0.007 0.053 -0.028 0.020 0.162

rand(lme4.1)

## Analysis of Random effects Table:  
## Chi.sq Chi.DF p.value   
## mathknow:schoolid 1.82e-12 1 1   
## schoolid/classid 6.29e+01 2 2e-14 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

#### MATHPREP

lme4.2<-lmer(math1st~housepov + mathknow + mathprep + yearstea + sex + minority + ses + (0+mathprep|schoolid) + (1|schoolid/classid),data=dat)  
summary(lme4.2)

## Linear mixed model fit by REML t-tests use Satterthwaite approximations  
## to degrees of freedom [lmerMod]  
## Formula:   
## math1st ~ housepov + mathknow + mathprep + yearstea + sex + minority +   
## ses + (0 + mathprep | schoolid) + (1 | schoolid/classid)  
## Data: dat  
##   
## REML criterion at convergence: 10729.5  
##   
## Scaled residuals:   
## Min 1Q Median 3Q Max   
## -3.8580 -0.6134 -0.0321 0.5971 3.6598   
##   
## Random effects:  
## Groups Name Variance Std.Dev.  
## classid.schoolid (Intercept) 93.89 9.69   
## schoolid (Intercept) 169.45 13.02   
## schoolid.1 mathprep 0.00 0.00   
## Residual 1064.95 32.63   
## Number of obs: 1081, groups: classid:schoolid, 285; schoolid, 105  
##   
## Fixed effects:  
## Estimate Std. Error df t value Pr(>|t|)   
## (Intercept) 539.63042 5.31210 275.40000 101.585 < 2e-16 \*\*\*  
## housepov -17.64847 13.21757 113.90000 -1.335 0.184   
## mathknow 1.35004 1.39168 234.50000 0.970 0.333   
## mathprep -0.27705 1.37583 205.30000 -0.201 0.841   
## yearstea 0.01129 0.14141 226.80000 0.080 0.936   
## sex -1.21419 2.09483 1022.30000 -0.580 0.562   
## minority -16.18678 3.02605 704.50000 -5.349 1.20e-07 \*\*\*  
## ses 10.05075 1.54484 1066.50000 6.506 1.18e-10 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Correlation of Fixed Effects:  
## (Intr) houspv mthknw mthprp yearst sex minrty  
## housepov -0.451   
## mathknow -0.083 0.058   
## mathprep -0.631 0.038 0.004   
## yearstea -0.259 0.071 0.029 -0.172   
## sex -0.190 -0.007 0.007 -0.006 0.016   
## minority -0.320 -0.178 0.115 0.001 0.024 -0.011   
## ses -0.121 0.082 -0.007 0.053 -0.028 0.020 0.162

rand(lme4.2)

## Analysis of Random effects Table:  
## Chi.sq Chi.DF p.value   
## mathprep:schoolid 0 1 1   
## schoolid/classid 28 2 8e-07 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

#### YEARSTEA

lme4.3<-lmer(math1st~housepov + mathknow + mathprep + yearstea + sex + minority + ses + (0+yearstea|schoolid) + (1|schoolid/classid),data=dat)  
summary(lme4.3)

## Linear mixed model fit by REML t-tests use Satterthwaite approximations  
## to degrees of freedom [lmerMod]  
## Formula:   
## math1st ~ housepov + mathknow + mathprep + yearstea + sex + minority +   
## ses + (0 + yearstea | schoolid) + (1 | schoolid/classid)  
## Data: dat  
##   
## REML criterion at convergence: 10729.5  
##   
## Scaled residuals:   
## Min 1Q Median 3Q Max   
## -3.8485 -0.6149 -0.0323 0.5980 3.6600   
##   
## Random effects:  
## Groups Name Variance Std.Dev.  
## classid.schoolid (Intercept) 9.266e+01 9.62593  
## schoolid (Intercept) 1.685e+02 12.97893  
## schoolid.1 yearstea 9.669e-03 0.09833  
## Residual 1.065e+03 32.63452  
## Number of obs: 1081, groups: classid:schoolid, 285; schoolid, 105  
##   
## Fixed effects:  
## Estimate Std. Error df t value Pr(>|t|)   
## (Intercept) 539.60060 5.30865 266.30000 101.645 < 2e-16 \*\*\*  
## housepov -17.71727 13.21854 113.60000 -1.340 0.183   
## mathknow 1.33198 1.39177 234.30000 0.957 0.340   
## mathprep -0.26633 1.37610 204.90000 -0.194 0.847   
## yearstea 0.01124 0.14193 122.40000 0.079 0.937   
## sex -1.21077 2.09476 1022.20000 -0.578 0.563   
## minority -16.16833 3.02641 702.60000 -5.342 1.24e-07 \*\*\*  
## ses 10.04529 1.54490 1066.10000 6.502 1.21e-10 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Correlation of Fixed Effects:  
## (Intr) houspv mthknw mthprp yearst sex minrty  
## housepov -0.450   
## mathknow -0.082 0.057   
## mathprep -0.632 0.037 0.003   
## yearstea -0.258 0.070 0.028 -0.172   
## sex -0.190 -0.007 0.006 -0.006 0.015   
## minority -0.320 -0.179 0.115 0.001 0.023 -0.010   
## ses -0.121 0.082 -0.007 0.053 -0.027 0.020 0.162

rand(lme4.3)

## Analysis of Random effects Table:  
## Chi.sq Chi.DF p.value   
## yearstea:schoolid 0.00698 1 0.9   
## schoolid/classid 49.88766 2 1e-11 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

## Why not try for a random slope on the housepov effect?

We would not be able to observe the effect of adding a random slope to housepov - there is no level higher up.

## Retry the above, allowing the slopes to be correlated with the random intercepts.

#### MATHKNOW

lme4.1.1<-lmer(math1st~housepov + mathknow + mathprep + yearstea + sex + minority + ses + (mathknow|schoolid)+(1|classid),data=dat)  
summary(lme4.1.1)

## Linear mixed model fit by REML t-tests use Satterthwaite approximations  
## to degrees of freedom [lmerMod]  
## Formula:   
## math1st ~ housepov + mathknow + mathprep + yearstea + sex + minority +   
## ses + (mathknow | schoolid) + (1 | classid)  
## Data: dat  
##   
## REML criterion at convergence: 10729.5  
##   
## Scaled residuals:   
## Min 1Q Median 3Q Max   
## -3.8581 -0.6131 -0.0324 0.5969 3.6603   
##   
## Random effects:  
## Groups Name Variance Std.Dev. Corr  
## classid (Intercept) 9.394e+01 9.69205   
## schoolid (Intercept) 1.693e+02 13.01223   
## mathknow 8.597e-04 0.02932 1.00  
## Residual 1.065e+03 32.63393   
## Number of obs: 1081, groups: classid, 285; schoolid, 105  
##   
## Fixed effects:  
## Estimate Std. Error df t value Pr(>|t|)   
## (Intercept) 539.64037 5.31212 275.40000 101.587 < 2e-16 \*\*\*  
## housepov -17.64148 13.21274 104.00000 -1.335 0.185   
## mathknow 1.35459 1.39203 214.60000 0.973 0.332   
## mathprep -0.27753 1.37601 201.30000 -0.202 0.840   
## yearstea 0.01114 0.14141 226.90000 0.079 0.937   
## sex -1.21329 2.09485 1021.70000 -0.579 0.563   
## minority -16.19376 3.02609 703.80000 -5.351 1.18e-07 \*\*\*  
## ses 10.04788 1.54488 1062.00000 6.504 1.20e-10 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Correlation of Fixed Effects:  
## (Intr) houspv mthknw mthprp yearst sex minrty  
## housepov -0.451   
## mathknow -0.082 0.057   
## mathprep -0.631 0.038 0.004   
## yearstea -0.259 0.071 0.029 -0.173   
## sex -0.190 -0.007 0.007 -0.006 0.016   
## minority -0.320 -0.178 0.115 0.001 0.024 -0.011   
## ses -0.121 0.082 -0.007 0.053 -0.028 0.020 0.162

rand(lme4.1.1)

## Analysis of Random effects Table:  
## Chi.sq Chi.DF p.value   
## mathknow:schoolid 0.000321 2 1.00   
## classid 6.676842 1 0.01 \*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

#### MATHPREP

lme4.2.1<-lmer(math1st~housepov + mathknow + mathprep + yearstea + sex + minority + ses + (mathprep|schoolid) + (1|classid),data=dat)  
summary(lme4.2.1)

## Linear mixed model fit by REML t-tests use Satterthwaite approximations  
## to degrees of freedom [lmerMod]  
## Formula:   
## math1st ~ housepov + mathknow + mathprep + yearstea + sex + minority +   
## ses + (mathprep | schoolid) + (1 | classid)  
## Data: dat  
##   
## REML criterion at convergence: 10724.7  
##   
## Scaled residuals:   
## Min 1Q Median 3Q Max   
## -3.8542 -0.6034 -0.0221 0.5915 3.6475   
##   
## Random effects:  
## Groups Name Variance Std.Dev. Corr   
## classid (Intercept) 78.46 8.858   
## schoolid (Intercept) 552.76 23.511   
## mathprep 15.89 3.986 -1.00  
## Residual 1064.26 32.623   
## Number of obs: 1081, groups: classid, 285; schoolid, 105  
##   
## Fixed effects:  
## Estimate Std. Error df t value Pr(>|t|)   
## (Intercept) 538.60855 5.60813 159.90000 96.041 < 2e-16 \*\*\*  
## housepov -14.01307 12.88690 116.10000 -1.087 0.279   
## mathknow 1.29884 1.37194 229.70000 0.947 0.345   
## mathprep 0.04074 1.34845 139.00000 0.030 0.976   
## yearstea -0.02586 0.13949 223.50000 -0.185 0.853   
## sex -1.16759 2.08697 1023.20000 -0.559 0.576   
## minority -16.46422 2.99524 663.70000 -5.497 5.52e-08 \*\*\*  
## ses 10.14166 1.53961 1060.90000 6.587 7.04e-11 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Correlation of Fixed Effects:  
## (Intr) houspv mthknw mthprp yearst sex minrty  
## housepov -0.461   
## mathknow -0.071 0.027   
## mathprep -0.692 0.107 0.012   
## yearstea -0.260 0.089 0.049 -0.155   
## sex -0.183 0.003 0.002 -0.008 0.023   
## minority -0.275 -0.187 0.107 -0.035 0.025 -0.013   
## ses -0.121 0.095 -0.001 0.061 -0.033 0.024 0.161

rand(lme4.2.1)

## Analysis of Random effects Table:  
## Chi.sq Chi.DF p.value   
## mathprep:schoolid 4.81 2 0.09 .  
## classid 5.10 1 0.02 \*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

#### YEARSTEA

lme4.3.1<-lmer(math1st~housepov + mathknow + mathprep + yearstea + sex + minority + ses + (yearstea|schoolid) + (1|classid),data=dat)  
summary(lme4.3.1)

## Linear mixed model fit by REML t-tests use Satterthwaite approximations  
## to degrees of freedom [lmerMod]  
## Formula:   
## math1st ~ housepov + mathknow + mathprep + yearstea + sex + minority +   
## ses + (yearstea | schoolid) + (1 | classid)  
## Data: dat  
##   
## REML criterion at convergence: 10723.7  
##   
## Scaled residuals:   
## Min 1Q Median 3Q Max   
## -3.7462 -0.6036 -0.0290 0.6041 3.8449   
##   
## Random effects:  
## Groups Name Variance Std.Dev. Corr   
## classid (Intercept) 37.9282 6.1586   
## schoolid (Intercept) 366.1175 19.1342   
## yearstea 0.5523 0.7432 -0.78  
## Residual 1066.4508 32.6566   
## Number of obs: 1081, groups: classid, 285; schoolid, 105  
##   
## Fixed effects:  
## Estimate Std. Error df t value Pr(>|t|)   
## (Intercept) 538.95245 5.48825 222.70000 98.201 < 2e-16 \*\*\*  
## housepov -17.13992 13.45960 119.60000 -1.273 0.205   
## mathknow 1.04635 1.34381 209.70000 0.779 0.437   
## mathprep 0.05047 1.34549 190.80000 0.038 0.970   
## yearstea 0.02204 0.15766 75.80000 0.140 0.889   
## sex -1.33553 2.08774 1024.50000 -0.640 0.523   
## minority -16.44556 2.99655 669.50000 -5.488 5.77e-08 \*\*\*  
## ses 10.15038 1.53873 1062.70000 6.597 6.62e-11 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Correlation of Fixed Effects:  
## (Intr) houspv mthknw mthprp yearst sex minrty  
## housepov -0.455   
## mathknow -0.085 0.049   
## mathprep -0.606 0.050 0.014   
## yearstea -0.370 0.084 0.012 -0.139   
## sex -0.184 -0.004 0.008 -0.004 0.009   
## minority -0.305 -0.169 0.122 -0.007 0.032 -0.012   
## ses -0.119 0.079 -0.001 0.049 -0.019 0.022 0.168

rand(lme4.3.1)

## Analysis of Random effects Table:  
## Chi.sq Chi.DF p.value   
## yearstea:schoolid 5.825 2 0.05 .  
## classid 0.903 1 0.34   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

### report anything unusual about the variance components

## try to add a random slope for each student level predictor at the classroom level (one by one - not all together)

#### SEX

lme5.1<-lmer(math1st~housepov + mathknow + mathprep + yearstea + sex + minority + ses + (0 + sex|classid) + (1|schoolid/classid),data=dat)  
summary(lme5.1)

## Linear mixed model fit by REML t-tests use Satterthwaite approximations  
## to degrees of freedom [lmerMod]  
## Formula:   
## math1st ~ housepov + mathknow + mathprep + yearstea + sex + minority +   
## ses + (0 + sex | classid) + (1 | schoolid/classid)  
## Data: dat  
##   
## REML criterion at convergence: 10729.5  
##   
## Scaled residuals:   
## Min 1Q Median 3Q Max   
## -3.8580 -0.6134 -0.0321 0.5971 3.6598   
##   
## Random effects:  
## Groups Name Variance Std.Dev.  
## classid sex 0.00 0.00   
## classid:schoolid (Intercept) 93.89 9.69   
## schoolid (Intercept) 169.45 13.02   
## Residual 1064.95 32.63   
## Number of obs: 1081, groups:   
## classid, 285; classid:schoolid, 285; schoolid, 105  
##   
## Fixed effects:  
## Estimate Std. Error df t value Pr(>|t|)   
## (Intercept) 539.63042 5.31210 275.40000 101.585 < 2e-16 \*\*\*  
## housepov -17.64847 13.21757 113.90000 -1.335 0.184   
## mathknow 1.35004 1.39168 234.50000 0.970 0.333   
## mathprep -0.27705 1.37583 205.30000 -0.201 0.841   
## yearstea 0.01129 0.14141 226.80000 0.080 0.936   
## sex -1.21419 2.09483 1022.40000 -0.580 0.562   
## minority -16.18678 3.02605 704.50000 -5.349 1.20e-07 \*\*\*  
## ses 10.05075 1.54484 1066.50000 6.506 1.18e-10 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Correlation of Fixed Effects:  
## (Intr) houspv mthknw mthprp yearst sex minrty  
## housepov -0.451   
## mathknow -0.083 0.058   
## mathprep -0.631 0.038 0.004   
## yearstea -0.259 0.071 0.029 -0.172   
## sex -0.190 -0.007 0.007 -0.006 0.016   
## minority -0.320 -0.178 0.115 0.001 0.024 -0.011   
## ses -0.121 0.082 -0.007 0.053 -0.028 0.020 0.162

rand(lme5.1)

## Analysis of Random effects Table:  
## Chi.sq Chi.DF p.value   
## sex:classid 0.0 1 1   
## schoolid/classid 70.4 2 5e-16 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

#### MINORITY

lme5.2<-lmer(math1st~housepov + mathknow + mathprep + yearstea + sex + minority + ses + (0 + minority|classid) + (1|schoolid/classid),data=dat)  
summary(lme5.2)

## Linear mixed model fit by REML t-tests use Satterthwaite approximations  
## to degrees of freedom [lmerMod]  
## Formula:   
## math1st ~ housepov + mathknow + mathprep + yearstea + sex + minority +   
## ses + (0 + minority | classid) + (1 | schoolid/classid)  
## Data: dat  
##   
## REML criterion at convergence: 10729.5  
##   
## Scaled residuals:   
## Min 1Q Median 3Q Max   
## -3.8580 -0.6134 -0.0321 0.5971 3.6598   
##   
## Random effects:  
## Groups Name Variance Std.Dev.   
## classid minority 4.495e-11 6.704e-06  
## classid:schoolid (Intercept) 9.389e+01 9.690e+00  
## schoolid (Intercept) 1.694e+02 1.302e+01  
## Residual 1.065e+03 3.263e+01  
## Number of obs: 1081, groups:   
## classid, 285; classid:schoolid, 285; schoolid, 105  
##   
## Fixed effects:  
## Estimate Std. Error df t value Pr(>|t|)   
## (Intercept) 539.63042 5.31210 275.40000 101.585 < 2e-16 \*\*\*  
## housepov -17.64847 13.21757 113.90000 -1.335 0.184   
## mathknow 1.35004 1.39168 234.50000 0.970 0.333   
## mathprep -0.27705 1.37583 205.30000 -0.201 0.841   
## yearstea 0.01129 0.14141 226.80000 0.080 0.936   
## sex -1.21419 2.09483 1022.40000 -0.580 0.562   
## minority -16.18678 3.02605 704.50000 -5.349 1.20e-07 \*\*\*  
## ses 10.05075 1.54484 1066.50000 6.506 1.18e-10 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Correlation of Fixed Effects:  
## (Intr) houspv mthknw mthprp yearst sex minrty  
## housepov -0.451   
## mathknow -0.083 0.058   
## mathprep -0.631 0.038 0.004   
## yearstea -0.259 0.071 0.029 -0.172   
## sex -0.190 -0.007 0.007 -0.006 0.016   
## minority -0.320 -0.178 0.115 0.001 0.024 -0.011   
## ses -0.121 0.082 -0.007 0.053 -0.028 0.020 0.162

rand(lme5.2)

## Analysis of Random effects Table:  
## Chi.sq Chi.DF p.value   
## minority:classid 1.82e-12 1 1   
## schoolid/classid 6.77e+01 2 2e-15 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

#### SES

lme5.3<-lmer(math1st~housepov + mathknow + mathprep + yearstea + sex + minority + ses + (0 + ses|classid) + (1|schoolid/classid),data=dat)  
summary(lme5.3)

## Linear mixed model fit by REML t-tests use Satterthwaite approximations  
## to degrees of freedom [lmerMod]  
## Formula:   
## math1st ~ housepov + mathknow + mathprep + yearstea + sex + minority +   
## ses + (0 + ses | classid) + (1 | schoolid/classid)  
## Data: dat  
##   
## REML criterion at convergence: 10727.9  
##   
## Scaled residuals:   
## Min 1Q Median 3Q Max   
## -3.7163 -0.6032 -0.0331 0.5855 3.6840   
##   
## Random effects:  
## Groups Name Variance Std.Dev.  
## classid ses 49.60 7.043   
## classid:schoolid (Intercept) 87.11 9.333   
## schoolid (Intercept) 171.02 13.077   
## Residual 1043.44 32.302   
## Number of obs: 1081, groups:   
## classid, 285; classid:schoolid, 285; schoolid, 105  
##   
## Fixed effects:  
## Estimate Std. Error df t value Pr(>|t|)   
## (Intercept) 539.71226 5.30641 274.50000 101.710 < 2e-16 \*\*\*  
## housepov -17.50879 13.21775 113.40000 -1.325 0.188   
## mathknow 1.36796 1.38563 229.40000 0.987 0.325   
## mathprep -0.27938 1.37171 204.90000 -0.204 0.839   
## yearstea 0.01103 0.14117 227.00000 0.078 0.938   
## sex -1.37733 2.09334 1022.90000 -0.658 0.511   
## minority -16.29362 3.02464 703.30000 -5.387 9.78e-08 \*\*\*  
## ses 10.14363 1.64248 176.40000 6.176 4.41e-09 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Correlation of Fixed Effects:  
## (Intr) houspv mthknw mthprp yearst sex minrty  
## housepov -0.451   
## mathknow -0.082 0.058   
## mathprep -0.631 0.040 0.005   
## yearstea -0.259 0.070 0.029 -0.172   
## sex -0.190 -0.007 0.006 -0.005 0.014   
## minority -0.321 -0.180 0.111 0.002 0.025 -0.011   
## ses -0.108 0.081 0.002 0.050 -0.026 0.020 0.145

rand(lme5.3)

## Analysis of Random effects Table:  
## Chi.sq Chi.DF p.value   
## ses:classid 1.6 1 0.2   
## schoolid/classid 77.9 2 <2e-16 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

## why is it a bad idea to include a class-level variable with random slopes at the classroom level?

We will not be able to observe the varying slopes at the classroom-level, only one level higher (school-level).

## retry the above, allowing the slopes to be correlated with the random intercepts.

#### SEX

lme5.1.1<-lmer(math1st~housepov + mathknow + mathprep + yearstea + sex + minority + ses + (sex|classid) + (1|schoolid) ,data=dat)  
summary(lme5.1.1)

## Linear mixed model fit by REML t-tests use Satterthwaite approximations  
## to degrees of freedom [lmerMod]  
## Formula:   
## math1st ~ housepov + mathknow + mathprep + yearstea + sex + minority +   
## ses + (sex | classid) + (1 | schoolid)  
## Data: dat  
##   
## REML criterion at convergence: 10729  
##   
## Scaled residuals:   
## Min 1Q Median 3Q Max   
## -3.7565 -0.6134 -0.0307 0.5916 3.7116   
##   
## Random effects:  
## Groups Name Variance Std.Dev. Corr   
## classid (Intercept) 130.07 11.41   
## sex 31.36 5.60 -0.67  
## schoolid (Intercept) 169.85 13.03   
## Residual 1056.41 32.50   
## Number of obs: 1081, groups: classid, 285; schoolid, 105  
##   
## Fixed effects:  
## Estimate Std. Error df t value Pr(>|t|)   
## (Intercept) 5.400e+02 5.332e+00 2.723e+02 101.285 < 2e-16 \*\*\*  
## housepov -1.829e+01 1.323e+01 1.145e+02 -1.382 0.170   
## mathknow 1.306e+00 1.391e+00 2.315e+02 0.939 0.349   
## mathprep -3.459e-01 1.374e+00 2.014e+02 -0.252 0.801   
## yearstea 3.087e-03 1.416e-01 2.270e+02 0.022 0.983   
## sex -1.197e+00 2.122e+00 2.160e+02 -0.564 0.573   
## minority -1.619e+01 3.028e+00 7.042e+02 -5.347 1.21e-07 \*\*\*  
## ses 1.010e+01 1.544e+00 1.065e+03 6.539 9.62e-11 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Correlation of Fixed Effects:  
## (Intr) houspv mthknw mthprp yearst sex minrty  
## housepov -0.452   
## mathknow -0.085 0.060   
## mathprep -0.628 0.040 0.005   
## yearstea -0.258 0.072 0.029 -0.174   
## sex -0.203 -0.005 0.003 -0.008 0.015   
## minority -0.321 -0.178 0.116 0.003 0.024 -0.009   
## ses -0.123 0.083 -0.005 0.054 -0.027 0.020 0.164

rand(lme5.1.1)

## Analysis of Random effects Table:  
## Chi.sq Chi.DF p.value   
## sex:classid 0.5 2 0.8   
## schoolid 24.9 1 6e-07 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

#### MINORITY

lme5.2.1<-lmer(math1st~housepov + mathknow + mathprep + yearstea + sex + minority + ses + (minority|classid) + (1|schoolid),data=dat)  
summary(lme5.2.1)

## Linear mixed model fit by REML t-tests use Satterthwaite approximations  
## to degrees of freedom [lmerMod]  
## Formula:   
## math1st ~ housepov + mathknow + mathprep + yearstea + sex + minority +   
## ses + (minority | classid) + (1 | schoolid)  
## Data: dat  
##   
## REML criterion at convergence: 10726.3  
##   
## Scaled residuals:   
## Min 1Q Median 3Q Max   
## -3.9037 -0.6221 -0.0295 0.6033 3.4574   
##   
## Random effects:  
## Groups Name Variance Std.Dev. Corr   
## classid (Intercept) 225.4 15.01   
## minority 171.3 13.09 -0.82  
## schoolid (Intercept) 157.4 12.55   
## Residual 1045.3 32.33   
## Number of obs: 1081, groups: classid, 285; schoolid, 105  
##   
## Fixed effects:  
## Estimate Std. Error df t value Pr(>|t|)   
## (Intercept) 539.73594 5.38023 270.70000 100.318 < 2e-16 \*\*\*  
## housepov -17.34698 12.91268 103.30000 -1.343 0.182   
## mathknow 1.45702 1.39355 234.00000 1.046 0.297   
## mathprep -0.13520 1.37018 204.00000 -0.099 0.921   
## yearstea -0.01636 0.14285 234.30000 -0.115 0.909   
## sex -1.01012 2.08966 1015.80000 -0.483 0.629   
## minority -16.48614 3.21756 183.20000 -5.124 7.55e-07 \*\*\*  
## ses 9.89350 1.54595 1062.90000 6.400 2.33e-10 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Correlation of Fixed Effects:  
## (Intr) houspv mthknw mthprp yearst sex minrty  
## housepov -0.435   
## mathknow -0.079 0.061   
## mathprep -0.618 0.037 -0.006   
## yearstea -0.265 0.080 0.038 -0.171   
## sex -0.188 -0.009 0.009 -0.005 0.015   
## minority -0.368 -0.171 0.108 -0.004 0.025 -0.009   
## ses -0.117 0.085 0.001 0.051 -0.023 0.021 0.149

rand(lme5.2.1)

## Analysis of Random effects Table:  
## Chi.sq Chi.DF p.value   
## minority:classid 3.2 2 0.2   
## schoolid 20.1 1 7e-06 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

#### SES

lme5.3.1<-lmer(math1st~housepov + mathknow + mathprep + yearstea + sex + minority + ses + (ses|classid) + (1|schoolid),data=dat)  
summary(lme5.3.1)

## Linear mixed model fit by REML t-tests use Satterthwaite approximations  
## to degrees of freedom [lmerMod]  
## Formula:   
## math1st ~ housepov + mathknow + mathprep + yearstea + sex + minority +   
## ses + (ses | classid) + (1 | schoolid)  
## Data: dat  
##   
## REML criterion at convergence: 10725.7  
##   
## Scaled residuals:   
## Min 1Q Median 3Q Max   
## -3.5688 -0.6004 -0.0316 0.5959 3.6176   
##   
## Random effects:  
## Groups Name Variance Std.Dev. Corr  
## classid (Intercept) 86.06 9.277   
## ses 44.09 6.640 0.75  
## schoolid (Intercept) 173.16 13.159   
## Residual 1048.32 32.378   
## Number of obs: 1081, groups: classid, 285; schoolid, 105  
##   
## Fixed effects:  
## Estimate Std. Error df t value Pr(>|t|)   
## (Intercept) 539.52093 5.26665 269.60000 102.441 < 2e-16 \*\*\*  
## housepov -16.28994 13.13445 111.30000 -1.240 0.217   
## mathknow 1.37996 1.37294 222.40000 1.005 0.316   
## mathprep -0.37734 1.34603 182.80000 -0.280 0.780   
## yearstea 0.01605 0.14080 227.60000 0.114 0.909   
## sex -1.32178 2.08794 1017.10000 -0.633 0.527   
## minority -16.09272 3.03497 717.70000 -5.302 1.52e-07 \*\*\*  
## ses 10.05535 1.64507 171.10000 6.112 6.44e-09 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Correlation of Fixed Effects:  
## (Intr) houspv mthknw mthprp yearst sex minrty  
## housepov -0.450   
## mathknow -0.078 0.059   
## mathprep -0.625 0.036 -0.001   
## yearstea -0.266 0.074 0.030 -0.165   
## sex -0.186 -0.009 0.007 -0.009 0.013   
## minority -0.325 -0.181 0.108 0.004 0.021 -0.014   
## ses -0.084 0.078 0.015 0.056 -0.024 0.022 0.142

rand(lme5.3.1)

## Analysis of Random effects Table:  
## Chi.sq Chi.DF p.value   
## ses:classid 3.84 2 0.1   
## schoolid 26.02 1 3e-07 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

## try to add a random slope for each student level predictor at the school level (one by one - not all together)

#### SEX

lme6.1<-lmer(math1st~housepov + mathknow + mathprep + yearstea + sex + minority + ses + (0 + sex|schoolid) + (1|schoolid/classid),data=dat)  
summary(lme6.1)

## Linear mixed model fit by REML t-tests use Satterthwaite approximations  
## to degrees of freedom [lmerMod]  
## Formula:   
## math1st ~ housepov + mathknow + mathprep + yearstea + sex + minority +   
## ses + (0 + sex | schoolid) + (1 | schoolid/classid)  
## Data: dat  
##   
## REML criterion at convergence: 10728.9  
##   
## Scaled residuals:   
## Min 1Q Median 3Q Max   
## -3.8578 -0.6110 -0.0259 0.5922 3.5557   
##   
## Random effects:  
## Groups Name Variance Std.Dev.  
## classid.schoolid (Intercept) 96.08 9.802   
## schoolid (Intercept) 161.63 12.713   
## schoolid.1 sex 35.83 5.986   
## Residual 1054.36 32.471   
## Number of obs: 1081, groups: classid:schoolid, 285; schoolid, 105  
##   
## Fixed effects:  
## Estimate Std. Error df t value Pr(>|t|)   
## (Intercept) 539.43517 5.30740 272.50000 101.638 < 2e-16 \*\*\*  
## housepov -16.77661 13.22881 112.40000 -1.268 0.207   
## mathknow 1.40067 1.39464 234.50000 1.004 0.316   
## mathprep -0.27193 1.38010 205.80000 -0.197 0.844   
## yearstea 0.01448 0.14163 226.40000 0.102 0.919   
## sex -1.33534 2.18746 138.10000 -0.610 0.543   
## minority -16.16536 3.02861 704.20000 -5.338 1.27e-07 \*\*\*  
## ses 9.98477 1.54243 1058.20000 6.473 1.46e-10 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Correlation of Fixed Effects:  
## (Intr) houspv mthknw mthprp yearst sex minrty  
## housepov -0.449   
## mathknow -0.081 0.055   
## mathprep -0.633 0.036 0.004   
## yearstea -0.259 0.070 0.028 -0.172   
## sex -0.179 -0.010 0.007 -0.004 0.013   
## minority -0.320 -0.178 0.114 0.001 0.024 -0.015   
## ses -0.120 0.081 -0.007 0.052 -0.029 0.020 0.161

rand(lme6.1)

## Analysis of Random effects Table:  
## Chi.sq Chi.DF p.value   
## sex:schoolid 0.614 1 0.4   
## schoolid/classid 56.701 2 5e-13 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

#### MINORITY

lme6.2<-lmer(math1st~housepov + mathknow + mathprep + yearstea + sex + minority + ses + (0 + minority|schoolid) + (1|schoolid/classid),data=dat)  
summary(lme6.2)

## Linear mixed model fit by REML t-tests use Satterthwaite approximations  
## to degrees of freedom [lmerMod]  
## Formula:   
## math1st ~ housepov + mathknow + mathprep + yearstea + sex + minority +   
## ses + (0 + minority | schoolid) + (1 | schoolid/classid)  
## Data: dat  
##   
## REML criterion at convergence: 10729.5  
##   
## Scaled residuals:   
## Min 1Q Median 3Q Max   
## -3.8580 -0.6134 -0.0321 0.5971 3.6598   
##   
## Random effects:  
## Groups Name Variance Std.Dev.  
## classid.schoolid (Intercept) 93.89 9.69   
## schoolid (Intercept) 169.45 13.02   
## schoolid.1 minority 0.00 0.00   
## Residual 1064.95 32.63   
## Number of obs: 1081, groups: classid:schoolid, 285; schoolid, 105  
##   
## Fixed effects:  
## Estimate Std. Error df t value Pr(>|t|)   
## (Intercept) 539.63042 5.31210 275.40000 101.585 < 2e-16 \*\*\*  
## housepov -17.64847 13.21757 113.90000 -1.335 0.184   
## mathknow 1.35004 1.39168 234.50000 0.970 0.333   
## mathprep -0.27705 1.37583 205.30000 -0.201 0.841   
## yearstea 0.01129 0.14141 226.80000 0.080 0.936   
## sex -1.21419 2.09483 1022.50000 -0.580 0.562   
## minority -16.18678 3.02605 704.50000 -5.349 1.20e-07 \*\*\*  
## ses 10.05075 1.54484 1066.60000 6.506 1.18e-10 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Correlation of Fixed Effects:  
## (Intr) houspv mthknw mthprp yearst sex minrty  
## housepov -0.451   
## mathknow -0.083 0.058   
## mathprep -0.631 0.038 0.004   
## yearstea -0.259 0.071 0.029 -0.172   
## sex -0.190 -0.007 0.007 -0.006 0.016   
## minority -0.320 -0.178 0.115 0.001 0.024 -0.011   
## ses -0.121 0.082 -0.007 0.053 -0.028 0.020 0.162

rand(lme6.2)

## Analysis of Random effects Table:  
## Chi.sq Chi.DF p.value   
## minority:schoolid 0.0 1 1   
## schoolid/classid 58.2 2 2e-13 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

#### SES

lme6.3<-lmer(math1st~housepov + mathknow + mathprep + yearstea + sex + minority + ses + (0 + ses|schoolid) + (1|schoolid/classid),data=dat)  
summary(lme6.3)

## Linear mixed model fit by REML t-tests use Satterthwaite approximations  
## to degrees of freedom [lmerMod]  
## Formula:   
## math1st ~ housepov + mathknow + mathprep + yearstea + sex + minority +   
## ses + (0 + ses | schoolid) + (1 | schoolid/classid)  
## Data: dat  
##   
## REML criterion at convergence: 10724.8  
##   
## Scaled residuals:   
## Min 1Q Median 3Q Max   
## -3.6138 -0.6185 -0.0290 0.5798 3.7130   
##   
## Random effects:  
## Groups Name Variance Std.Dev.  
## classid.schoolid (Intercept) 88.56 9.411   
## schoolid (Intercept) 167.98 12.961   
## schoolid.1 ses 72.50 8.515   
## Residual 1035.12 32.173   
## Number of obs: 1081, groups: classid:schoolid, 285; schoolid, 105  
##   
## Fixed effects:  
## Estimate Std. Error df t value Pr(>|t|)   
## (Intercept) 539.13751 5.27917 270.50000 102.126 < 2e-16 \*\*\*  
## housepov -16.94564 13.21116 112.80000 -1.283 0.202   
## mathknow 1.35576 1.38459 232.20000 0.979 0.329   
## mathprep -0.19801 1.35994 198.60000 -0.146 0.884   
## yearstea 0.03079 0.14052 223.90000 0.219 0.827   
## sex -1.40185 2.08170 1011.30000 -0.673 0.501   
## minority -16.52525 3.02189 700.10000 -5.469 6.32e-08 \*\*\*  
## ses 9.78982 1.82217 79.00000 5.373 7.62e-07 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Correlation of Fixed Effects:  
## (Intr) houspv mthknw mthprp yearst sex minrty  
## housepov -0.451   
## mathknow -0.079 0.056   
## mathprep -0.628 0.041 0.002   
## yearstea -0.260 0.070 0.028 -0.172   
## sex -0.190 -0.007 0.006 -0.007 0.018   
## minority -0.323 -0.180 0.110 0.001 0.024 -0.010   
## ses -0.091 0.076 0.006 0.042 -0.019 0.017 0.124

rand(lme6.3)

## Analysis of Random effects Table:  
## Chi.sq Chi.DF p.value   
## ses:schoolid 4.7 1 0.03 \*   
## schoolid/classid 73.7 2 <2e-16 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

## retry the above, allowing the slopes to be correlated with the random intercepts.

#### SEX

lme6.1.1<-lmer(math1st~housepov + mathknow + mathprep + yearstea + sex + minority + ses + (sex|schoolid) + (1|classid),data=dat)  
summary(lme6.1.1)

## Linear mixed model fit by REML t-tests use Satterthwaite approximations  
## to degrees of freedom [lmerMod]  
## Formula:   
## math1st ~ housepov + mathknow + mathprep + yearstea + sex + minority +   
## ses + (sex | schoolid) + (1 | classid)  
## Data: dat  
##   
## REML criterion at convergence: 10727.6  
##   
## Scaled residuals:   
## Min 1Q Median 3Q Max   
## -3.8048 -0.6095 -0.0222 0.5969 3.5525   
##   
## Random effects:  
## Groups Name Variance Std.Dev. Corr   
## classid (Intercept) 97.34 9.866   
## schoolid (Intercept) 206.33 14.364   
## sex 84.08 9.170 -0.43  
## Residual 1041.76 32.276   
## Number of obs: 1081, groups: classid, 285; schoolid, 105  
##   
## Fixed effects:  
## Estimate Std. Error df t value Pr(>|t|)   
## (Intercept) 5.399e+02 5.363e+00 2.626e+02 100.661 < 2e-16 \*\*\*  
## housepov -1.742e+01 1.325e+01 1.136e+02 -1.314 0.191   
## mathknow 1.379e+00 1.396e+00 2.364e+02 0.988 0.324   
## mathprep -2.796e-01 1.378e+00 2.061e+02 -0.203 0.839   
## yearstea 6.876e-03 1.418e-01 2.277e+02 0.048 0.961   
## sex -1.340e+00 2.301e+00 8.740e+01 -0.582 0.562   
## minority -1.642e+01 3.027e+00 7.076e+02 -5.425 7.96e-08 \*\*\*  
## ses 9.928e+00 1.540e+00 1.055e+03 6.448 1.72e-10 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Correlation of Fixed Effects:  
## (Intr) houspv mthknw mthprp yearst sex minrty  
## housepov -0.449   
## mathknow -0.082 0.060   
## mathprep -0.627 0.038 0.004   
## yearstea -0.258 0.072 0.027 -0.172   
## sex -0.222 -0.003 0.006 -0.005 0.014   
## minority -0.319 -0.178 0.114 0.004 0.024 -0.011   
## ses -0.121 0.083 -0.006 0.053 -0.028 0.018 0.163

rand(lme6.1.1)

## Analysis of Random effects Table:  
## Chi.sq Chi.DF p.value   
## sex:schoolid 1.86 2 0.394   
## classid 7.64 1 0.006 \*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

#### MINORITY

lme6.2.1<-lmer(math1st~housepov + mathknow + mathprep + yearstea + sex + minority + ses + (minority|schoolid) + (1|classid),data=dat)  
summary(lme6.2.1)

## Linear mixed model fit by REML t-tests use Satterthwaite approximations  
## to degrees of freedom [lmerMod]  
## Formula:   
## math1st ~ housepov + mathknow + mathprep + yearstea + sex + minority +   
## ses + (minority | schoolid) + (1 | classid)  
## Data: dat  
##   
## REML criterion at convergence: 10717.5  
##   
## Scaled residuals:   
## Min 1Q Median 3Q Max   
## -3.8952 -0.6358 -0.0345 0.6129 3.6444   
##   
## Random effects:  
## Groups Name Variance Std.Dev. Corr   
## classid (Intercept) 86.69 9.311   
## schoolid (Intercept) 381.20 19.524   
## minority 343.13 18.524 -0.83  
## Residual 1039.39 32.240   
## Number of obs: 1081, groups: classid, 285; schoolid, 105  
##   
## Fixed effects:  
## Estimate Std. Error df t value Pr(>|t|)   
## (Intercept) 5.395e+02 5.655e+00 1.731e+02 95.399 < 2e-16 \*\*\*  
## housepov -1.606e+01 1.257e+01 1.000e+02 -1.277 0.204   
## mathknow 1.632e+00 1.359e+00 2.248e+02 1.201 0.231   
## mathprep -2.918e-01 1.335e+00 1.981e+02 -0.218 0.827   
## yearstea -4.368e-03 1.376e-01 2.172e+02 -0.032 0.975   
## sex -8.628e-01 2.084e+00 1.022e+03 -0.414 0.679   
## minority -1.638e+01 3.896e+00 5.820e+01 -4.203 9.17e-05 \*\*\*  
## ses 9.431e+00 1.543e+00 1.063e+03 6.111 1.39e-09 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Correlation of Fixed Effects:  
## (Intr) houspv mthknw mthprp yearst sex minrty  
## housepov -0.394   
## mathknow -0.078 0.061   
## mathprep -0.576 0.037 -0.002   
## yearstea -0.253 0.091 0.024 -0.167   
## sex -0.172 -0.013 0.010 -0.005 0.014   
## minority -0.494 -0.157 0.099 -0.002 0.027 -0.014   
## ses -0.105 0.089 -0.005 0.052 -0.021 0.024 0.113

rand(lme6.2.1)

## Analysis of Random effects Table:  
## Chi.sq Chi.DF p.value   
## minority:schoolid 11.97 2 0.003 \*\*  
## classid 6.08 1 0.014 \*   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

#### SES

lme6.3.1<-lmer(math1st~housepov + mathknow + mathprep + yearstea + sex + minority + ses + (ses|schoolid) + (1|classid),data=dat)  
summary(lme6.3.1)

## Linear mixed model fit by REML t-tests use Satterthwaite approximations  
## to degrees of freedom [lmerMod]  
## Formula:   
## math1st ~ housepov + mathknow + mathprep + yearstea + sex + minority +   
## ses + (ses | schoolid) + (1 | classid)  
## Data: dat  
##   
## REML criterion at convergence: 10724.4  
##   
## Scaled residuals:   
## Min 1Q Median 3Q Max   
## -3.5646 -0.6166 -0.0264 0.5888 3.7073   
##   
## Random effects:  
## Groups Name Variance Std.Dev. Corr  
## classid (Intercept) 86.57 9.305   
## schoolid (Intercept) 171.18 13.083   
## ses 73.37 8.565 0.19  
## Residual 1035.90 32.185   
## Number of obs: 1081, groups: classid, 285; schoolid, 105  
##   
## Fixed effects:  
## Estimate Std. Error df t value Pr(>|t|)   
## (Intercept) 538.72222 5.27647 271.10000 102.099 < 2e-16 \*\*\*  
## housepov -15.89873 13.15393 111.70000 -1.209 0.229   
## mathknow 1.26025 1.38201 230.90000 0.912 0.363   
## mathprep -0.21697 1.35642 197.10000 -0.160 0.873   
## yearstea 0.03617 0.14002 220.40000 0.258 0.796   
## sex -1.40436 2.08074 1011.50000 -0.675 0.500   
## minority -16.26699 3.03580 668.90000 -5.358 1.16e-07 \*\*\*  
## ses 9.72646 1.82985 78.40000 5.315 9.75e-07 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Correlation of Fixed Effects:  
## (Intr) houspv mthknw mthprp yearst sex minrty  
## housepov -0.449   
## mathknow -0.077 0.057   
## mathprep -0.627 0.039 0.001   
## yearstea -0.259 0.073 0.028 -0.172   
## sex -0.188 -0.009 0.005 -0.008 0.017   
## minority -0.325 -0.182 0.108 0.002 0.021 -0.011   
## ses -0.062 0.070 0.007 0.045 -0.021 0.018 0.117

rand(lme6.3.1)

## Analysis of Random effects Table:  
## Chi.sq Chi.DF p.value   
## ses:schoolid 5.14 2 0.08 .  
## classid 6.21 1 0.01 \*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

### report anything unusual about the variance components

## take the two predictors that had "signif." random slopes, in the forms in which they worked (indep. or correlated)

The two predictors that had statistically significant random slopes are ses random slopes uncorrelated with the school random intercept, and minority random slopes correlated with the school random effect.

#### Model:

With ~ N(0,), ~ N(0,), ~ N(0,), ~ N(0,), and ~ N(0,), and all other pairs of random terms independent of one another.

lme.7<-lmer(math1st~housepov + mathknow + mathprep + yearstea + sex + minority + ses + (0+ses|schoolid) + (minority|schoolid) + (1|classid),data=dat)  
summary(lme.7)

## Linear mixed model fit by REML t-tests use Satterthwaite approximations  
## to degrees of freedom [lmerMod]  
## Formula:   
## math1st ~ housepov + mathknow + mathprep + yearstea + sex + minority +   
## ses + (0 + ses | schoolid) + (minority | schoolid) + (1 |   
## classid)  
## Data: dat  
##   
## REML criterion at convergence: 10712.4  
##   
## Scaled residuals:   
## Min 1Q Median 3Q Max   
## -3.6526 -0.6251 -0.0339 0.6050 3.6961   
##   
## Random effects:  
## Groups Name Variance Std.Dev. Corr   
## classid (Intercept) 80.63 8.979   
## schoolid (Intercept) 404.54 20.113   
## minority 336.04 18.332 -0.84  
## schoolid.1 ses 74.94 8.657   
## Residual 1009.73 31.776   
## Number of obs: 1081, groups: classid, 285; schoolid, 105  
##   
## Fixed effects:  
## Estimate Std. Error df t value Pr(>|t|)   
## (Intercept) 539.05335 5.66468 165.70000 95.160 < 2e-16 \*\*\*  
## housepov -15.32110 12.49443 99.30000 -1.226 0.223   
## mathknow 1.67475 1.35000 221.30000 1.241 0.216   
## mathprep -0.23546 1.31730 191.20000 -0.179 0.858   
## yearstea 0.02102 0.13657 213.70000 0.154 0.878   
## sex -1.03871 2.06951 1010.50000 -0.502 0.616   
## minority -16.72884 3.90720 55.40000 -4.282 7.43e-05 \*\*\*  
## ses 9.19654 1.82272 82.50000 5.046 2.65e-06 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Correlation of Fixed Effects:  
## (Intr) houspv mthknw mthprp yearst sex minrty  
## housepov -0.395   
## mathknow -0.072 0.060   
## mathprep -0.568 0.040 -0.004   
## yearstea -0.254 0.093 0.024 -0.166   
## sex -0.170 -0.014 0.010 -0.005 0.017   
## minority -0.509 -0.149 0.092 -0.003 0.027 -0.013   
## ses -0.080 0.083 0.006 0.041 -0.011 0.020 0.087

### Justified?

Comparing it to just the model with uncorrelated SES random slopes:

anova(lme6.3,lme.7)

## refitting model(s) with ML (instead of REML)

## Data: dat  
## Models:  
## object: math1st ~ housepov + mathknow + mathprep + yearstea + sex + minority +   
## object: ses + (0 + ses | schoolid) + (1 | schoolid/classid)  
## ..1: math1st ~ housepov + mathknow + mathprep + yearstea + sex + minority +   
## ..1: ses + (0 + ses | schoolid) + (minority | schoolid) + (1 |   
## ..1: classid)  
## Df AIC BIC logLik deviance Chisq Chi Df Pr(>Chisq)   
## object 12 10772 10832 -5373.9 10748   
## ..1 14 10764 10833 -5367.8 10736 12.239 2 0.0022 \*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

Comparing it to just the model with correlated MINORITY random slopes:

anova(lme6.2.1,lme.7)

## refitting model(s) with ML (instead of REML)

## Data: dat  
## Models:  
## object: math1st ~ housepov + mathknow + mathprep + yearstea + sex + minority +   
## object: ses + (minority | schoolid) + (1 | classid)  
## ..1: math1st ~ housepov + mathknow + mathprep + yearstea + sex + minority +   
## ..1: ses + (0 + ses | schoolid) + (minority | schoolid) + (1 |   
## ..1: classid)  
## Df AIC BIC logLik deviance Chisq Chi Df Pr(>Chisq)   
## object 13 10766 10831 -5370.2 10740   
## ..1 14 10764 10833 -5367.8 10736 4.8589 1 0.0275 \*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

Both LRT show that having both the random slopes added is an improvement in the model.