



Student Effort in school research project

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QAC 312

Statement of Research Question:

- ▶ In order to determine the effects a school has on student interest towards school, I've created the following research question:
- ▶ Do school level characteristics such as daily attendance rate interact with individual in school level characteristics such as student attachment to school and educational expectations to influence an individual's effort towards school?

Methods

UNDERSTANDING THE PROCESS

Methods

sample

Sample

The dataset worked with in this research project is the “**School Culture, Climate and Violence: Safety in Middle Schools of the Philadelphia Public School System**” data set.

- From this data set, I will be using a sample of $n=6,446$ students.
- All observations with missing data were dropped
- The units of observation in the survey are schools and individuals.
- Questions in the survey ranged from school community level characteristics, school level characteristics, and individual student level characteristics.
- For the purpose of my research question, the focus will be on school level and individual student level characteristics.

Methods

Measures

Measures

In order to answer my question, I chose the most appropriate variables from the data set. Of these variables, there are two level 1 variables, and one level 2 variable used, as well as my individual level response variable.

- Observed Response Variable:
 - SESC: Student Effort Towards School which is measured quantitatively from a scale of 0 through 5, 5 being maximum effort towards school, 0 being minimum effort towards school. Indicates the care and effort a student devotes to schoolwork.

Methods

Measures

- Observed Level 1 Predictor Variables:
 - ATSSC: Student Attachment Towards School, which is measured quantitatively from a scale of 0 through 10, 10 being maximum attachment towards school, 0 being minimum attachment towards school. Indicates students' liking towards school.
 - EESC: Student Educational Expectation from School, which is also measured quantitatively from a scale of 0 through 5, 5 being maximum expectations, 0 being minimum expectations. Indicates the level of academic orientation.

Methods

Measures

- Observed Level 2 Predictor Variable:
 - PATT92: Schools' average daily attendance rate since 1992, which is measured quantitatively.
 - I used this variable because I felt it could be a good indication of the school's climate.
 - As in, if a school has a very high attendance rate, I expect the climate of that school to have more kids putting in more effort towards school.

Methods

Analysis

Analysis

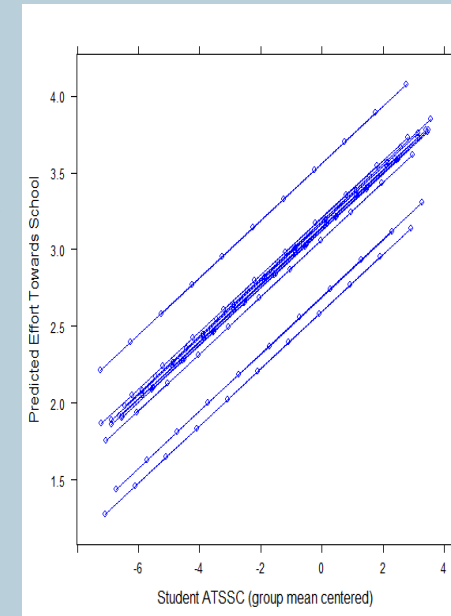
In my analysis of the data (through the use of R software), I started by observing a basic Random Intercept Model and built up to a hierarchical level model.

1. My first model was a Random Intercept Model.

- In this model, I use the response variable “student effort towards school”. In creating this model, I now understand the distribution of the response variables across schools and can later compare to my final level 2 model.

2. The second model was a RIM with a level 1 predictor.

- In this model, I can see if there is an association between my response variable and my level 1 predictor variable, which was “student attachment towards school”.
- Shown in the graph, there is a direct relationship for all schools between student attachment and effort towards school.



Methods

Analysis

3. The next model included two level 1 predictors and a Random Slope

- In this model, I not only added the other level 1 predictor, “educational expectation” onto my previous model, but also used that variable as the random slope parameter. In doing this, I create the opportunity for my level 1 predictor variable to have a different effect for each school.

4. Finally, the last model is my final level 2 model

- I inserted the level 2 as a predictor and interaction variable.
- This model includes the level 2 predictor variable and shows me just how school level characteristics interact with individual level characteristics.

Descriptive Statistics

►The sample mean for my response variable student effort towards school was 3.09

►The most frequent value recorded was 4, as 27% of the sample responded with a 4 as their effort rating.

►The least frequent value recorded was 0, as only 5% of the sample responded with a 0 as their effort rating.

►The number of level 2 units in my data set is 11 with an average of 586 level one observations per level two units.

►The level 2 units are schools, so out of 11 schools, each had about 586 observed data points.

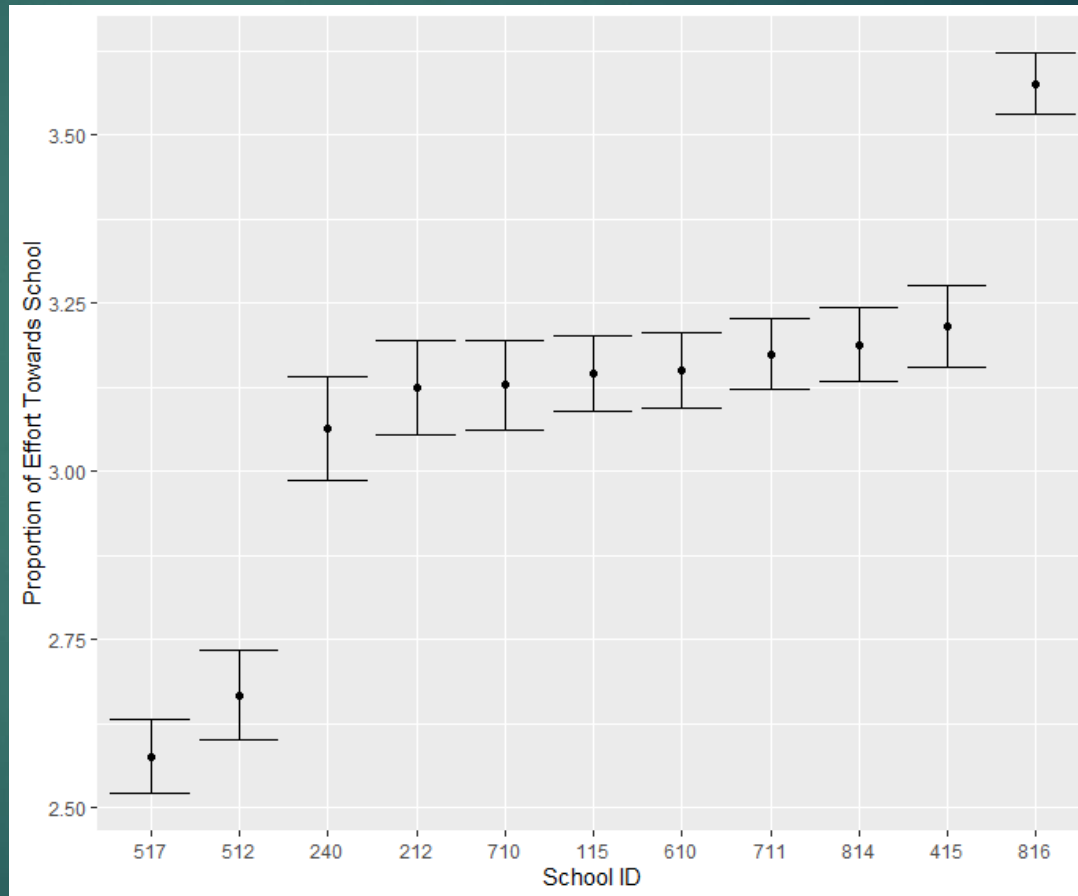
Random Intercept Model

Random Intercept Model

Parameter Estimate for Intercept

-For my response variable Student Effort Towards School, there was a grand mean of 3.09.

-This is shown in the plot. While most of the schools are somewhere close to the mean, there are 3 schools that evidently do not fall close to the mean.



Random Intercept Model

Level 1 and Level 2 Variance Estimates

-The level 1 variance, or in school variance, was 1.98. This tells me the variability of a student's effort towards school from that student's school's mean effort towards school.

-For the level 2 variance, or between school variance, the number was .063. This tells me variance in each school's student's mean effort towards school minus the overall variance. So, it would be likely that there would not be much variance from the mean effort towards school for each school.

Scaled residuals:

Min	1Q	Median	3Q	Max
-2.5298	-0.8118	0.2162	0.6235	1.7048

Random effects:

Groups	Name	Variance	Std.Dev.
school	(Intercept)	0.06306	0.2511
Residual		1.98120	1.4076

Number of obs: 6446, groups: school, 11

Fixed effects:

	Estimate	Std. Error	t value
(Intercept)	3.09338	0.07791	39.71

Random Intercept Model

Intraclass Correlation Coefficient (ICC)

```
> totalvar<-0.063+1.981
> icc<-0.063/totalvar
> print(icc)
[1] 0.03082192
```

```
> performance::icc(hlm1)
# Intraclass Correlation Coefficient

Adjusted ICC: 0.031
Conditional ICC: 0.031
> print(hlm1ci)
          2.5 %    97.5 %
.sig01    0.1693465 0.4140765
.sigma    1.3835801 1.4322237
(Intercept) 2.9261356 3.2597897
```

-Building off the level 1 and 2 variance estimates and using the total variance, the ICC for the data was .031, which explains the variance by being in a certain school. In other words, the ICC is low enough to suggest that the variance between two random students in the same school is small, but the confidence intervals indicate that it is statistically significant.

Design Effect (DEFF) and Standard Error Bias (DEFT)

```
> deseфф<-1+0.031*(586-1)
> print(deseфф)
[1] 19.135
> deff=sqrt(deseфф)
> print(deff)
[1] 4.374357
```

-The design effect was 19.1, while the standard error bias was 4.37. This tells me that the standard error would be about 4x smaller if I ran a regular logistic analysis (without HLM).

Random Intercept Model

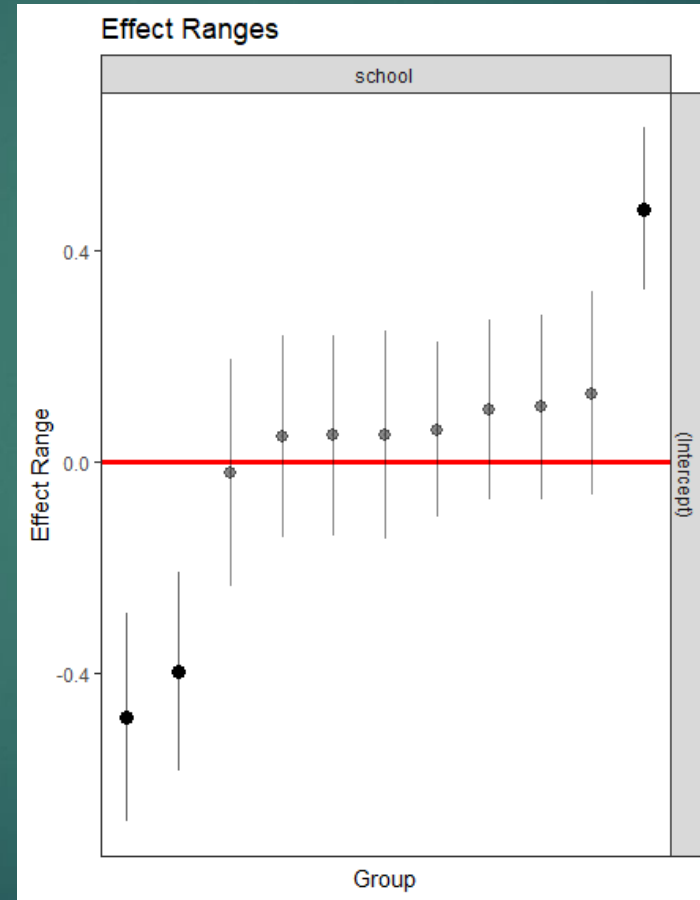
Effective Sample Size

```
> effsize=6446/19.135  
> print(effsize)  
[1] 336.8696
```

-To understand the portion of my data which shows correlation, effective sample size is used.

-As shown, the effective sample size is the total number of observations over the value of the design effect. The effective sample size for my data was 336.87, telling me that out of the 6,446 students, about 336 students contribute unique information.

Random Effects Plot



-As you can see in the effects plot (with no predictor variables), there are 2 schools with values significantly lower and 1 school with a value significantly higher than the grand mean effort towards school (dark shaded points). We can see this because the confidence intervals of variance does not overlap with zero. There also tends to be a trend for the values that are not significantly high or low to be above the grand average mean.



Final Level 2 Model

	Random Intercept Model	Level 1 and 2 Predictors Model	
Parameter	Estimate (95% CI)	Estimate (95% CI)	
Average effort towards School (y_{00})	3.09 (2.93, 3.26)	3.11 (3.06, 3.17)	
Average Effect of ATSSC on Effort towards school. (y_{10})		0.167 (.15, .19)	
Average effect of EESC on Student effort (y_{20})		0.152 (0.133, 0.172)	
Average effect of PATT92 on student effort towards school(y_{30})		.046 (0.033, 0.059)	
Patt92 * Student EESC interaction (y_{40})		0.0015 (-0.0039, 0.0055)	
Variance			
School Mean effort towards school (m_0)	.063	0.0039	
Educational Expectation slope (m_2)		.0013	
Student effort towards school (e_{ij})	1.98	1.71	
ICC	.063/1.98 = .031	.0039/1.71 = .002	
Total between school variance in mean effort towards school explained (level 2)		.063-.0039/.063 = .93	
Total Within school variance in effort towards school explained (level 1)		2.043-1.71/2.043 = .163	

-Table of fixed parameter estimates and variance/standard deviation estimates and confidence intervals for random intercept model and final model (side by side):

$$Y_{IJ} = Y_{00} + Y_{10}(ATSSC_C) + Y_{20}(EESC_C) + Y_{30}(PATT92_C) + Y_{40}(PATT92 * EESC_C) M_0 + M_2 + E_{IJ}$$

Final Level 2 Model

$$Y_{ij} = y_{00} + y_{10}(\text{atssc_c}) + y_{20}(\text{eesc}) + y_{30}(\text{patt92}) + y_{40}(\text{patt92} * \text{atssc_c}) m_0 + m_1 + e_{ij}$$

y_{00} = Average school mean effort towards school adjusted for student attachment towards school, student expectations, and daily attendance rate was 3.11

y_{10} = Average slope across schools for the association between student attachment (atssc) and effort towards school was .167, which indicates that, on average, for every unit increase in student attachment towards school, the mean school effort increased by .167.

y_{20} = Average slope across schools for the association between student educational expectations (eesc) and effort towards school was .152. This tells me that on average, students with higher educational expectations showed .152 units more of effort towards school.

y_{30} = The average slope across schools for the association between school attendance rates since 1992 and total student effort towards school was .046. On average, for every unit increase in daily attendance rate in school (since 1992), the mean school effort towards school rating increased by .046 points.

y_{40} = A significant interaction between school level PATT92 and student level EESC shows the association between student educational expectations and effort towards school was stronger for students at schools with higher attendance rates than lower (since 1992).

m_0 = The average difference between schools in mean effort towards school compared to the grand mean effort rating was .0039.

m_2 = The average difference between schools in the association between student educational expectations and effort towards school rating compared to the average slope was .0013.

e_{ij} = The average difference between students estimated effort towards school rating and the mean effort towards school rating was 1.71

ICC Comparison

As seen in the table, the ICC's between models were *not* the same.

❖ Random Intercept Model ICC:

❖ 0.031

❖ Level 2 Predictor Model ICC:

❖ 0.002

	npar	AIC	BIC	logLik	deviance	Chisq	Df	Pr(>Chisq)
h1m1	3	22738	22759	-11366	22732			
h1m6g	9	21781	21842	-10882	21763	969.01	6	< 2.2e-16 ***

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

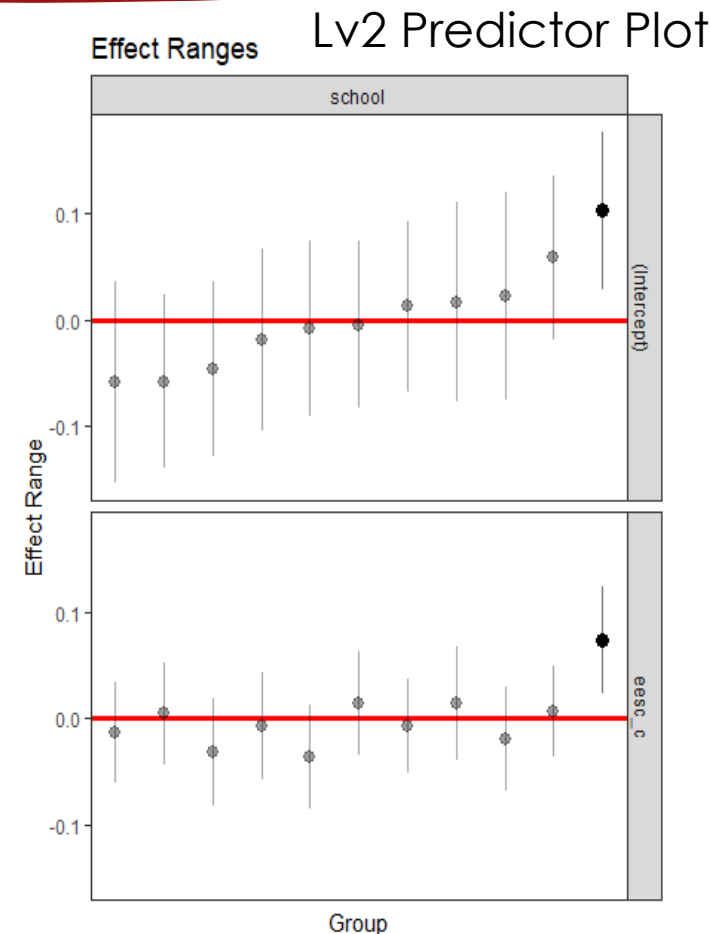
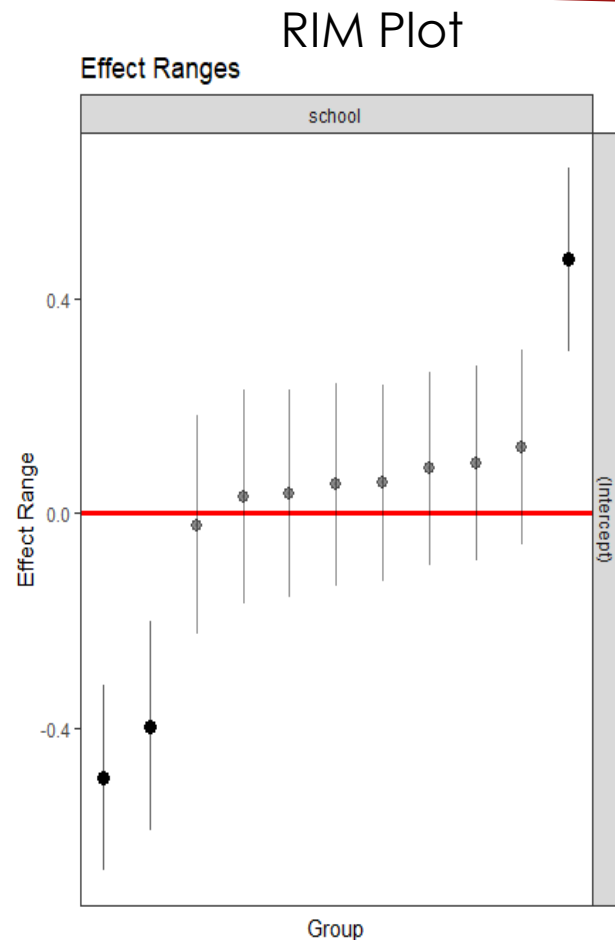
- The ICC value falling from .031 to .002 was not what I expected to see from my model. In fact, I was expecting the opposite, a value increase from the ICC which would then prove to show that the Level 2 Predictor Model statistically showed more correlation between predictor variables.
- However, since the ICCs were low to begin with, looking at the chi-squared difference test (shown on the left) could help indicate the better model to use. The AIC and BIC both dropped by roughly 1,000 points, proving to me that the level 2 model is an improved model.

Variance Comparison

- ▶ Student level predictors of attachment towards school and educational expectations explained 16% of the variance between students and their schools' mean effort towards school rating.
- ▶ The variance of *only* the fixed effects in the model explained about 15% of the variance in students' effort towards school.

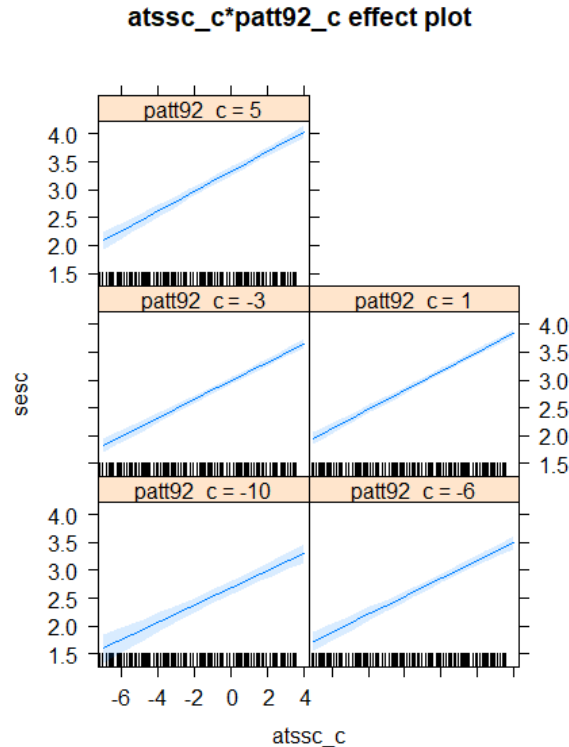
Random Effects Comparison

- By looking at the final level model 2 plot, after adjusting for student attsc, educational expectations and school daily attendance rate, we can see that the number of schools with mean school effort ratings that differ significantly from the grand mean has dropped from 3 to 1.
- We can also see there is only 1 school that differs significantly from the slope of the grand mean and educational expectations.



- What this tells me is through using my Final Lv2 Model, I was able to evidently relate the significant variance from the grand mean to my predictor variables for 2 schools!
- To understand the variance of the last school, I would add another predictor variable to my model to see if it were to become less significantly different.

Interaction Plot



► According to the interaction plot, all five graphs show a positive correlation between student attachment to school (atssc) and student effort towards school (sesc) with various degrees of correlation. For schools with higher daily attendance rates, the slope is relatively the same, but the intercept is higher, showing me having a higher daily attendance rate is related to student effort towards school.



Thank You!