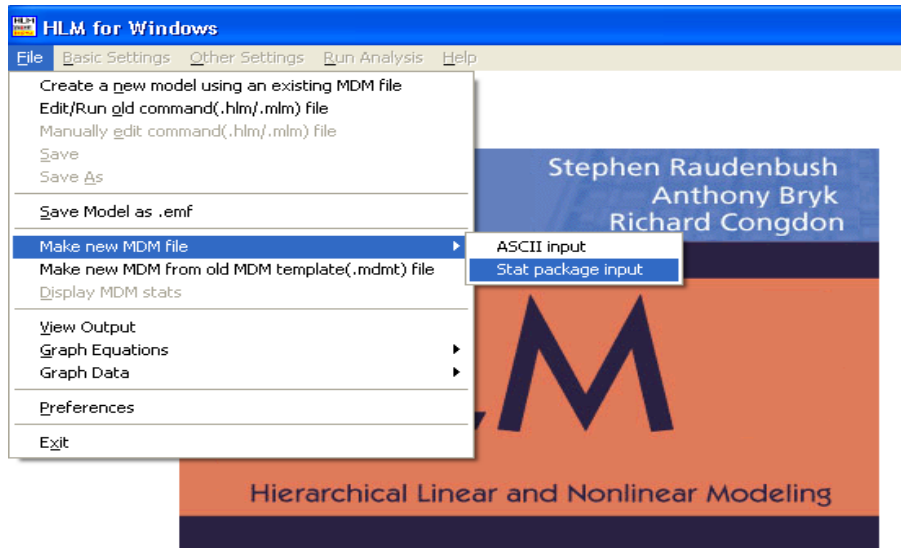


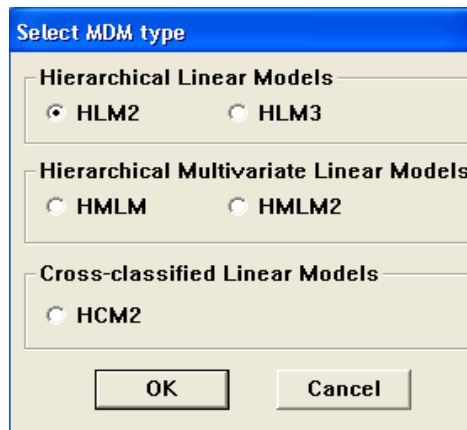
Running the HSB dataset in HLM

HLM 6 uses datasets that are disaggregated at the appropriate level. In this example, we will use datasets in SPSS format, one dataset for each level.

We start by creating a Multivariate Data Matrix (MDM) File. To create the .MDM file (be sure to click on *Stat Package Input*) if using SPSS data (.SAV) files as input.

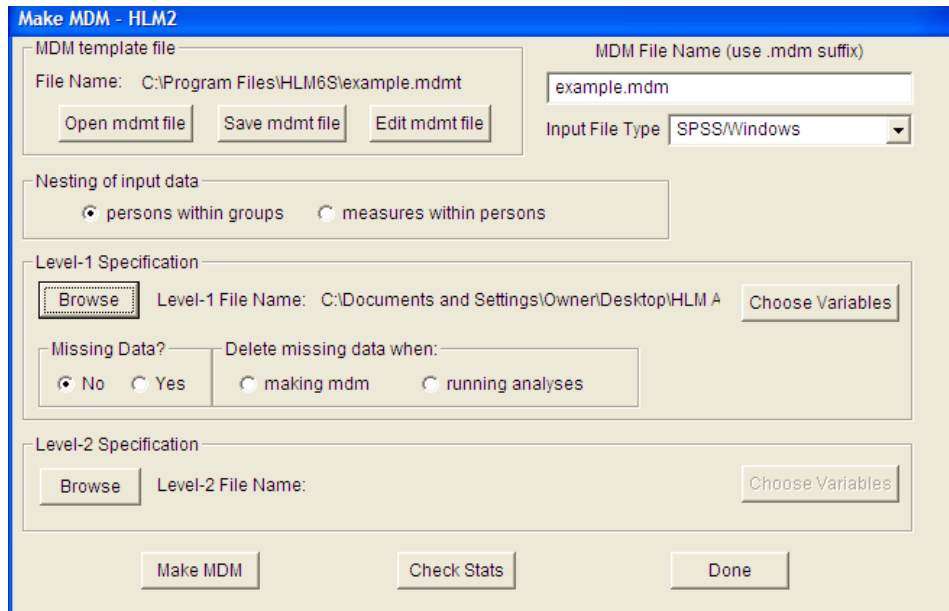


You then need to select the HLM Model Type when Creating MDM. Since we are running a 2-level model, we will select “HLM2.”



First name the MDM file for later use, check the correct data file type and select the Level One file

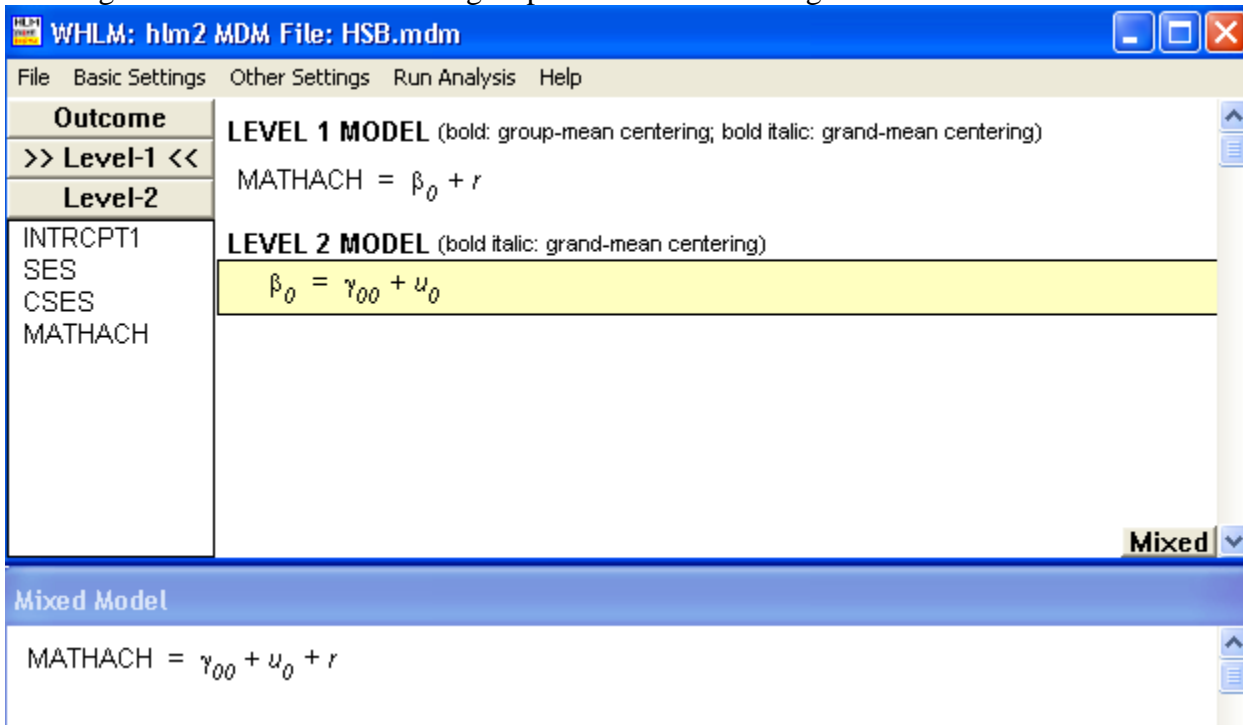
Next we have to name the MDM File and selecting (or Browse to) the Level One File



Then click on **Choose Variables** to identify the ID variable, dependent variable and level one predictors. Next select the Level two data file and then click on **Choose Variables** for the Level two file. You still need to identify the linking level two id and any Level two predictors. Next click on **Save MDMT** file, giving a name for the file. Then click on **Make MDM** and you will see an MS-DOS window that (only briefly) appears (see Figure 5). This window simply lists some descriptive statistics for the variables of interest.

The Null Model

After setting up the datasets and the mdm file, we define the null model by clicking on “MATHACH” and selecting “Outcome Variable.” Doing so produces the following:



The screenshot shows the HLM software interface with the following content:

WHLM: hlm2 MDM File: HSB.mdm

File Basic Settings Other Settings Run Analysis Help

Outcome

>> Level-1 <<

Level-2

INTRCPT1

SES

CSES

MATHACH

LEVEL 1 MODEL (bold: group-mean centering; bold italic: grand-mean centering)

MATHACH = $\beta_0 + r$

LEVEL 2 MODEL (bold italic: grand-mean centering)

$\beta_0 = \gamma_{00} + u_0$

Mixed

Mixed Model

MATHACH = $\gamma_{00} + u_0 + r$

After clicking on “Run Analysis” we can view the output by selecting “View Output” under the “File” menu.

Program: HLM 6 Hierarchical Linear and Nonlinear Modeling
Authors: Stephen Raudenbush, Tony Bryk, & Richard Congdon
Publisher: Scientific Software International, Inc. (c) 2000
techsupport@ssicentral.com
www.ssicentral.com

Module: HLM2.EXE (6.02.25138.2)
Date: 2 February 2009, Monday
Time: 15:12:46

SPECIFICATIONS FOR THIS HLM2 RUN

Problem Title: no title

The data source for this run = HSB.mdm
The command file for this run = whltemp.hlm
Output file name = C:\Documents and Settings\28586523\My Documents\OLD
STUFF\HLM-Online\software\hlm2.txt
The maximum number of level-1 units = 7185
The maximum number of level-2 units = 160
The maximum number of iterations = 100
Method of estimation: restricted maximum likelihood

Weighting Specification

Weight
Variable

	Weighting?	Name	Normalized?
Level 1	no		
Level 2	no		
Precision	no		

The outcome variable is MATHACH

The model specified for the fixed effects was:

```
-----
Level-1                               Level-2
Coefficients                           Predictors
-----
INTRCPT1, B0                          INTRCPT2, G00
-----
```

The model specified for the covariance components was:

```
-----
Sigma squared (constant across level-2 units)

Tau dimensions
  INTRCPT1
-----
```

Summary of the model specified (in equation format)

Level-1 Model

$$Y = B0 + R$$

Level-2 Model

$$B0 = G00 + U0$$

Iterations stopped due to small change in likelihood function

***** ITERATION 4 *****

Sigma_squared = 39.14831

Tau

INTRCPT1,B0 8.61431

Tau (as correlations)

INTRCPT1,B0 1.000

```
-----
Random level-1 coefficient  Reliability estimate
-----
INTRCPT1, B0                0.901
-----
```

The value of the likelihood function at iteration 4 = -2.355840E+004

The outcome variable is MATHACH

Final estimation of fixed effects:

```
-----
Fixed Effect          Coefficient    Standard      Approx.
                    Error          T-ratio      d.f.        P-value
-----
For      INTRCPT1, B0
          INTRCPT2, G00    12.636972    0.244412    51.704      159      0.000
-----
```

The outcome variable is MATHACH

Final estimation of fixed effects
(with robust standard errors)

Fixed Effect	Coefficient	Standard Error	T-ratio	Approx. d.f.	P-value
For INTRCPT1, B0					
INTRCPT2, G00	12.636972	0.243628	51.870	159	0.000

Final estimation of variance components:

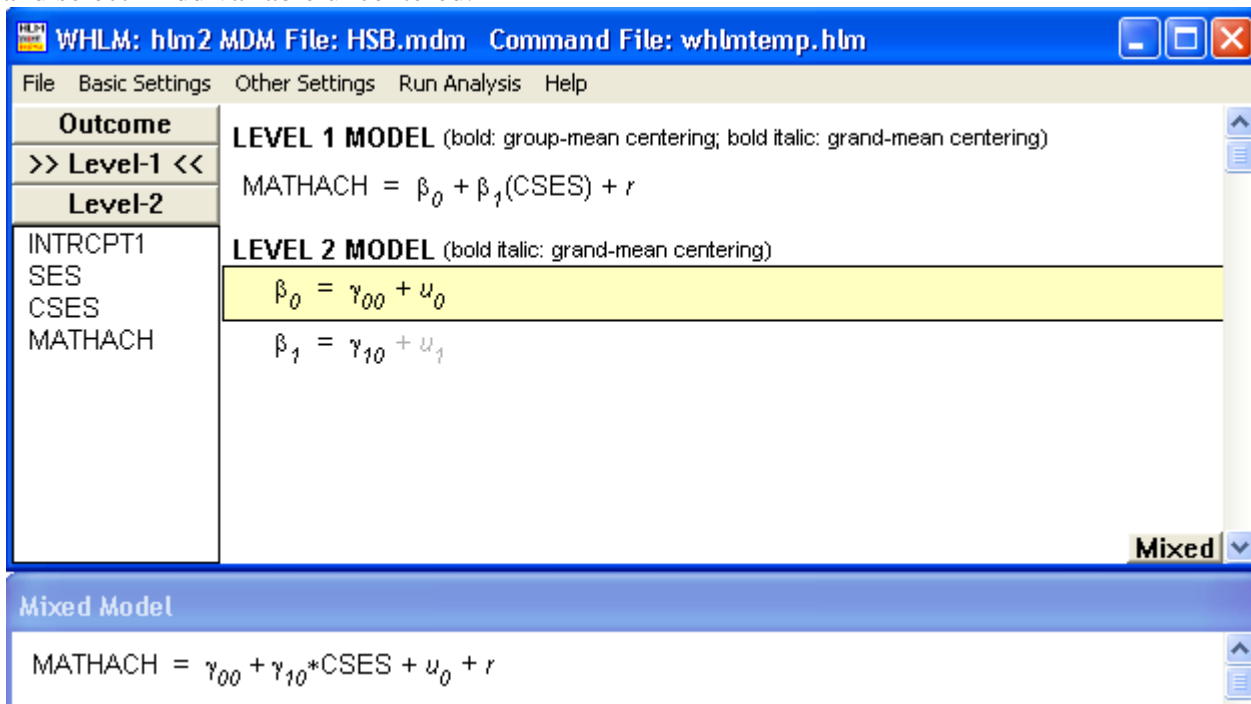
Random Effect		Standard Deviation	Variance Component	df	Chi-square	P-value
INTRCPT1, level-1,	U0	2.93501	8.61431	159	1660.23259	0.000
	R	6.25686	39.14831			

Statistics for current covariance components model

Deviance = 47116.793469
Number of estimated parameters = 2

Model 1

We will add the main effect for cses and run a random intercept model. To do this, we simply click on “cses” and select “Add variable uncentered.”



The screenshot shows the HLM software interface. The title bar reads "WHLM: hlm2 MDM File: HSB.mdm Command File: whlmtemp.hlm". The menu bar includes "File", "Basic Settings", "Other Settings", "Run Analysis", and "Help". On the left, a tree view shows the model structure: "Outcome" (selected), ">> Level-1 <<", "Level-2", "INTRCPT1", "SES", "CSES", and "MATHACH". The main window displays the following model specifications:

LEVEL 1 MODEL (bold: group-mean centering; bold italic: grand-mean centering)
 $MATHACH = \beta_0 + \beta_1(CSES) + r$

LEVEL 2 MODEL (bold italic: grand-mean centering)
 $\beta_0 = \gamma_{00} + u_0$
 $\beta_1 = \gamma_{10} + u_1$

The "Mixed" model type is selected at the bottom right. Below the main window, a "Mixed Model" section shows the overall equation: $MATHACH = \gamma_{00} + \gamma_{10}*CSES + u_0 + r$.

We can again click on “Run Analysis” and view the following output:

Summary of the model specified (in equation format)

Level-1 Model

$$Y = B0 + B1*(CSES) + R$$

Level-2 Model

$$B0 = G00 + U0$$

$$B1 = G10$$

Iterations stopped due to small change in likelihood function

***** ITERATION 4 *****

Sigma_squared = 37.01040

Tau

INTRCPT1,B0 8.67262

Tau (as correlations)

INTRCPT1,B0 1.000

Random level-1 coefficient Reliability estimate

INTRCPT1, B0 0.907

The value of the likelihood function at iteration 4 = -2.336108E+004

The outcome variable is MATHACH

Final estimation of fixed effects:

Fixed Effect	Coefficient	Standard Error	T-ratio	Approx. d.f.	P-value
For INTRCPT1, B0					
INTRCPT2, G00	12.649285	0.244505	51.734	159	0.000
For CSES slope, B1					
INTRCPT2, G10	2.191168	0.108655	20.166	7183	0.000

The outcome variable is MATHACH

Final estimation of fixed effects
(with robust standard errors)

Fixed Effect	Coefficient	Standard Error	T-ratio	Approx. d.f.	P-value
For INTRCPT1, B0					
INTRCPT2, G00	12.649285	0.243732	51.898	159	0.000
For CSES slope, B1					
INTRCPT2, G10	2.191168	0.129367	16.938	7183	0.000

Final estimation of variance components:

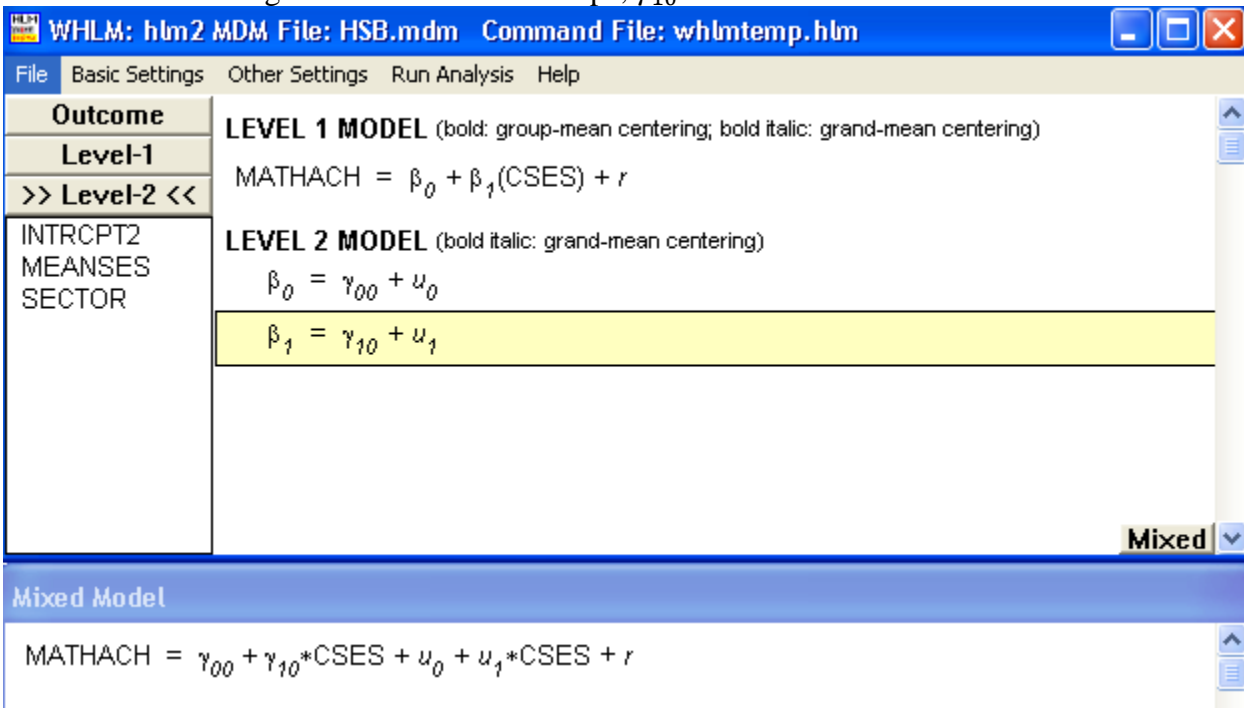
Random Effect		Standard Deviation	Variance Component	df	Chi-square	P-value
INTRCPT1, level-1,	U0	2.94493	8.67262	159	1756.20299	0.000
	R	6.08362	37.01040			

Statistics for current covariance components model

Deviance = 46722.159234
Number of estimated parameters = 2

Model 2

In Model 2, we add the random component to the slope of “cses.” To do this, simply click on the u_1 which is grayed-out in the Level-2 Model $\beta_1 = \gamma_{10} + u_1$. This will allow the slopes for each of the schools to have variation around the grand estimate for the slope, γ_{10} .



The screenshot shows the WHLM software interface. The title bar reads "WHLM: hlm2 MDM File: HSB.mdm Command File: whlmtemp.hlm". The menu bar includes "File", "Basic Settings", "Other Settings", "Run Analysis", and "Help". The main window is divided into two panes. The top pane, titled "Outcome", shows the "Level-2" model specification. The "Level-1" model is $MATHACH = \beta_0 + \beta_1(CSES) + r$. The "Level-2" model is $\beta_0 = \gamma_{00} + u_0$ and $\beta_1 = \gamma_{10} + u_1$. The u_1 term is highlighted in yellow. The bottom pane, titled "Mixed Model", shows the combined equation: $MATHACH = \gamma_{00} + \gamma_{10}*CSES + u_0 + u_1*CSES + r$. The "Mixed" dropdown menu is visible in the bottom right corner.

Again, clicking on “Run Analysis” will allow you to view this output:

Summary of the model specified (in equation format)

Level-1 Model

$$Y = B0 + B1*(CSES) + R$$

Level-2 Model

$$B0 = G00 + U0$$

$$B1 = G10 + U1$$

Iterations stopped due to small change in likelihood function

***** ITERATION 16 *****

Sigma_squared = 36.70357

Tau

INTRCPT1,B0 8.68155 0.05096

CSES,B1 0.05096 0.68031

Tau (as correlations)

INTRCPT1,B0 1.000 0.021

CSES,B1 0.021 1.000

Random level-1 coefficient Reliability estimate

INTRCPT1, B0 0.908

CSES, B1 0.260

The value of the likelihood function at iteration 16 = -2.335620E+004

The outcome variable is MATHACH

Final estimation of fixed effects:

Fixed Effect	Coefficient	Standard Error	T-ratio	Approx. d.f.	P-value
For INTRCPT1, B0 INTRCPT2, G00	12.649342	0.244512	51.733	159	0.000
For CSES slope, B1 INTRCPT2, G10	2.193154	0.127877	17.150	159	0.000

The outcome variable is MATHACH

Final estimation of fixed effects
(with robust standard errors)

Fixed Effect	Coefficient	Standard Error	T-ratio	Approx. d.f.	P-value
For INTRCPT1, B0 INTRCPT2, G00	12.649342	0.243747	51.895	159	0.000
For CSES slope, B1 INTRCPT2, G10	2.193154	0.127846	17.155	159	0.000

Final estimation of variance components:

Random Effect	Standard Deviation	Variance Component	df	Chi-square	P-value
INTRCPT1, U0	2.94645	8.68155	159	1770.72597	0.000
CSES slope, U1	0.82481	0.68031	159	213.43759	0.003
level-1, R	6.05835	36.70357			

Statistics for current covariance components model

Deviance = 46712.400281
Number of estimated parameters = 4

Model 3

For model 3, we are going to add “meanses” as both a main effect and a cross-level interaction effect with “cses.” To do this, first we must click on the “Level-2” button to view the variables at Level-2. With the first Level 2 equation highlighted (in yellow), click on “MEANSES” and select “add variable uncentered.” Then click on the second Level 2 equation ($\beta_1 = \gamma_{10} + u_1$) and click on “MEANSES” and select “add variable uncentered.” Doing so will produce the following:

The screenshot shows the HLM software interface. The title bar reads "WHLM: hlm2 MDM File: HSB.mdm Command File: whlmtemp.hlm". The menu bar includes "File", "Basic Settings", "Other Settings", "Run Analysis", and "Help". On the left, a sidebar lists "Outcome", "Level-1", and ">> Level-2 <<". The main window displays the Level-1 model: $MATHACH = \beta_0 + \beta_1(CSES) + r$. Below it, the Level-2 model is shown: $\beta_0 = \gamma_{00} + \gamma_{01}(MEANSES) + u_0$ and $\beta_1 = \gamma_{10} + \gamma_{11}(MEANSES) + u_1$. The second equation is highlighted in yellow. A "Mixed" dropdown menu is visible in the bottom right corner of the main window. Below the main window, a "Mixed Model" section shows the full equation: $MATHACH = \gamma_{00} + \gamma_{01}*MEANSES + \gamma_{10}*CSES + \gamma_{11}*MEANSES*CSES + u_0 + u_1*CSES + r$.

After clicking on “Run Analysis”, you can view the following output:

Summary of the model specified (in equation format)

Level-1 Model

$$Y = B0 + B1*(CSES) + R$$

Level-2 Model

$$B0 = G00 + G01*(MEANSES) + U0$$

$$B1 = G10 + G11*(MEANSES) + U1$$

Iterations stopped due to small change in likelihood function

***** ITERATION 18 *****

Sigma_squared = 36.71907

Tau

INTRCPT1,B0 2.69003 -0.25854

CSES,B1 -0.25854 0.66759

Tau (as correlations)

INTRCPT1,B0 1.000 -0.193

CSES,B1 -0.193 1.000

Random level-1 coefficient Reliability estimate

INTRCPT1, B0 0.756

The value of the likelihood function at iteration 18 = -2.327773E+004

The outcome variable is MATHACH

Final estimation of fixed effects:

Fixed Effect	Coefficient	Standard Error	T-ratio	Approx. d.f.	P-value
For INTRCPT1, B0					
INTRCPT2, G00	12.658605	0.149174	84.858	158	0.000
MEANSES, G01	5.870504	0.361214	16.252	158	0.000
For CSES slope, B1					
INTRCPT2, G10	2.196036	0.127647	17.204	158	0.000
MEANSES, G11	0.285613	0.317942	0.898	158	0.371

The outcome variable is MATHACH

Final estimation of fixed effects
(with robust standard errors)

Fixed Effect	Coefficient	Standard Error	T-ratio	Approx. d.f.	P-value
For INTRCPT1, B0					
INTRCPT2, G00	12.658605	0.148266	85.378	158	0.000
MEANSES, G01	5.870504	0.319867	18.353	158	0.000
For CSES slope, B1					
INTRCPT2, G10	2.196036	0.125277	17.529	158	0.000
MEANSES, G11	0.285613	0.354129	0.807	158	0.421

Final estimation of variance components:

Random Effect	Standard Deviation	Variance Component	df	Chi-square	P-value
INTRCPT1, U0	1.64013	2.69003	158	675.03675	0.000
CSES slope, U1	0.81706	0.66759	158	211.94878	0.003
level-1, R	6.05963	36.71907			

Statistics for current covariance components model

Deviance = 46555.465626
 Number of estimated parameters = 4

Model 4

The steps for adding “sector”, are the same as the steps for adding “meanses.” Simple click on each of the Level 2 equations and select “add variable uncentered” for the “sector” variable. Doing so will produce the following:

WHLM: hlm2 MDM File: HSB.mdm Command File: whltemp.hlm

File Basic Settings Other Settings Run Analysis Help

Outcome

Level-1

>> **Level-2** <<

INTRCPT2
MEANSES
SECTOR

LEVEL 1 MODEL (bold: group-mean centering; bold italic: grand-mean centering)

$$\text{MATHACH} = \beta_0 + \beta_1(\text{CSES}) + r$$

LEVEL 2 MODEL (bold italic: grand-mean centering)

$$\beta_0 = \gamma_{00} + \gamma_{01}(\text{MEANSES}) + \gamma_{02}(\text{SECTOR}) + u_0$$

$$\beta_1 = \gamma_{10} + \gamma_{11}(\text{MEANSES}) + \gamma_{12}(\text{SECTOR}) + u_1$$

Mixed

Mixed Model

$$\text{MATHACH} = \gamma_{00} + \gamma_{01} * \text{MEANSES} + \gamma_{02} * \text{SECTOR} + \gamma_{10} * \text{CSES} + \gamma_{11} * \text{MEANSES} * \text{CSES} + \gamma_{12} * \text{SECTOR} * \text{CSES} + u_0 + u_1 * \text{CSES} + r$$

With the following output:

Summary of the model specified (in equation format)

Level-1 Model

$$Y = B0 + B1 * (\text{CSES}) + R$$

Level-2 Model

$$B0 = G00 + G01 * (\text{MEANSES}) + G02 * (\text{SECTOR}) + U0$$

$$B1 = G10 + G11 * (\text{MEANSES}) + G12 * (\text{SECTOR}) + U1$$

Iterations stopped due to small change in likelihood function

***** ITERATION 126 *****

Sigma_squared = 36.70311

Tau

INTRCPT1,B0	2.38231	0.19146
CSES,B1	0.19146	0.14898

Tau (as correlations)

INTRCPT1,B0	1.000	0.321
CSES,B1	0.321	1.000

Random level-1 coefficient	Reliability estimate
INTRCPT1, B0	0.733
CSES, B1	0.073

The value of the likelihood function at iteration 126 = -2.325094E+004

The outcome variable is MATHACH

Final estimation of fixed effects:

Fixed Effect	Coefficient	Standard Error	T-ratio	Approx. d.f.	P-value
For INTRCPT1, B0					
INTRCPT2, G00	12.113588	0.198807	60.931	157	0.000
MEANSES, G01	5.339249	0.369301	14.458	157	0.000
SECTOR, G02	1.216614	0.306388	3.971	157	0.000
For CSES slope, B1					
INTRCPT2, G10	2.937961	0.157138	18.697	157	0.000
MEANSES, G11	1.034384	0.302572	3.419	157	0.001
SECTOR, G12	-1.640920	0.242910	-6.755	157	0.000

The outcome variable is MATHACH

Final estimation of fixed effects
(with robust standard errors)

Fixed Effect	Coefficient	Standard Error	T-ratio	Approx. d.f.	P-value
For INTRCPT1, B0					
INTRCPT2, G00	12.113588	0.173871	69.670	157	0.000
MEANSES, G01	5.339249	0.334790	15.948	157	0.000
SECTOR, G02	1.216614	0.308406	3.945	157	0.000
For CSES slope, B1					
INTRCPT2, G10	2.937961	0.147625	19.902	157	0.000
MEANSES, G11	1.034384	0.332805	3.108	157	0.003
SECTOR, G12	-1.640920	0.237407	-6.912	157	0.000

Final estimation of variance components:

Random Effect	Standard Deviation	Variance Component	df	Chi-square	P-value
INTRCPT1, U0	1.54347	2.38231	157	605.69063	0.000
CSES slope, U1	0.38599	0.14898	157	162.30877	0.369
level-1, R	6.05831	36.70311			

Statistics for current covariance components model

Deviance = 46501.879303
Number of estimated parameters = 4