Multilevel SEM analysis with structured means

In this example, we consider a multilevel SEM analysis with structured means. The between-schools model is a one factor CFA model with a fixed factor variance, a latent mean, equal intercepts and equal measurement error covariances while the within-schools model is a one factor CFA model with equal measurement error covariances.

The dataset **maths.lsf** is based on a longitudinal study and consists of data from 1721 students nested within 55 schools. This dataset is based on the datasets eg1.sav, eg2.sav and eg3.sav described in Chapter 4 of Raudenbush, S, Bryk, A, Cheong, Y.F. & Congdon, R (2001).

The following variables are available:

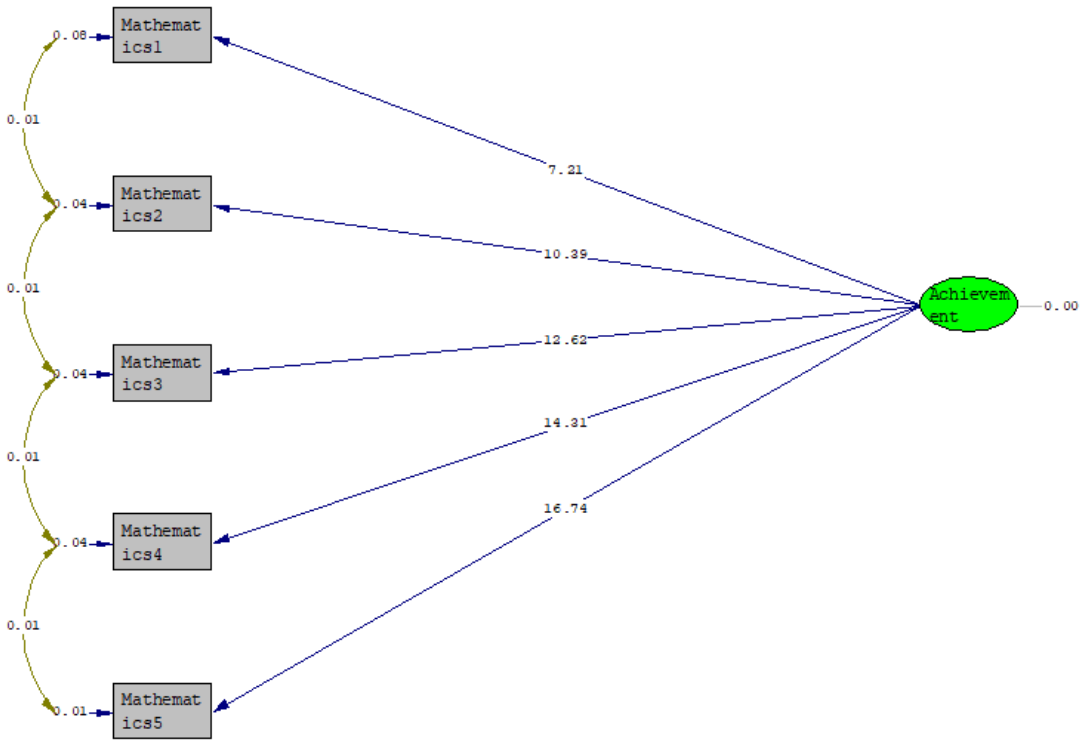
- SchoolID Cluster (level 2) ID
- ChildID Student number
- Retained 1 If retained in the same grade at least once
- 'Maths score 1' Score in IRT metric on mathematics test on first measurement occasion
- 'Maths score 2' Score in IRT metric on mathematics test on second measurement occasion
- 'Maths score 3' Score in IRT metric on mathematics test on third measurement occasion
- 'Maths score 4' Score in IRT metric on mathematics test on fourth measurement occasion
- 'Maths score 5' Score in IRT metric on mathematics test on fifth measurement occasion
- Gender 1 if female, 0 if male
- 'Ethnicity 1' 1 if African American, 0= other
- 'Ethnicity 2' 1 if Hispanic, 0= other
- Size School level variable, number of students in school
- 'Low Income' School level variable, percent of students from low income families
- Mobility School level variable, percent of students moving during academic year

The model to be fitted is described in the syntax file **math_trend3a_16.lis**.

```
!     STRUCTURED MEANS
! In this example, we specify equal non-random intercepts and a latent mean for the one
! factor CFA model between schools (eq tx(5) tx(4) tx(3) tx(2) tx(1); ka=fr).
TI
DA NI=14 NO=0 NG=2 MA=CM MI=-9
RA FI=maths_16.lsf
$CLUSTER  SchoolID
SE
4 5 6 7 8 /
mo nx=5 nk=1 tx=fr lx=fu,fr td=sy,fi ka=fr ph=sy,fi
lk
```

```
Achieve
va 0.001 ph(1,1)
eq tx(5) tx(4) tx(3) tx(2) tx(1)
fr td(1,1) td(2,2) td(3,3) td(4,4) td(5,5)
fr td(2,1) td(3,2) td(4,3) td(5,4)
eq td(2,1) td(3,2) td(4,3) td(5,4)
pd
ou
Group2 : Within Schools
DA NI=14 NO=0 NG=2 MA=CM MI=-9
RA FI=maths_16.LSF
SE
4 5 6 7 8 /
mo nx=5 nk=1 tx=fi lx=fu,fr td=sy,fi ka=fi  ph=sy,fr
lk
Achieve
va 0.0 ka(1)
va 0.0 tx(5) tx(4) tx(3) tx(2) tx(1)
fi lx(1,1)
va 1.0 lx(1,1)
fr td(1,1) td(2,2) td(3,3) td(4,4) td(5,5)
fr td(2,1) td(3,2) td(4,3) td(5,4)
eq td(2,1) td(3,2) td(4,3) td(5,4)
OU ND=3 MI
```

The path diagram for this model is shown below, followed by selected output.



From the estimated lambdas it appears that the difference in estimates is not linear as these estimates increase monotonically. This would indicate that a linear growth curve model over the period during which measurements were made would probably be more appropriate if we wanted to fit a regression model to these data. The fit statistics given above indicate that the model provides an adequate description of the data.

A section of the output is given below.

Covariance Matrix

	Mathematics1	Mathematics2	Mathematics3	Mathematics4	Mathematics5
Mathematics1	0.138				
Mathematics2	0.090	0.133			
Mathematics3	0.127	0.161	0.251		
Mathematics4	0.123	0.158	0.250	0.290	
Mathematics5	0.123	0.170	0.246	0.281	0.300

Total Variance = 1.113 Generalized Variance = 0.433105D-06

Largest Eigenvalue = 0.970 Smallest Eigenvalue = 0.007

Condition Number = 11.793

Means

Mathematics1	Mathematics2	Mathematics3	Mathematics4	Mathematics5
-1.976	-0.929	-0.198	0.356	1.160

Group2 : Within Schools

Covariance Matrix

	Mathematics1	Mathematics2	Mathematics3	Mathematics4	Mathematics5
Mathematics1	0.774				
Mathematics2	0.510	0.875			
Mathematics3	0.610	0.781	1.263		
Mathematics4	0.566	0.701	0.930	1.063	
Mathematics5	0.527	0.668	0.863	0.881	1.035

Total Variance = 5.010 Generalized Variance = 0.0194

Largest Eigenvalue = 3.891 Smallest Eigenvalue = 0.160

Condition Number = 4.930

LISREL Estimates (Maximum Likelihood)

LAMBDA-X

	Achievement
Mathematics1	7.205
	(1.792)
	4.021
Mathematics2	10.386
	(1.670)
	6.219
Mathematics3	12.624
	(1.754)
	7.197
Mathematics4	14.306

(1.894)
7.552

Mathematics5 16.740
(2.190)
7.642

Group2 : Within Schools
Number of Iterations = 54

LISREL Estimates (Maximum Likelihood)

LAMBDA-X

	Achievement
Mathematics1	1.000
Mathematics2	1.233
	(0.055)
	22.400
Mathematics3	1.583
	(0.071)
	22.162
Mathematics4	1.519
	(0.066)
	23.044
Mathematics5	1.458
	(0.064)
	22.618

PHI

	Achievement
	0.375
	(0.035)
	10.794