Advanced Secondary Analysis of Large-scale Assessments in Education:

A Discussion of Methods

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Outline

Brief theoretical foundations

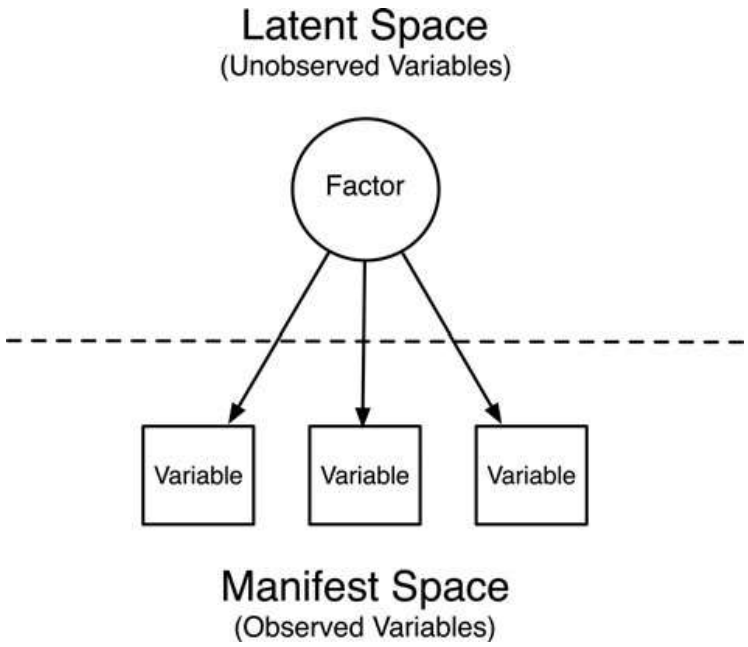
CFA Estimation: example

SEM estimation: example

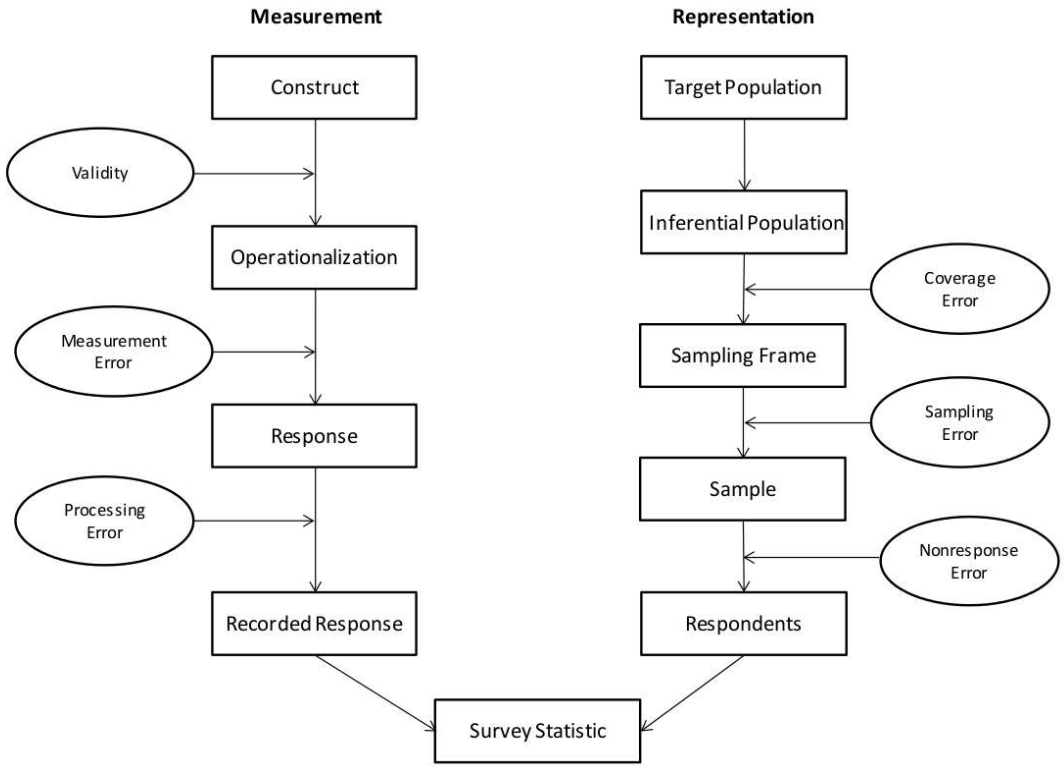
Brief theoretical foundations

Measurement in social sciences

- A hughe number of constructs, concepts, and attributes are considered as latent
- The less measurement error, the better instrument



Total error: sources of error



Latent variables

- Indirectly observed: hipothetical
- Could be infered from observed indicators (e.g. items)
- Multiple indicators that covariates, could be intepreted as common factor

Latent variables

- Clasical Test Theory (simplified):

$$X = T + E$$

$$\sigma_x^2 = \sigma_t^2 + \sigma_e^2$$

- Existence of multiple indicators allows to differentiate:

common variance

$$\sigma_t^2$$

and unique variance

$$\sigma_e^2$$

Factor Analysis

- Set of methods oriented to explain the correlation among variables which could be interpreted as latent variables or factors
- The existence of a common factor explain the association among indicators
- Conditional dependency: the correlations would be 0 if partialize the factor.

Purpose

- To reduce complexity and increse comprehension
- To validate scales in terms of the measured construct
- To separate the common variance from unique variance

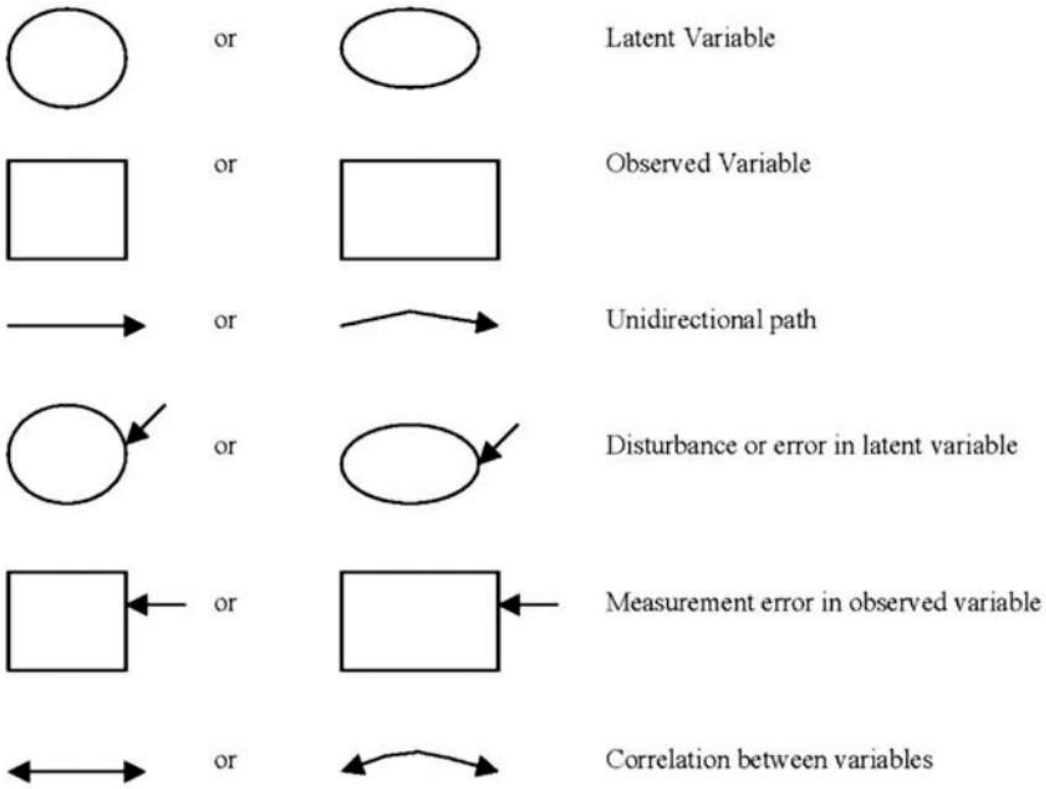
General fuoundations

- Covariance, correlation and partial correlation
- Simple and multiple regression
- In general, could consider similar assumptions than in linear regression

Assumptions

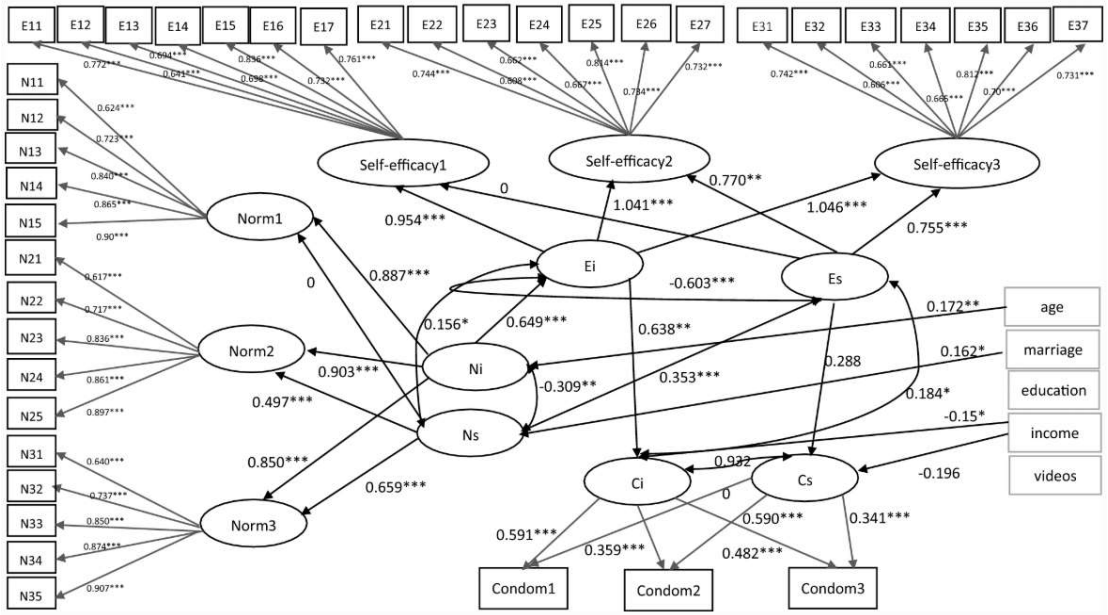
- Intervalar measurment level
- Normality
- Linear relationship among variables
- Correlations must have certain level for its agrupation
- Sample size: >200 cases or between 5-10 for each variable (rule of thumb)

Diagrams for representation



¿Parsimony?

From: Mediation Analysis of Peer Norms, Self-Efficacy, and Condom Use Among Chinese Men Who Have Sex with Men: A Parallel Process Latent Growth Curve Model

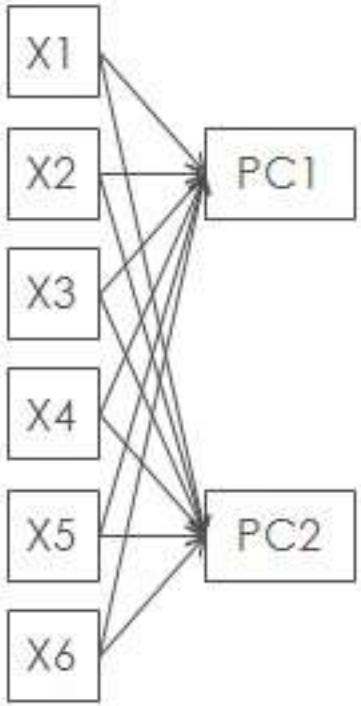


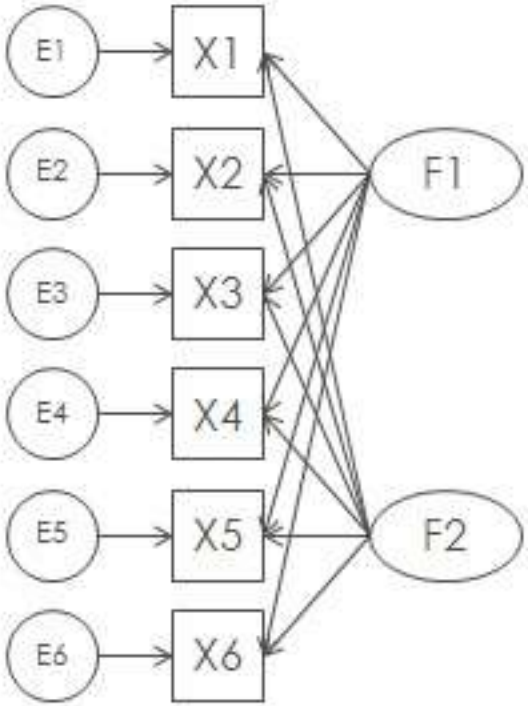
Structural model of parallel process latent growth curve modeling among peer norms, self-efficacy and condom use with covariates among online high-risk MSM in China, 2015 (n = 804). *Note* $^{*}p < .05$; $^{**}p < .01$; $^{***}p < .001$. All of the regression coefficients presented in the figure were significant at the 95% confident intervals. The model fit indexes were RMSEA = 0.046, 90% CI (0.044, 0.048), CFI = 0.956, TLI = 0.955. Ni is the latent intercept factor of peer norms. Ns is the latent slope growth factor of peer norms. Ei is the latent intercept factor of self-efficacy. Es is the latent slope growth factor of self-efficacy.

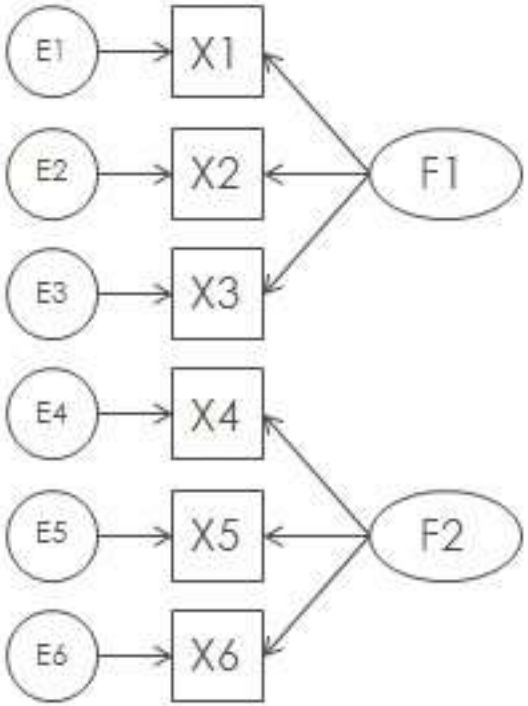
Three methods for measurement evaluations

- Principal component analyses: definition of component from a linear combination of variables
- Exploratory factor analyses: descriptive thecnique which allow to determine a number of latent factors from a set of indicators, separating common and unique variance
- **Confirmatory Factor Analyses**: techinque which allow hipothetize (and confirm) a latent variable, specifing a set of parameters

Three methods for measurement evaluations

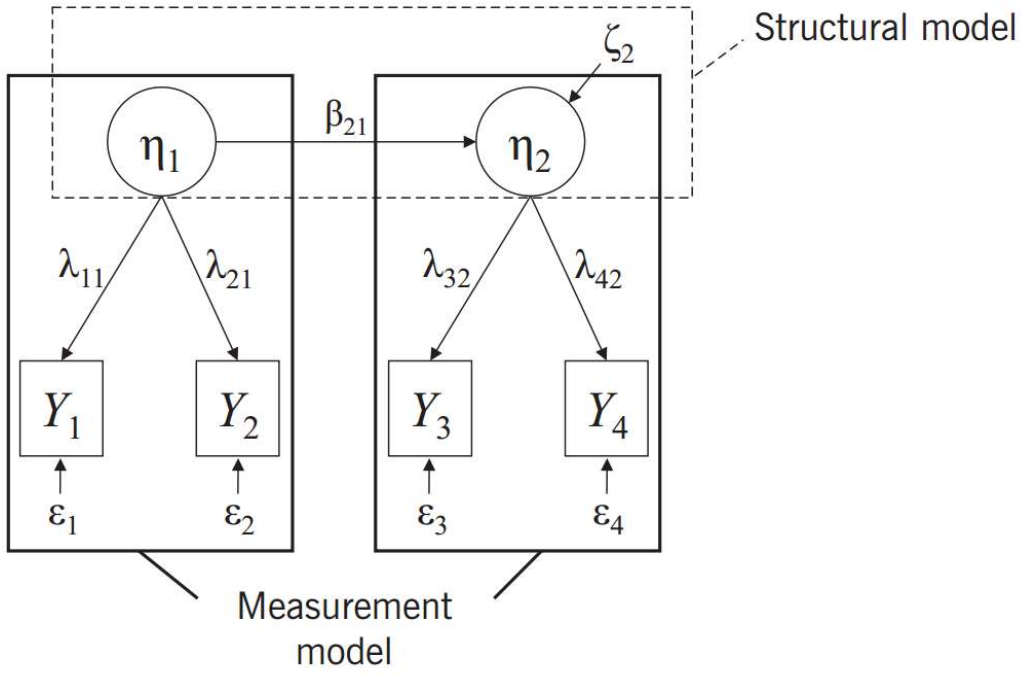




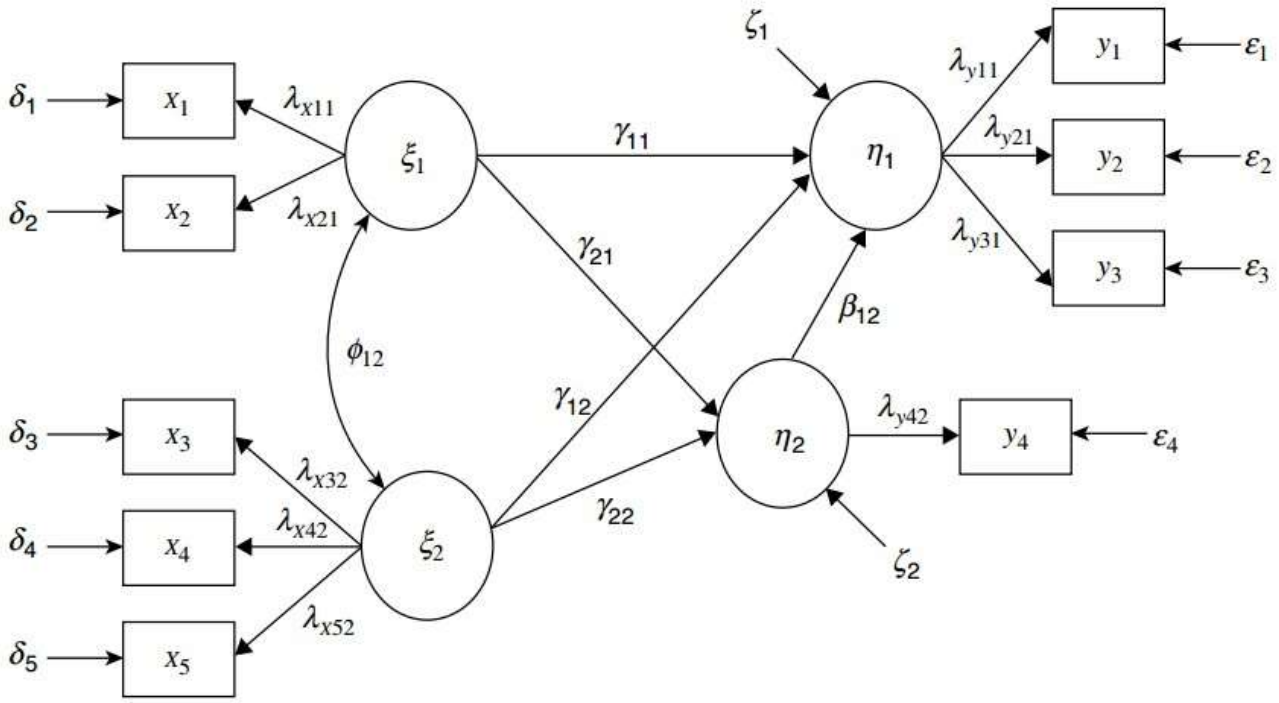


Beyond measurement model: SEM

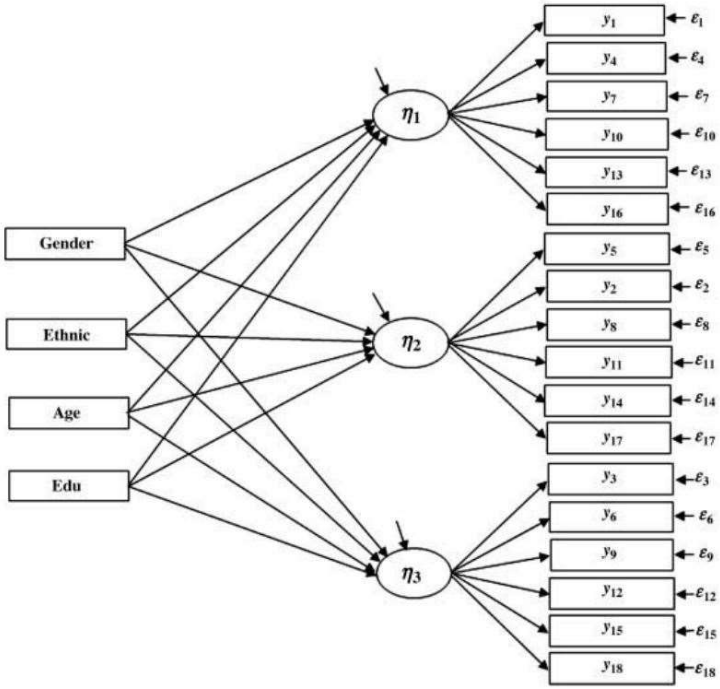
- SEM allow to estimate models that include measurement and structural relations



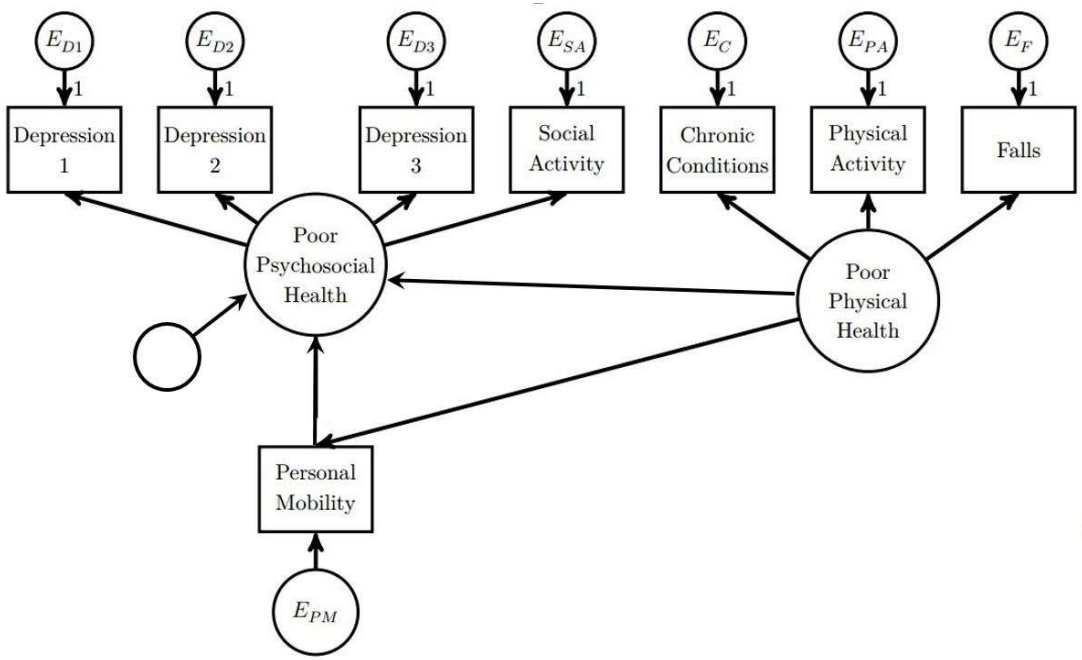
Structural regressions between latent variables



Regressions between latent on observed variables (MIMIC)



Regressions between observed on latent variables



Regressions between observed variables

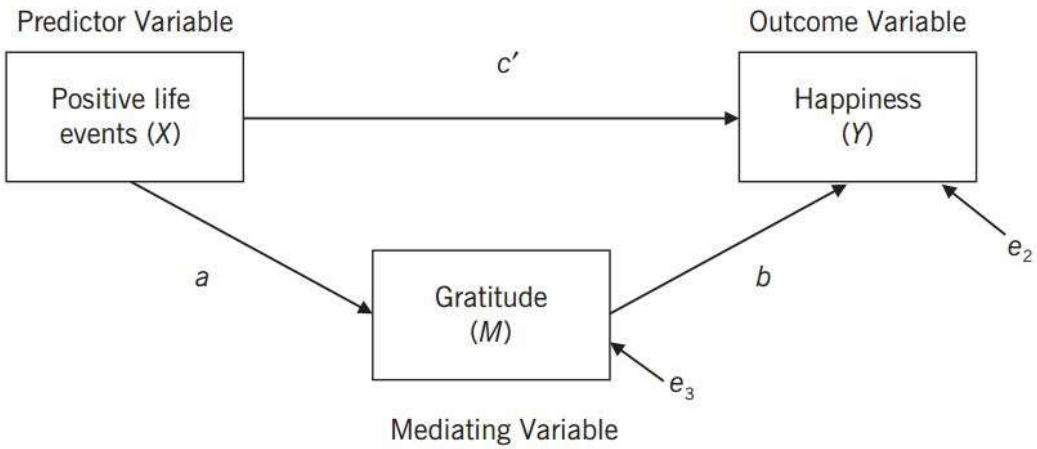


FIGURE 3.3. Second model with statistical notation.

Estimation process of CFA and SEM

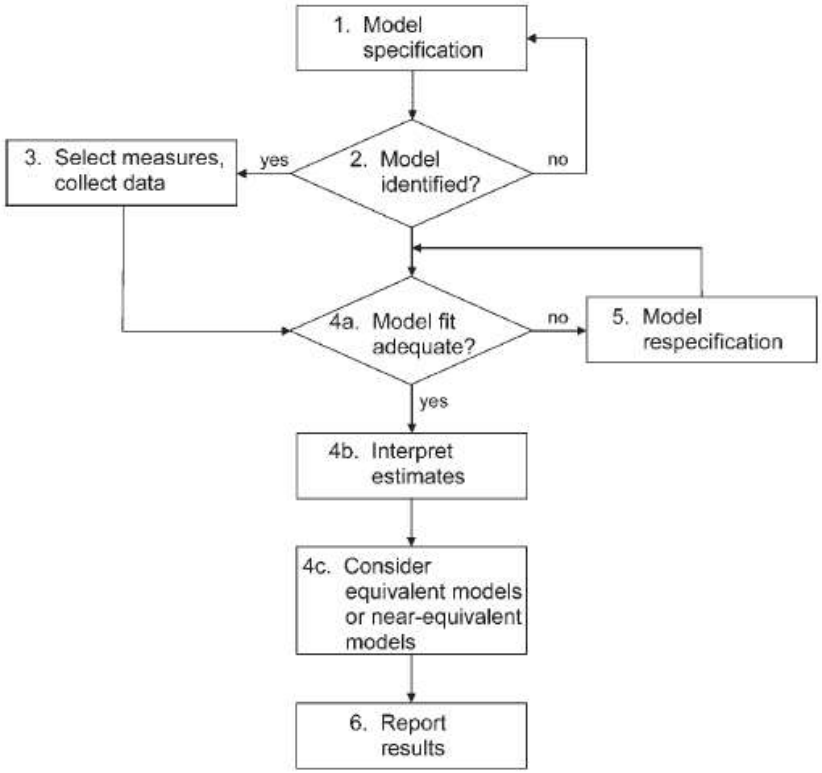


FIGURE 5.1. Flowchart of the basic steps of SEM.

Step by step

- Specification and identification
- Estimation
- Fit interpretation
- Report

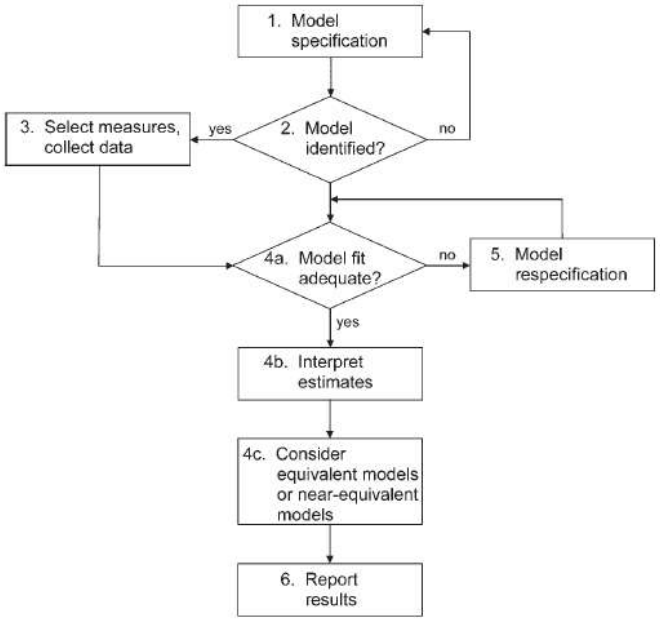
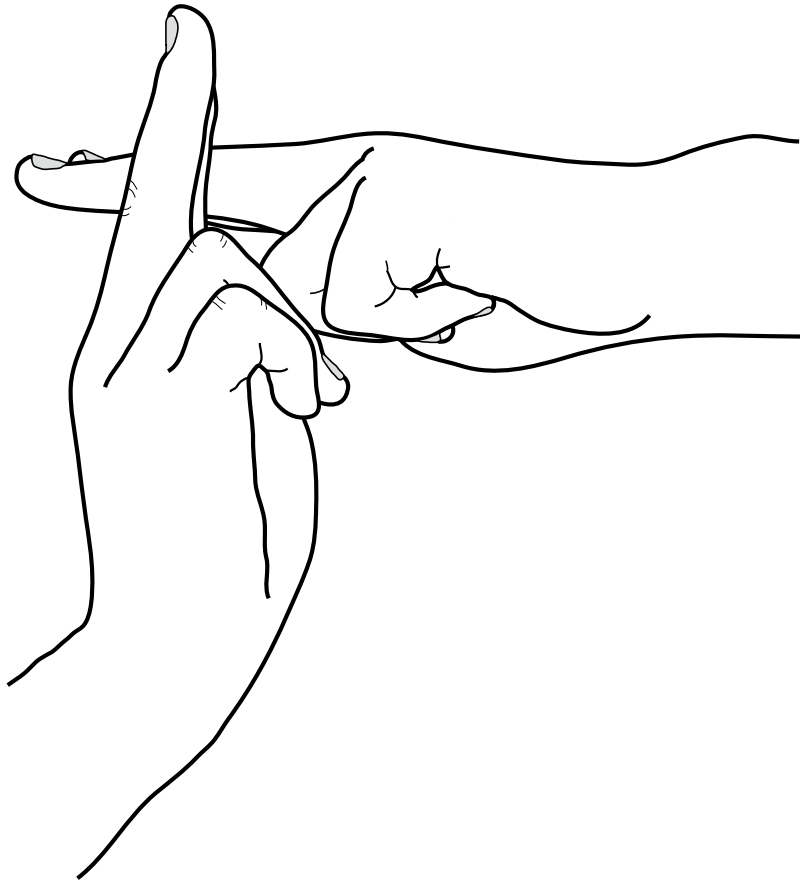
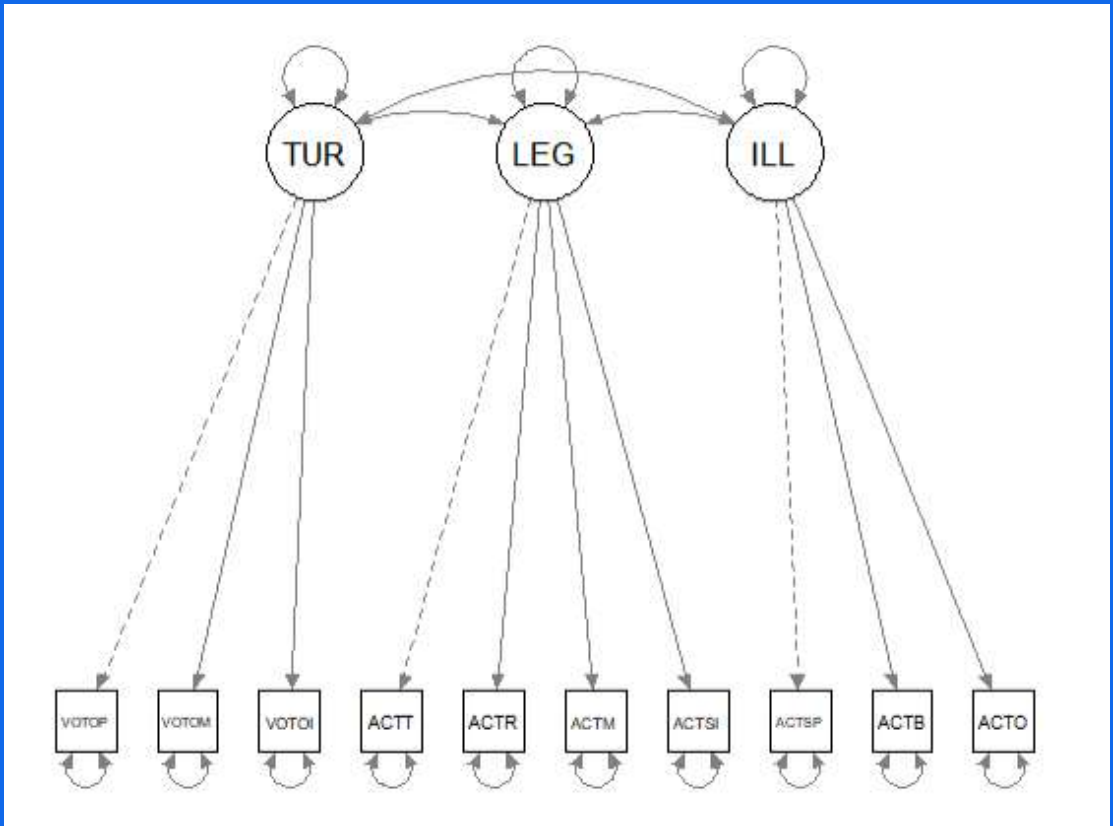


FIGURE 5.1. Flowchart of the basic steps of SEM.

Hands on!



CFA example


TUR
LEG
ILL
VOTOP
VOTOM
VOTOI
ACTT
ACTR
ACTM
ACTSI
ACTSP
ACTB
ACTO

Measurement model: Political participation using ICCS 2016 (Italy)

- Fornal participation

Q31 Listed below are different ways adults can take an active part in society.
When you are an adult, what do you think you will do?

(Please tick only one box in each row.)

		I would certainly do this	I would probably do this	I would probably not do this	I would certainly not do this
IS3G31A	a) Vote in <local elections>	☐ 1	☐ 2	☐ 3	☐ 4
IS3G31B	b) Vote in <national elections>	☐ 1	☐ 2	☐ 3	☐ 4
IS3G31C	c) Get information about candidates before voting in an election	☐ 1	☐ 2	☐ 3	☐ 4

Measurement model: Political participation using ICCS 2016 (Italy)

- Activist participation (legal and Illegal)

Q30 There are many different ways how citizens may express their opinions about important issues in society.

Would you take part in any of the following activities to express your opinion in the future?

(Please tick only one box in each row.)

			I would certainly do this	*I would probably do this*	*I would probably not do this*	*I would certainly not do this*
IS3G30A	a)	Talk to others about your views on political or social issues	☐ 1	☐ 2	☐ 3	☐ 4
IS3G30B	b)	Contact an <elected representative>	☐ 1	☐ 2	☐ 3	☐ 4
IS3G30C	c)	Take part in a peaceful march or rally	☐ 1	☐ 2	☐ 3	☐ 4
IS3G30D	d)	Collect signatures for a petition	☐ 1	☐ 2	☐ 3	☐ 4
IS3G30E	e)	Contribute to an online discussion forum about social or political issues	☐ 1	☐ 2	☐ 3	☐ 4
IS3G30F	f)	Organize an online group to take a stance on a controversial political or social issue	☐ 1	☐ 2	☐ 3	☐ 4
IS3G30G	g)	Participate in an online campaign	☐ 1	☐ 2	☐ 3	☐ 4
IS3G30H	h)	Choose to buy certain products in support of social justice (e.g. <fair trade goods>, <ethically sourced products>)	☐ 1	☐ 2	☐ 3	☐ 4
IS3G30I	i)	Spray-paint protest slogans on walls	☐ 1	☐ 2	☐ 3	☐ 4
IS3G30J	j)	Stage a protest by blocking traffic	☐ 1	☐ 2	☐ 3	☐ 4
IS3G30K	k)	Occupy public buildings as a sign of protest	☐ 1	☐ 2	☐ 3	☐ 4

Read data

```
pacman::p_load(dplyr, stargazer, skimr, xaringan, srvyr, lme4, broom, texreg, scales, plotly, desctable, descriptr, forcats, GGally, MplusAutomation, semPlot, corrplot)


load("./data/mergeita16.Rdata")
names(mergeita16)
```

```
 [1] "idcntry"      "country"      "idschool_scr" "idclass_scr"  "idstud_scr"
 [6] "sidi_invalsi" "totwgts"      "wgtfac1"      "wgtadj1s"     "wgtfac2s"
[11] "wgtadj2s"     "wgtadj3s"     "jkzones"      "jkreps"       "pv1civ"
[16] "pv2civ"       "pv3civ"       "pv4civ"       "pv5civ"       "s_gender"
[21] "s_cntatt"     "s_abuse"      "s_civlrn"     "s_geneql"     "s_ethrght"
[26] "univ"         "s_poldisc"    "s_hisced"     "s_homlit"     "s_immig"
[31] "s_sint"       "s_citcon"     "s_citeff"     "s_citresp"    "s_citsoc"
[36] "s_opdisc"     "s_socmed"     "s_intrust"    "formal"       "activ"
[41] "illegal"      "s_elecpart"   "s_polpart"    "s_compart"    "s_schpart"
[46] "s_legact"     "s_illact"     "actspray"     "actblock"     "actocup"
[51] "acttalk"      "actrep"       "actmarch"     "actsign"      "votopre"
[56] "votomun"      "votoinf"      "wle_ita"      "wle_ita_200"  "ital"
[61] "prov"
```

```
desc= mergeita16 %>%
  select(actspray, actblock, actocup, acttalk, actrep, actmarch, actsign, votopre, votomun, votoinf)
stargazer(desc,title="Descriptive Statistics", type = "text")
```

```
Descriptive Statistics
=============================================================
Statistic   N   Mean  St. Dev.  Min  Pctl(25) Pctl(75)  Max
-------------------------------------------------------------
actspray  3,373 1.746  0.925   1.000  1.000    2.000   4.000
actblock  3,376 1.646  0.832   1.000  1.000    2.000   4.000
actocup   3,378 1.651  0.849   1.000  1.000    2.000   4.000
acttalk   3,390 2.791  0.835   1.000  2.000    3.000   4.000
actrep    3,369 2.207  0.750   1.000  2.000    3.000   4.000
actmarch  3,359 2.557  0.826   1.000  2.000    3.000   4.000
actsign   3,378 2.649  0.830   1.000  2.000    3.000   4.000
votopre   3,386 3.525  0.705   1.000  3.000    4.000   4.000
votomun   3,382 3.471  0.739   1.000  3.000    4.000   4.000
votoinf   3,356 3.515  0.735   1.000  3.000    4.000   4.000
-------------------------------------------------------------
```

Explore correlations

```
corMat  <- cor(desc, use = "pairwise.complete.obs")  # estimar matriz pearson
options(digits=3) # decimales
print(corMat)
```

```
         actspray actblock actocup acttalk actrep actmarch actsign votopre
actspray  1.00000   0.5914  0.5707 0.00814  0.120   0.0604  0.0768 -0.1049
actblock  0.59139   1.0000  0.7162 0.06033  0.220   0.1459  0.1599 -0.0687
actocup   0.57067   0.7162  1.0000 0.05204  0.193   0.1397  0.1565 -0.0632
acttalk   0.00814   0.0603  0.0520 1.00000  0.476   0.2788  0.3475  0.2681
actrep    0.12045   0.2199  0.1935 0.47626  1.000   0.3202  0.3503  0.1679
actmarch  0.06043   0.1459  0.1397 0.27885  0.320   1.0000  0.4873  0.1899
actsign   0.07682   0.1599  0.1565 0.34753  0.350   0.4873  1.0000  0.2094
votopre  -0.10486  -0.0687 -0.0632 0.26807  0.168   0.1899  0.2094  1.0000
votomun  -0.14988  -0.0837 -0.0853 0.24220  0.157   0.1853  0.2046  0.7562
votoinf  -0.12834  -0.1056 -0.0871 0.21644  0.113   0.2067  0.2049  0.5173
         votomun votoinf
actspray -0.1499 -0.1283
actblock -0.0837 -0.1056
actocup  -0.0853 -0.0871
acttalk   0.2422  0.2164
actrep    0.1571  0.1127
actmarch  0.1853  0.2067
actsign   0.2046  0.2049
votopre   0.7562  0.5173
votomun   1.0000  0.5505
votoinf   0.5505  1.0000
```

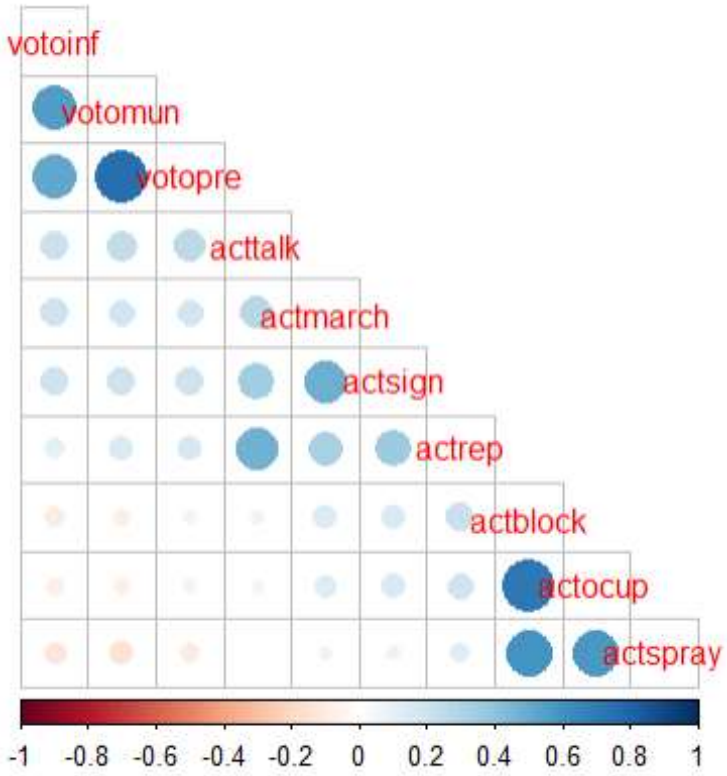
Explore correlations

```
stargazer(corMat, title="correlaciones", type = "text") #Latex table
```

```
correlaciones
================================================================================================
         actspray actblock actocup acttalk actrep actmarch actsign votopre votomun votoinf
------------------------------------------------------------------------------------------------
actspray    1      0.591    0.571   0.008  0.120   0.060    0.077  -0.105  -0.150  -0.128
actblock  0.591      1      0.716   0.060  0.220   0.146    0.160  -0.069  -0.084  -0.106
actocup   0.571    0.716      1     0.052  0.193   0.140    0.156  -0.063  -0.085  -0.087
acttalk   0.008    0.060    0.052     1    0.476   0.279    0.348   0.268   0.242   0.216
actrep    0.120    0.220    0.193   0.476    1     0.320    0.350   0.168   0.157   0.113
actmarch  0.060    0.146    0.140   0.279  0.320     1      0.487   0.190   0.185   0.207
actsign   0.077    0.160    0.156   0.348  0.350   0.487      1     0.209   0.205   0.205
votopre   -0.105   -0.069  -0.063   0.268  0.168   0.190    0.209     1     0.756   0.517
votomun   -0.150   -0.084  -0.085   0.242  0.157   0.185    0.205   0.756     1     0.550
votoinf   -0.128   -0.106  -0.087   0.216  0.113   0.207    0.205   0.517   0.550     1
------------------------------------------------------------------------------------------------
```

Explore correlations

```
corrplot(corMat, type="lower",
         order="AOE", cl.pos="b", tl.pos="d") #agrega nombres en diag.
```



Model specification

- Mplus Syntax

```
m4 <- mplusObject(
  TITLE = "CFA;",
  VARIABLE="
  cluster = idschool_scr;
  Stratification = jkzones;
  Weight = totwgts;",
  ANALYSIS=
    "type = complex;",

  MODEL = "
   turnout BY votopre votomun votoinf;
   leg BY acttalk actrep actmarch actsign;
   ill BY actspray actblock actocup;
  "
  ,
  OUTPUT = "CINTERVAL sampstat mod stdyx;",
  rdata = mergeita16)
```

- Generate input and output files

```
fit4 <- mplusModeler(m4, modelout = "m4.inp", run = 1L)
```

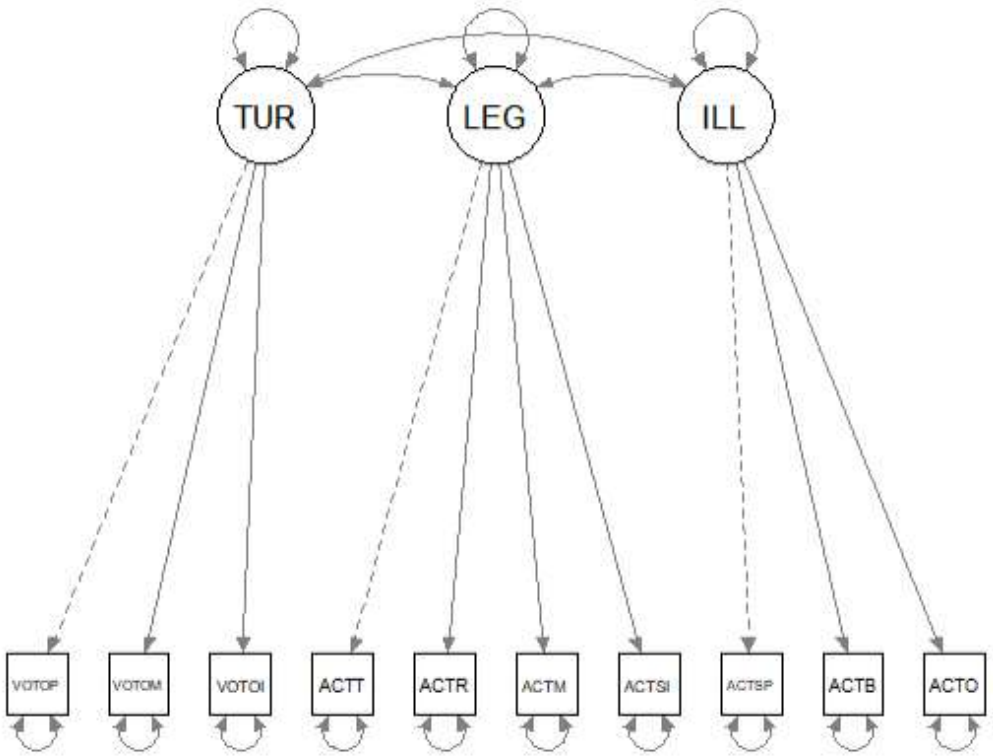
Model specification

- Mplus Syntax

```
TITLE: CFA;
DATA:
FILE = "m4_aa695dd1a4ce4e5cf60735b5179bb330.dat";

VARIABLE:
NAMES = idschool_scr totwgts jkzones actspray actblock actocup acttalk actrep
     actmarch actsign votopre votomun votoinf;
 MISSING=.;

  cluster = idschool_scr;
  Stratification = jkzones;
  Weight = totwgts;

ANALYSIS:
type = complex;

MODEL:

   turnout BY votopre votomun votoinf;
   leg BY acttalk actrep actmarch actsign;
   ill BY actspray actblock actocup;

OUTPUT:
CINTERVAL sampstat mod stdyx;
```

Model specification

```
semPaths("./m4.out", intercepts = FALSE, rotation=2)
```



Model results

UNIVARIATE HIGHER-ORDER MOMENT DESCRIPTIVE STATISTICS

Variable/ Sample Size	Mean/ Variance	Skewness/ Kurtosis	Minimum/ Maximum	% with Min/Max	Percentiles 20%/60%	40%/80%	Median
ACTSPRAY	1.750	1.016	1.000	52.24%	1.000	1.000	1.000
3373.000	0.865	-0.030	4.000	6.52%	2.000	3.000	
ACTBLOCK	1.649	1.212	1.000	54.03%	1.000	1.000	1.000
3376.000	0.696	0.785	4.000	4.56%	2.000	2.000	
ACTOCUP	1.651	1.198	1.000	54.77%	1.000	1.000	1.000
3378.000	0.719	0.653	4.000	4.77%	2.000	2.000	
ACTTALK	2.786	-0.301	1.000	6.96%	2.000	3.000	3.000
3390.000	0.698	-0.458	4.000	19.62%	3.000	3.000	
ACTREP	2.207	0.320	1.000	15.11%	2.000	2.000	2.000
3369.000	0.564	-0.098	4.000	4.81%	2.000	3.000	
ACTMARCH	2.553	-0.016	1.000	9.32%	2.000	2.000	3.000
3359.000	0.683	-0.550	4.000	12.44%	3.000	3.000	
ACTSIGN	2.649	-0.165	1.000	8.56%	2.000	2.000	3.000
3378.000	0.688	-0.514	4.000	14.48%	3.000	3.000	
VOTOPRE	3.519	-1.535	1.000	2.30%	3.000	4.000	4.000
3386.000	0.503	2.185	4.000	62.64%	4.000	4.000	
VOTOMUN	3.466	-1.364	1.000	2.54%	3.000	3.000	4.000
3382.000	0.548	1.466	4.000	59.40%	4.000	4.000	
VOTOINF	3.511	-1.515	1.000	2.50%	3.000	4.000	4.000
3356.000	0.542	1.853	4.000	63.50%	4.000	4.000	

Model results: fit indexes

```
MODEL FIT INFORMATION

Number of Free Parameters                       33

Chi-Square Test of Model Fit

          Value                            407.838*
          Degrees of Freedom                    32
          P-Value                           0.0000
          Scaling Correction Factor         1.3241
            for MLR
[...]

RMSEA (Root Mean Square Error Of Approximation)

          Estimate                           0.059
          90 Percent C.I.                    0.054  0.064
          Probability RMSEA <= .05           0.002

CFI/TLI

          CFI                                0.950
          TLI                                0.930
[...]
```

Model results: Standardized results

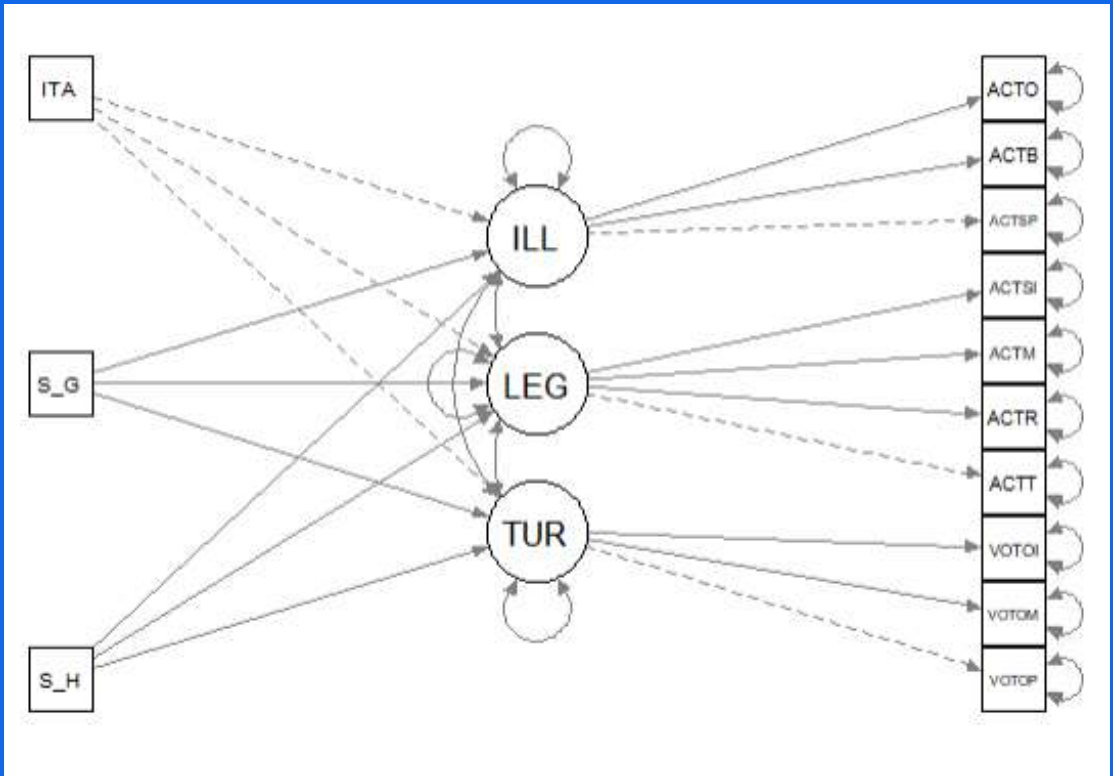
```
STANDARDIZED MODEL RESULTS
STDYX Standardization
                                                  Two-Tailed
                  Estimate       S.E.  Est./S.E.    P-Value

 TURNOUT  BY
    VOTOPRE          0.845      0.013     65.202      0.000
    VOTOMUN          0.892      0.011     77.958      0.000
    VOTOINF          0.616      0.018     34.180      0.000

 LEG      BY
    ACTTALK          0.596      0.022     26.934      0.000
    ACTREP           0.616      0.020     31.239      0.000
    ACTMARCH         0.593      0.022     26.918      0.000
    ACTSIGN          0.655      0.019     34.851      0.000

 ILL      BY
    ACTSPRAY         0.690      0.016     44.106      0.000
    ACTBLOCK         0.864      0.014     62.117      0.000
    ACTOCUP          0.830      0.014     59.268      0.000

 LEG      WITH
    TURNOUT          0.383      0.023     16.715      0.000

 ILL      WITH
    TURNOUT         -0.128      0.024     -5.317      0.000
    LEG              0.262      0.028      9.437      0.000
[...]

R-SQUARE

    Observed                                      Two-Tailed
    Variable        Estimate       S.E.  Est./S.E.    P-Value

    ACTSPRAY         0.475      0.022     22.053      0.000
    ACTBLOCK         0.746      0.024     31.059      0.000
    ACTOCUP          0.689      0.023     29.634      0.000
    ACTTALK          0.356      0.026     13.467      0.000
    ACTREP           0.380      0.024     15.619      0.000
    ACTMARCH         0.352      0.026     13.459      0.000
    ACTSIGN          0.429      0.025     17.425      0.000
    VOTOPRE          0.714      0.022     32.601      0.000
    VOTOMUN          0.796      0.020     38.979      0.000
    VOTOINF          0.380      0.022     17.090      0.000
```

Model results

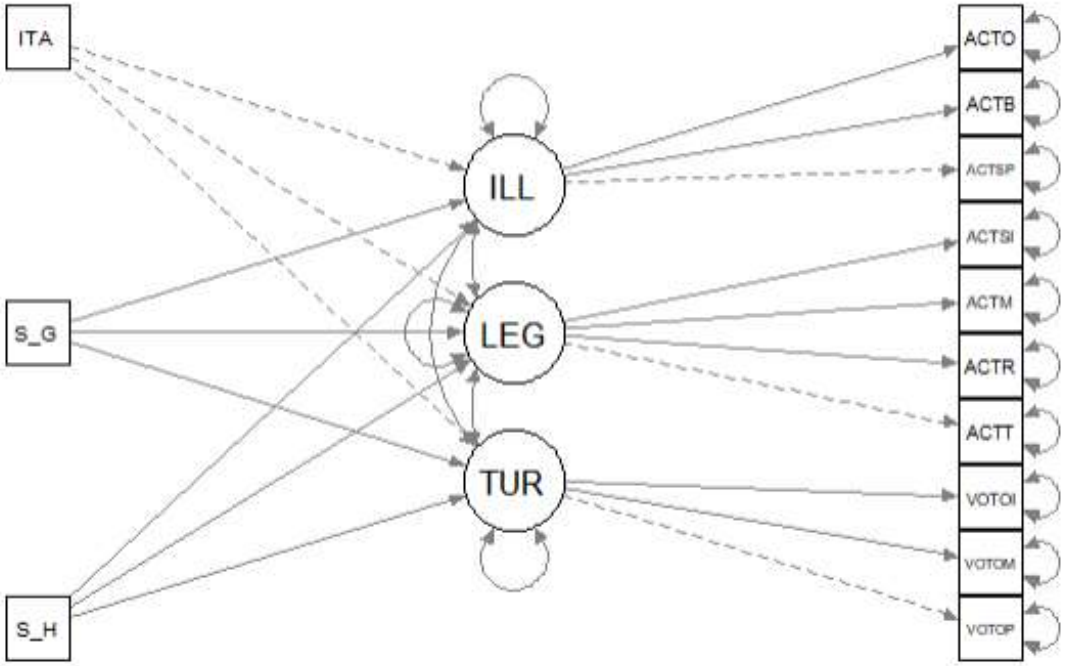
```
screenreg(fit4, type = 'stdyx', summaries = c("ChiSqM_Value", "ChiSqM_PValue", "CFI", "TLI", "RMSEA_Estimate", "Observations"), digits = 3, single.row=TRUE)
```

```
==========================================
                         Model 1
------------------------------------------
VOTOPRE<-TURNOUT          0.845 (0.013) ***
VOTOMUN<-TURNOUT          0.892 (0.011) ***
VOTOINF<-TURNOUT          0.616 (0.018) ***
ACTTALK<-LEG              0.596 (0.022) ***
ACTREP<-LEG               0.616 (0.020) ***
ACTMARCH<-LEG             0.593 (0.022) ***
ACTSIGN<-LEG              0.655 (0.019) ***
ACTSPRAY<-ILL             0.690 (0.016) ***
ACTBLOCK<-ILL             0.864 (0.014) ***
ACTOCUP<-ILL              0.830 (0.014) ***
LEG<->TURNOUT             0.383 (0.023) ***
ILL<->TURNOUT            -0.128 (0.024) ***
ILL<->LEG                 0.262 (0.028) ***
ACTSPRAY<-Intercepts      1.882 (0.018) ***
ACTBLOCK<-Intercepts      1.977 (0.021) ***
ACTOCUP<-Intercepts       1.947 (0.018) ***
ACTTALK<-Intercepts       3.335 (0.049) ***
ACTREP<-Intercepts        2.936 (0.038) ***
ACTMARCH<-Intercepts      3.089 (0.038) ***
ACTSIGN<-Intercepts       3.191 (0.039) ***
VOTOPRE<-Intercepts       4.961 (0.110) ***
VOTOMUN<-Intercepts       4.682 (0.085) ***
VOTOINF<-Intercepts       4.764 (0.111) ***
TURNOUT<->TURNOUT         1.000 (0.000)
LEG<->LEG                 1.000 (0.000)
ILL<->ILL                 1.000 (0.000)
ACTSPRAY<->ACTSPRAY       0.525 (0.022) ***
ACTBLOCK<->ACTBLOCK       0.254 (0.024) ***
ACTOCUP<->ACTOCUP         0.311 (0.023) ***
ACTTALK<->ACTTALK         0.644 (0.026) ***
ACTREP<->ACTREP           0.620 (0.024) ***
ACTMARCH<->ACTMARCH       0.648 (0.026) ***
ACTSIGN<->ACTSIGN         0.571 (0.025) ***
VOTOPRE<->VOTOPRE         0.286 (0.022) ***
VOTOMUN<->VOTOMUN         0.204 (0.020) ***
VOTOINF<->VOTOINF         0.620 (0.022) ***
------------------------------------------
ChiSqM_Value            407.838
ChiSqM_PValue             0.000
CFI                       0.950
TLI                       0.930
RMSEA_Estimate            0.059
Observations           3406
==========================================
*** p < 0.001, ** p < 0.01, * p < 0.05
```

SEM example


ITA
S_G
S_H
ILL
LEG
TUR
ACTO
ACTB
ACTSP
ACTSI
ACTM
ACTR
ACTT
VOTOI
VOTOM
VOTOP

SEM model: Political participation using ICCS 2016 (Italy)



Model specification: SEM (Education + Gender + Reading skills)

- Mplus Syntax

```
m7 <- mplusObject(
  TITLE = "SEM;",
  VARIABLE="
  cluster = idschool_scr;
  Stratification = jkzones;
  Weight = totwgts;",
  ANALYSIS=
    "type = complex;",

  MODEL = "
   turnout BY votopre votomun votoinf;
   leg BY acttalk actrep actmarch actsign;
   ill BY actspray actblock actocup;

   turnout ON s_hisced s_gender ital ;
   leg ON s_hisced s_gender ital;
   ill ON s_hisced s_gender ital;


  "
  ,
  OUTPUT = "CINTERVAL sampstat mod stdyx;",
  rdata = mergeita16)
```

- Generate input and output files

```
fit7 <- mplusModeler(m7, modelout = "m7.inp", run = 1L)
```

Model results

```
screenreg(fit7, type = 'stdyx', summaries = c("ChiSqM_Value", "ChiSqM_PValue", "CFI", "TLI", "RMSEA_Estimate", "Observations"), digits = 3, single.row=TRUE)
```

```
==========================================
                           Model 1
------------------------------------------
TURNOUT<-S_HISCED           0.069 (0.022) **
TURNOUT<-S_GENDER          -0.009 (0.019)
TURNOUT<-ITAL               0.244 (0.023) ***
LEG<-S_HISCED               0.058 (0.024) *
LEG<-S_GENDER               0.076 (0.022) **
LEG<-ITAL                   0.050 (0.027)
ILL<-S_HISCED              -0.009 (0.019)
ILL<-S_GENDER              -0.043 (0.021) *
ILL<-ITAL                  -0.200 (0.021) ***
VOTOPRE<-TURNOUT            0.846 (0.012) ***
VOTOMUN<-TURNOUT            0.888 (0.011) ***
VOTOINF<-TURNOUT            0.617 (0.018) ***
ACTTALK<-LEG                0.589 (0.024) ***
ACTREP<-LEG                 0.598 (0.022) ***
ACTMARCH<-LEG               0.610 (0.022) ***
ACTSIGN<-LEG                0.661 (0.020) ***
ACTSPRAY<-ILL               0.684 (0.016) ***
ACTBLOCK<-ILL               0.870 (0.014) ***
ACTOCUP<-ILL                0.827 (0.014) ***
LEG<->TURNOUT               0.373 (0.024) ***
ILL<->TURNOUT              -0.081 (0.026) **
ILL<->LEG                   0.292 (0.028) ***
ACTSPRAY<-Intercepts        2.625 (0.081) ***
ACTBLOCK<-Intercepts        2.921 (0.096) ***
ACTOCUP<-Intercepts         2.844 (0.090) ***
ACTTALK<-Intercepts         3.089 (0.109) ***
ACTREP<-Intercepts          2.668 (0.100) ***
ACTMARCH<-Intercepts        2.826 (0.096) ***
ACTSIGN<-Intercepts         2.901 (0.109) ***
VOTOPRE<-Intercepts         3.829 (0.156) ***
VOTOMUN<-Intercepts         3.502 (0.141) ***
VOTOINF<-Intercepts         3.994 (0.141) ***
ACTSPRAY<->ACTSPRAY         0.533 (0.022) ***
ACTBLOCK<->ACTBLOCK         0.242 (0.025) ***
ACTOCUP<->ACTOCUP           0.315 (0.023) ***
ACTTALK<->ACTTALK           0.654 (0.028) ***
ACTREP<->ACTREP             0.642 (0.026) ***
ACTMARCH<->ACTMARCH         0.628 (0.026) ***
ACTSIGN<->ACTSIGN           0.563 (0.026) ***
VOTOPRE<->VOTOPRE           0.284 (0.021) ***
VOTOMUN<->VOTOMUN           0.211 (0.020) ***
VOTOINF<->VOTOINF           0.619 (0.022) ***
TURNOUT<->TURNOUT           0.930 (0.012) ***
LEG<->LEG                   0.987 (0.006) ***
ILL<->ILL                   0.955 (0.009) ***
------------------------------------------
ChiSqM_Value              643.174
ChiSqM_PValue               0.000
CFI                         0.930
TLI                         0.901
RMSEA_Estimate              0.058
Observations             3266
==========================================
```

Some extensions

CFA

- Constrains equivalences
- Measurement Invariance or equivalence
- Measurement model with categorical indicators

SEM

- Mediation modeling
- Multilevel SEM
- Longitudinal modeling (Crosslagged or Latent Growth Modeling)

Muchas Gracias!
Grazie Mille!

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V Seminar: "INVALSI data: a tool for teaching and scientific research"
ROME, February 25th – 28th, 2021