

Competing Path Models

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Norwegian University of Science and Technology - A Course in MplusAutomation

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Preparation

Example of competing path models study from [Nishina, Juvonen, Witkow \(2005\)](#)

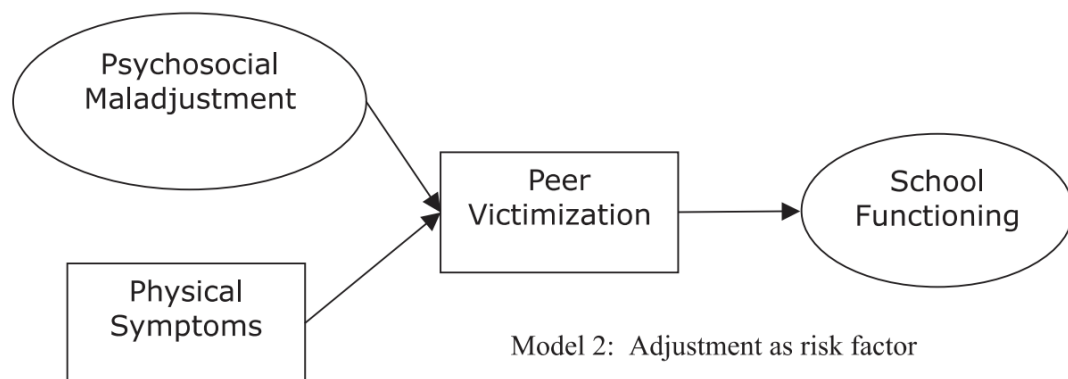
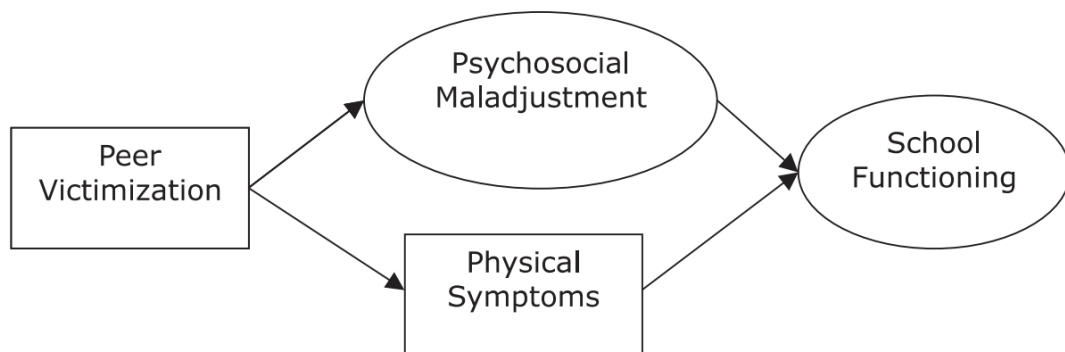


figure. Picture adapted from Nishina, Juvonen, Witkow (2005)

Data source:

This lab exercise utilizes the *California Test Score Data Set 1998-1999* from the California Department of Education (Stock, James, and Watson, 2003) [See documentation here](#)

This dataset is available via the R-package {Ecdat} and can be directly loaded into the R environment.

Note: All models specified in the following exercise are for demonstration only and are **not** theoretically justified or valid.

Load packages

```
library(MplusAutomation)
library(haven)
library(tidyverse)
library(here)
library(corrplot)
library(reshape2)
library(janitor)
library(ggribes)
library(DiagrammeR)
library(semPlot)
library(sjPlot)
library(Ecdat)
library(gt)
library(gtsummary)
```

Begin lab 2 exercise

Read the dataframe into your R-environment from package {Ecdat}

```
data(Caschool)

ca_schools <- as.data.frame(Caschool)
```

Look at the data with `glimpse`

```
glimpse(ca_schools)
```

Subset variables to use in path model analyses with `select`

```
path_vars <- ca_schools %>%
  select(str, expnstu, compstu, elpct, mealpct,
         readscr, mathscr, testscr)
```

Explore the data

K through 8th grade schools in California ($N = 420$)

Take a look at focal variables, make a `tribble` table

```
var_table <- tribble(
  ~"Name",    ~"Labels",
  #-----/-----/,
  "str"       , "student teacher ratio"      ,
  "expnstu"   , "expenditure per student"    ,
  "compstu"   , "computer per student"       ,
  "elpct"     , "percent of English learners",
  "mealpct"   , "percent qualifying for reduced-price lunch",
  "readscr"   , "average reading score"       ,
  "mathscr"   , "average math score"          ,
  "testscr"   , "average test score (read.scr+math.scr)/2" )

var_table %>%
  gt()
```

Name	Labels
str	student teacher ratio
expnstu	expenditure per student
compstu	computer per student
elpct	percent of English learners
mealpct	percent qualifying for reduced-price lunch
readscr	average reading score
mathscr	average math score
testscr	average test score (read.scr+math.scr)/2

check some basic descriptives with the `{gtsummary}` package

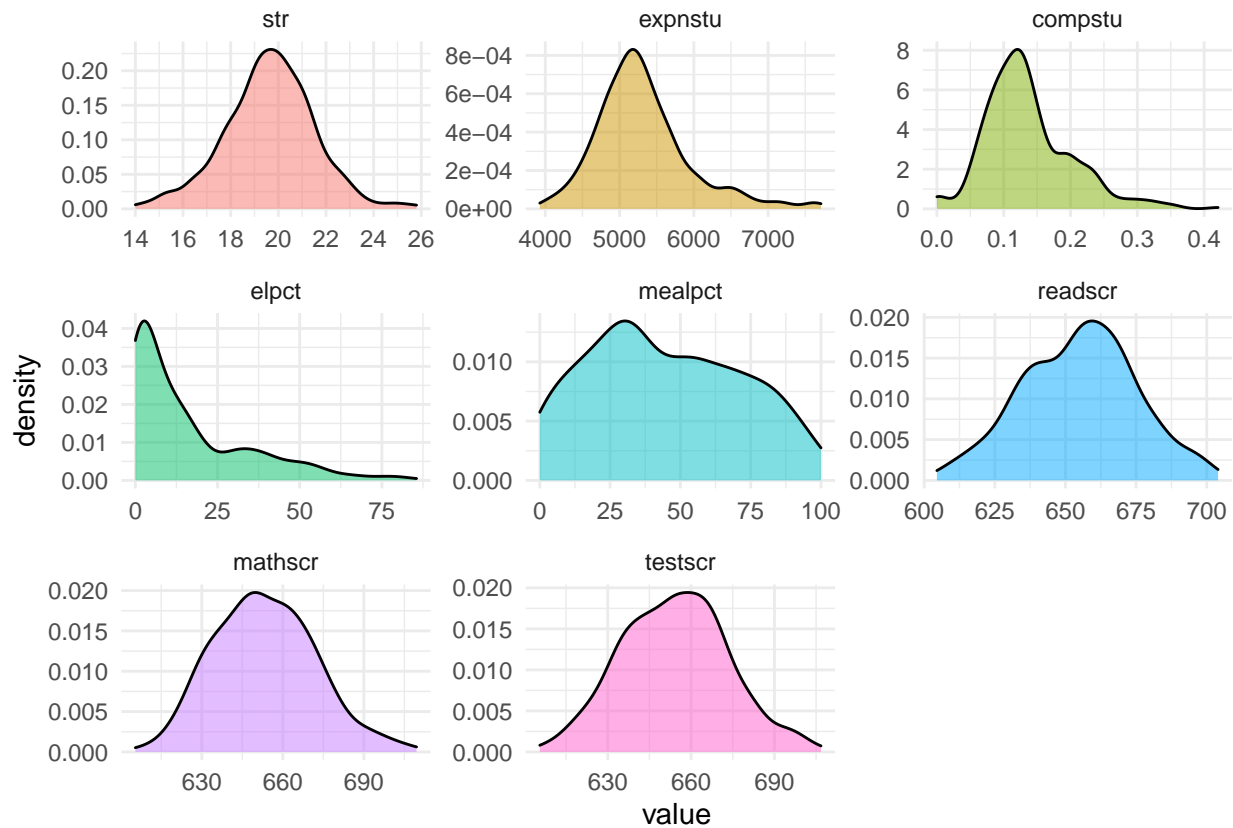
```
table1 <- tbl_summary(path_vars,
  statistic = list(all_continuous() ~ "{mean} ({sd})"),
  missing = "no" ) %>%
  bold_labels()

table1
```

Characteristic	N = 420
str	19.64 (1.89)
expnstu	5312 (634)
compstu	0.14 (0.06)
elpct	16 (18)
mealpct	45 (27)
readscr	655 (20)
mathscr	653 (19)
testscr	654 (19)

look at shape of variable distributions

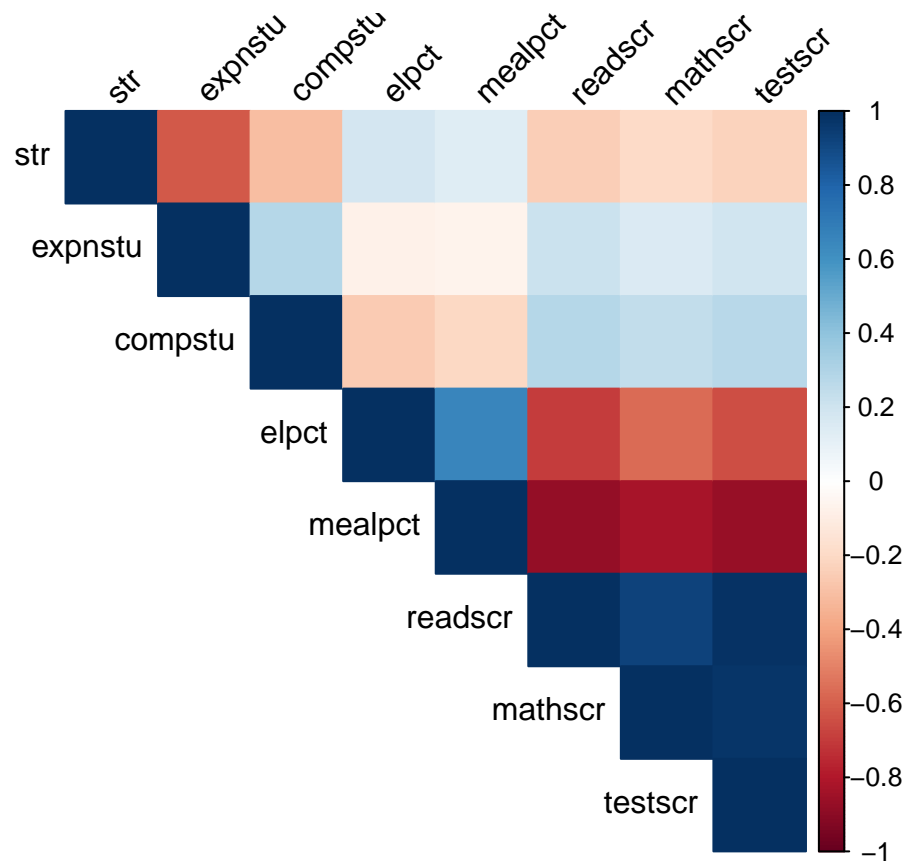
```
melt(path_vars) %>%
  ggplot(., aes(x=value, label=variable)) +
  geom_density(aes(fill = variable),
               alpha = .5, show.legend = FALSE) +
  facet_wrap(~variable, scales = "free") +
  theme_minimal()
```



look at correlation matrix with {corrplot}

```
p_cor <- cor(path_vars, use = "pairwise.complete.obs")

corrplot(p_cor,
  method = "color",
  type = "upper",
  tl.col="black",
  tl.srt=45)
```



Specifying path models using {MplusAutomation}

recall what the unrestricted variance-covariance matrix **looks** like

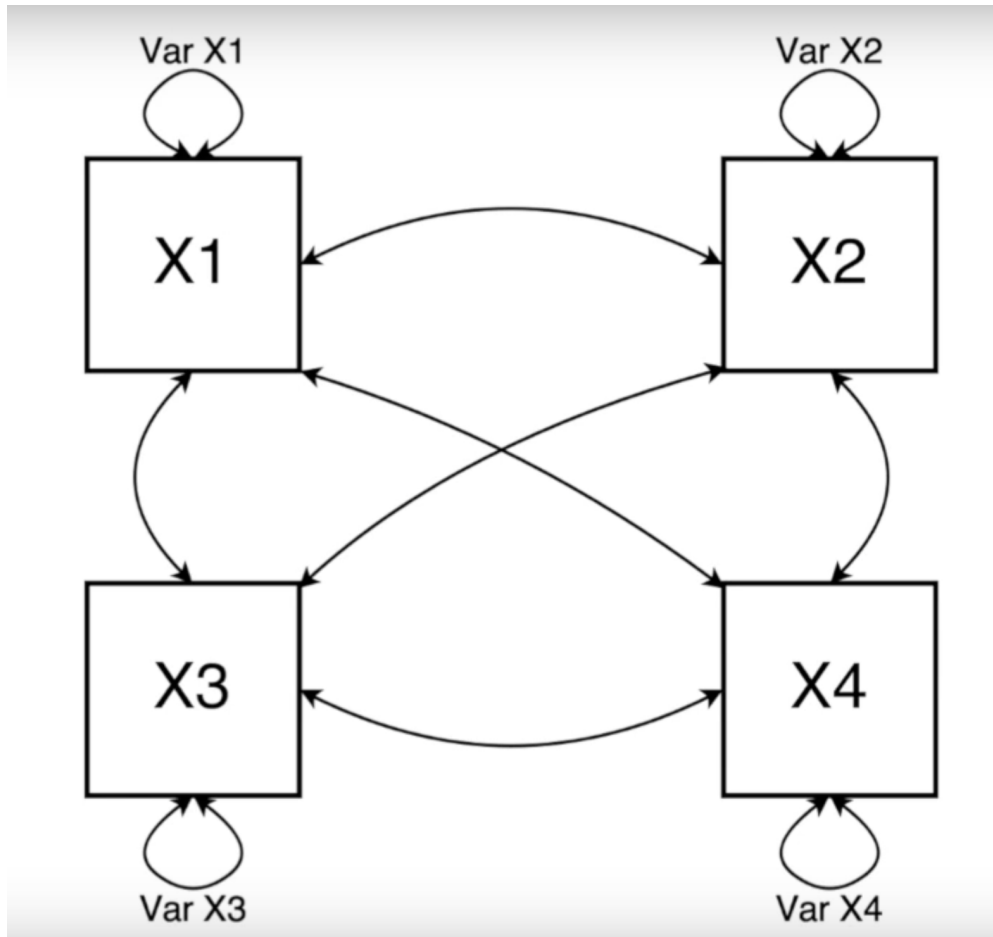


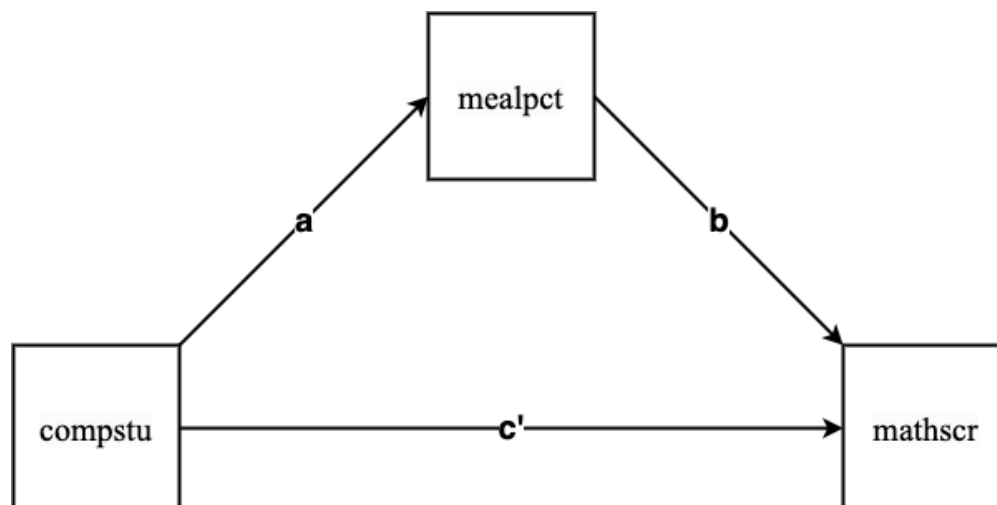
figure. Unrestricted variance covariance matrix picture from {openMX} video tutorial.

Estimate model 1

Indirect path model:

1. **covariate**: ratio of computers to students (`compstu`)
 2. **mediator**: percent qualifying for reduced-price lunch (`mealpct`)
 3. **outcome**: average math score (`mathscr`)
-

Path diagram model 1



```

m1_path <- mplusObject(
  TITLE = "m1 model indirect - Lab 1",
  VARIABLE =
    "usevar =
      compstu      ! covariate
      mealpct      ! mediator
      mathscr;      ! outcome",

  ANALYSIS =
    "estimator = MLR" ,

  MODEL =
    "mathscr on compstu;      ! direct path (c')
    mathscr on mealpct;      ! b path
    mealpct on compstu;      ! a path

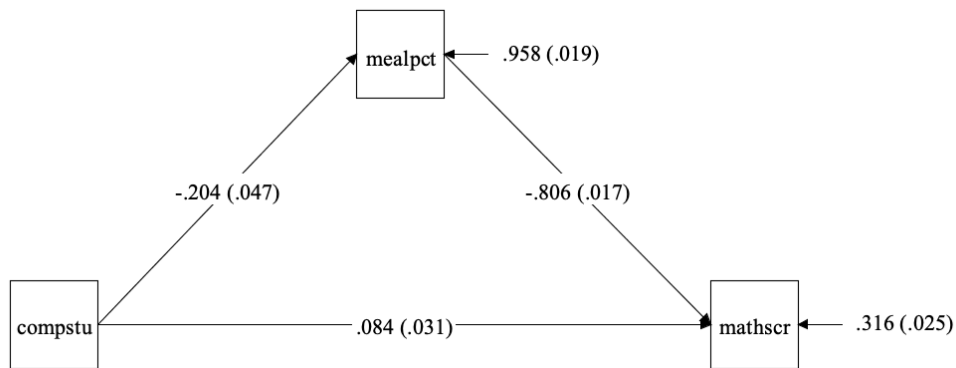
    Model indirect:
    mathscr ind compstu;" ,

  OUTPUT = "sampstat standardized modindices (ALL)",

  usevariables = colnames(path_vars),
  rdata = path_vars)

m1_path_fit <- mplusModeler(m1_path,
  dataout=here("13-comp-models", "mplus_files", "CA_schls.dat"),
  modelout=here("13-comp-models", "mplus_files", "m1_path_indirect.inp"),
  check=TRUE, run = TRUE, hashfilename = FALSE)
  
```

View path diagram for model 1 with standardized estimates (using Diagrammer in Mplus)



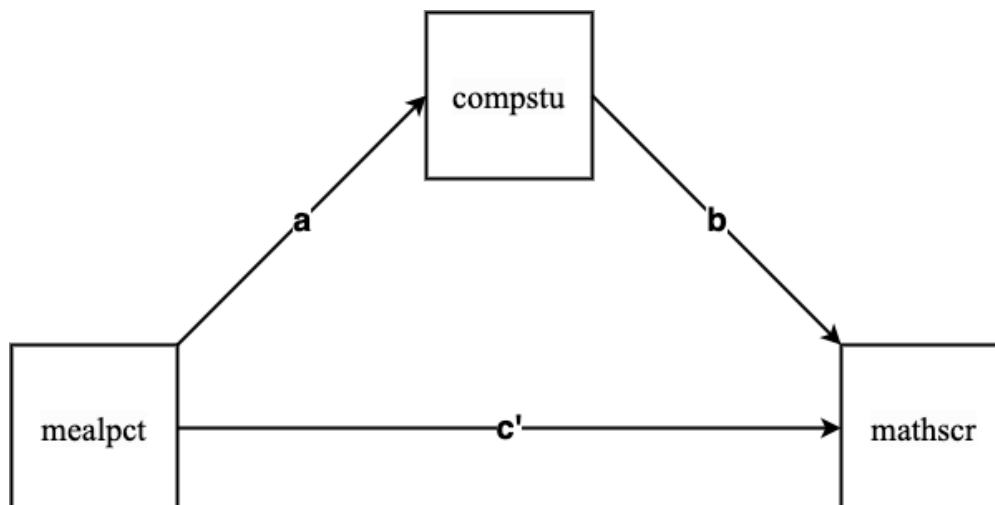
Estimate model 2

change variable status (**switch mediator and covariate variables**)

Indirect path model:

1. covariate: percent qualifying for reduced-price lunch (**mealpct**)
 2. mediator: ratio of computers to students (**compstu**)
 3. outcome: average math score (**mathscr**)
-

Path diagram model 2




```

m2_path <- mplusObject(
  TITLE = "m2 model indirect",
  VARIABLE =
    "usevar =
      mealpct          ! covariate
      compstu          ! mediator
      mathscr;         ! outcome",

  ANALYSIS =
    "estimator = MLR" ,

  MODEL =
    "mathscr on compstu;          ! direct path (c')
    mathscr on mealpct;          ! b path
    mealpct on compstu;          ! a path

    Model indirect:
    mathscr ind compstu;" ,

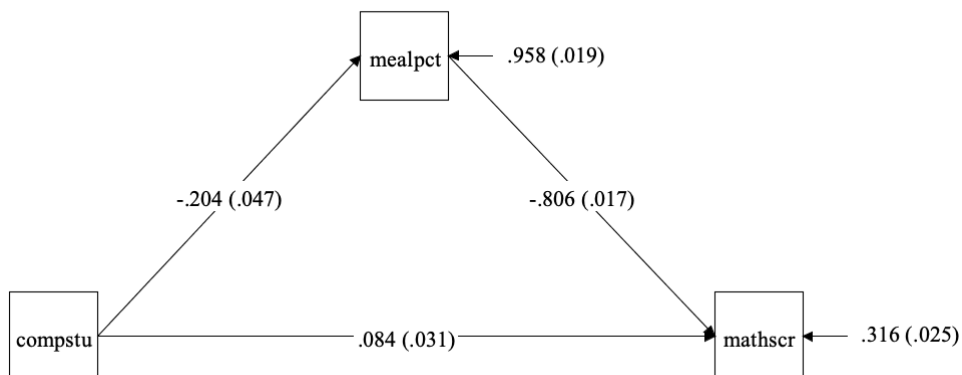
  OUTPUT = "sampstat standardized modindices (ALL)",

  usevariables = colnames(path_vars),
  rdata = path_vars)

m2_path_fit <- mplusModeler(m2_path,
  dataout=here("13-comp-models", "mplus_files", "CA_schls.dat"),
  modelout=here("13-comp-models", "mplus_files", "m2_path_indirect.inp"),
  check=TRUE, run = TRUE, hashfilename = FALSE)

```

View path diagram for model 2 with standardized estimates (using the Diagrammer in Mplus)

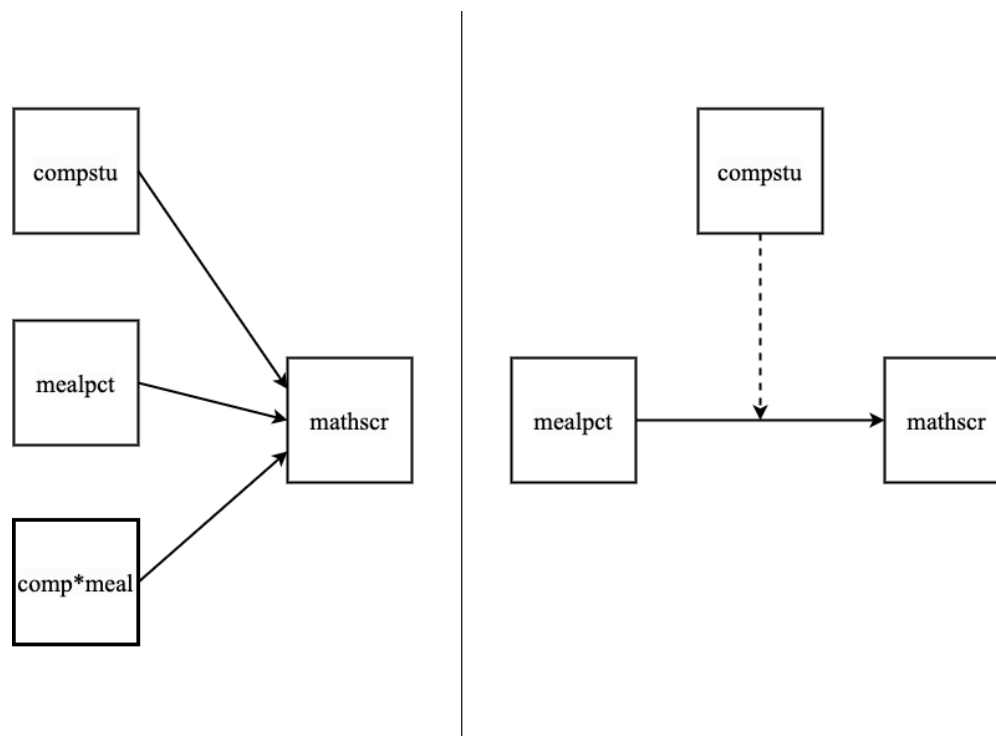


Estimate model 3

Path model with interaction (moderation):

1. covariate-moderator: percent qualifying for reduced-price lunch (**mealpct**)
2. covariate-moderator: ratio of computers to students (**compstu**)
3. outcome: average math score (**mathscr**)

Path diagram model 3



```
m3_path <- mplusObject(  
  TITLE = "m3 model interact",  
  VARIABLE =  
    "usevar =  
      compstu      ! covariate-moderator  
      mealpct      ! covariate-moderator  
      mathscr      ! outcome  
      int_ab;      ! interaction term ",  
  
  DEFINE =  
    "int_ab = compstu*mealpct; ! create interaction term" ,  
  
  ANALYSIS =  
    "estimator = MLR" ,  
)
```

```

MODEL =
  "mathscr on compstu mealpct int_ab; ",

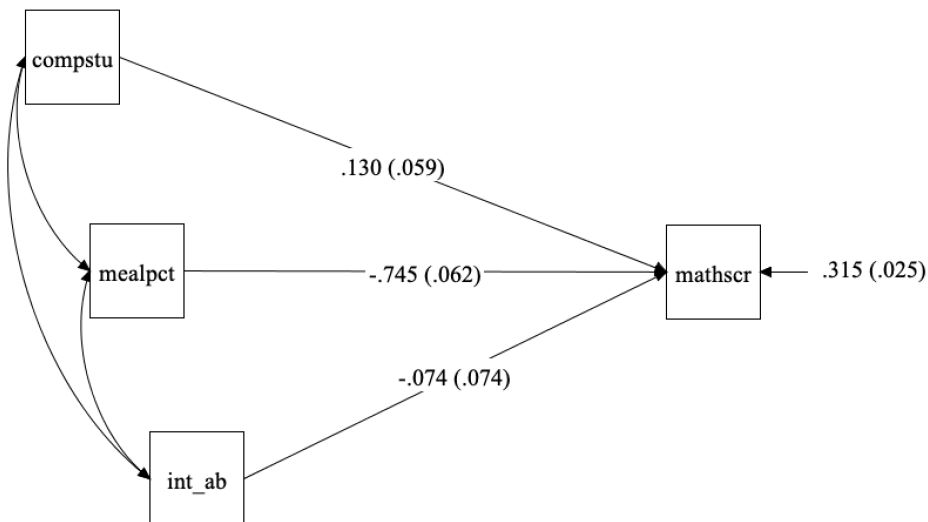
OUTPUT = "sampstat standardized modindices (ALL)",

usevariables = colnames(path_vars),
rdata = path_vars)

m3_path_fit <- mplusModeler(m3_path,
  dataout=here("13-comp-models", "mplus_files", "CA_schls.dat"),
  modelout=here("13-comp-models", "mplus_files", "m3_path_interact.inp"),
  check=TRUE, run = TRUE, hashfilename = FALSE)

```

View path diagram for model 3 with standardized estimates (using the Diagrammer in Mplus)



Estimate model 4

Two indirect paths or “mediators”

```

m4_path <- mplusObject(
  TITLE = "m4 model indirect (two mediators)",
  VARIABLE =
    "usevar =
      str          ! covariate
      elpct        ! mediator
      mealpct      ! mediator

```

```

mathscr          ! outcome",

DEFINE =
  "int_ab = compstu*mealpct;  ! create interaction term" ,

ANALYSIS =
  "estimator = MLR" ,

MODEL =
  "mathscr on str;           ! direct path (c')
  mathscr on elpct mealpct;  ! b paths
  elpct mealpct on str;     ! a paths

  Model indirect:
  mathscr ind str;" ,

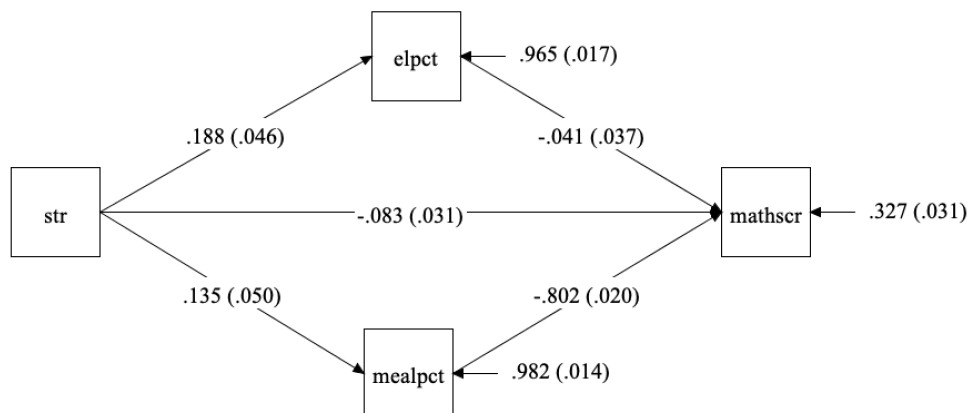
OUTPUT = "sampstat standardized modindices (ALL)",

usevariables = colnames(path_vars),
rdata = path_vars)

m4_path_fit <- mplusModeler(m4_path,
  dataout=here("13-comp-models", "mplus_files", "CA_schls.dat"),
  modelout=here("13-comp-models", "mplus_files", "m4_path_indirect.inp"),
  check=TRUE, run = TRUE, hashfilename = FALSE)

```

View path diagram for model 4 with standardized estimates (using the Diagrammer in Mplus)



Estimate model 5

Add modification statement - correlate mediators mealpct with elpct

```
m5_path <- mplusObject(
  TITLE = "m5 model indirect (correlate mediators)",
  VARIABLE =
    "usevar =
      str          ! covariate
      elpct        ! mediator
      mealpct      ! mediator
      mathscr      ! outcome",

  DEFINE =
    "int_ab = compstu*mealpct; ! create interaction term" ,

  ANALYSIS =
    "estimator = MLR" ,

  MODEL =
    "mathscr on str;          ! direct path (c')
    mathscr on elpct mealpct; ! b paths
    elpct mealpct on str;    ! a paths

    mealpct with elpct      ! modification statement

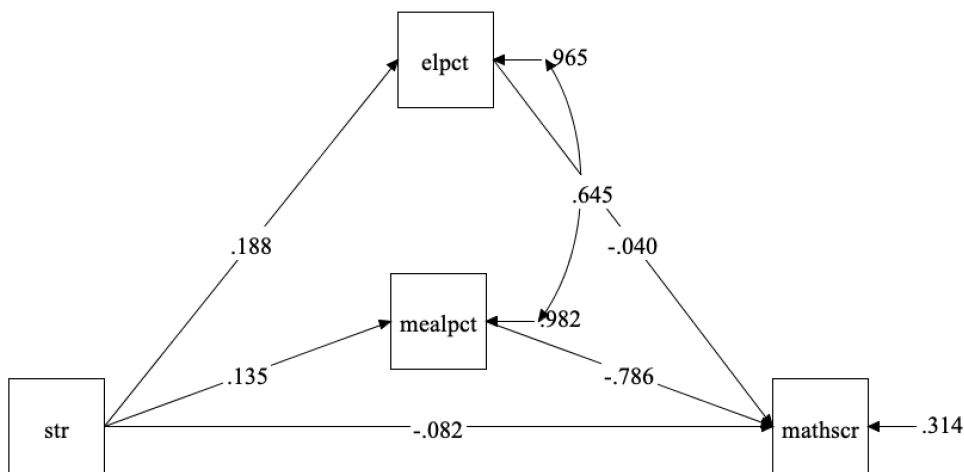
    Model indirect:
    mathscr ind str; " ,

  OUTPUT = "sampstat standardized modindices (ALL)",

  usevariables = colnames(path_vars),
  rdata = path_vars)

m5_path_fit <- mplusModeler(m5_path,
  dataout=here("13-comp-models", "mplus_files", "CA_schls.dat"),
  modelout=here("13-comp-models", "mplus_files", "m5_path_indirect.inp"),
  check=TRUE, run = TRUE, hashfilename = FALSE)
```

View path diagram for model 5 with standardized estimates (using the Diagrammer in Mplus)



End

References

- Hallquist, M. N., & Wiley, J. F. (2018). MplusAutomation: An R Package for Facilitating Large-Scale Latent Variable Analyses in Mplus. *Structural equation modeling: a multidisciplinary journal*, 25(4), 621-638.
- Horst, A. (2020). Course & Workshop Materials. GitHub Repositories, [https://https://allisonhorst.github.io/](https://allisonhorst.github.io/)
- Ingels, S. J., Pratt, D. J., Herget, D. R., Burns, L. J., Dever, J. A., Ottem, R., ... & Leinwand, S. (2011). High School Longitudinal Study of 2009 (HSLs: 09): Base-Year Data File Documentation. NCES 2011-328. National Center for Education Statistics.
- Muthén, L.K. and Muthén, B.O. (1998-2017). Mplus User's Guide. Eighth Edition. Los Angeles, CA: Muthén & Muthén
- R Core Team (2017). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL <http://www.R-project.org/>
- Wickham et al., (2019). Welcome to the tidyverse. *Journal of Open Source Software*, 4(43), 1686, <https://doi.org/10.21105/joss.01686>