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)

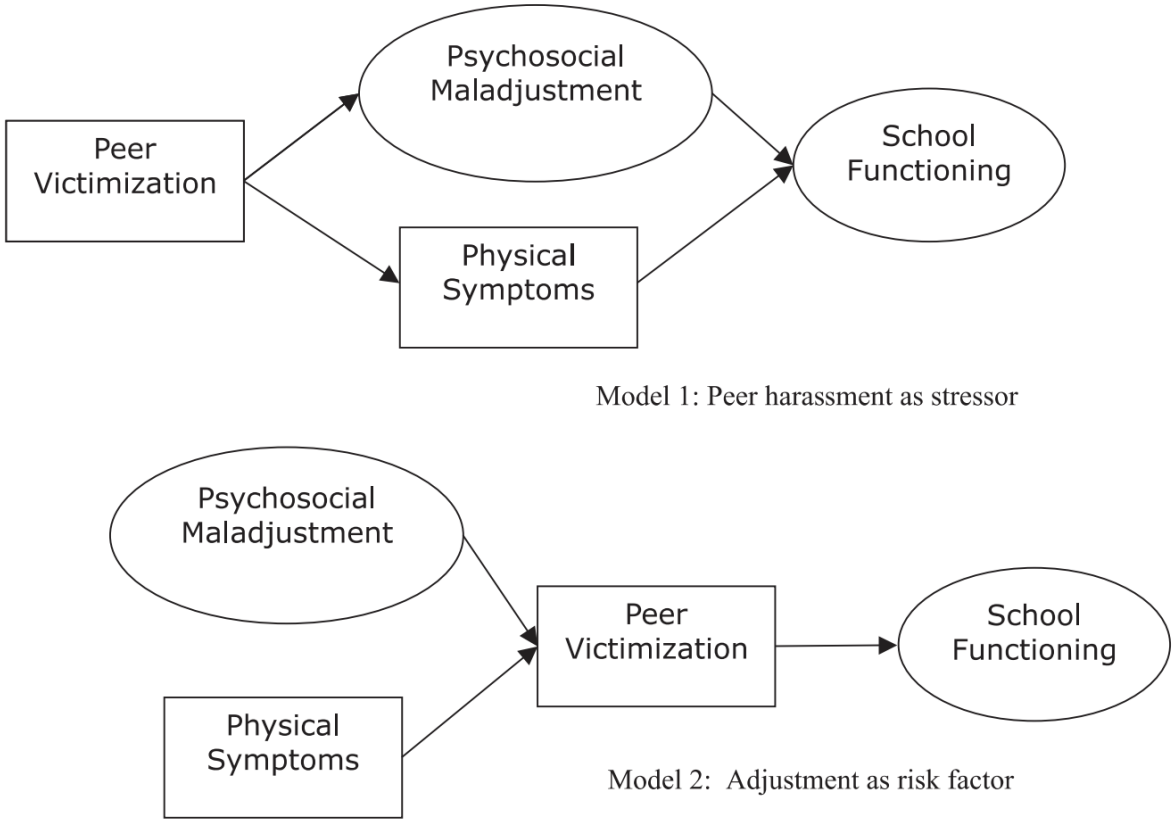


figure. Picture adapted from Nishina, Juvonen, Witkow (2005)

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(ggridges)
library(DiagrammeR)
library(semPlot)
library(sjPlot)
library(Ecdat)
library(gt)
library(gtsummary)
```

Change starting location to folder `13-comp-models`

```
source("rep_functions.R")

change_here(glue("{project_location}/13-comp-models"))

here()
```

```
## [1] "/Users/agarber/github/NTNU-workshop/13-comp-models"
```

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

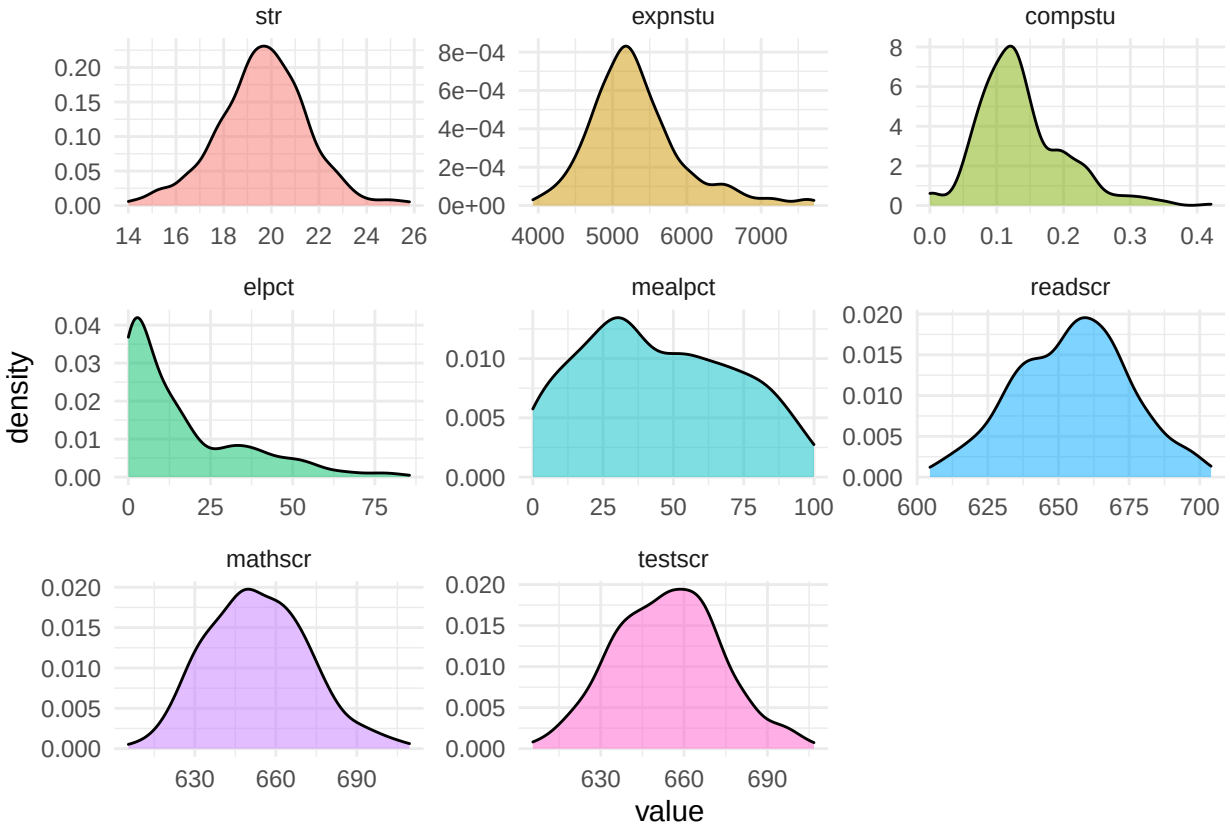
```
table1 <- tbl_summary(path_vars,
                      statistic = list(all_continuous() ~ "{mean} ({sd})"),
                      missing = "no" ) %>%
  bold_labels()

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

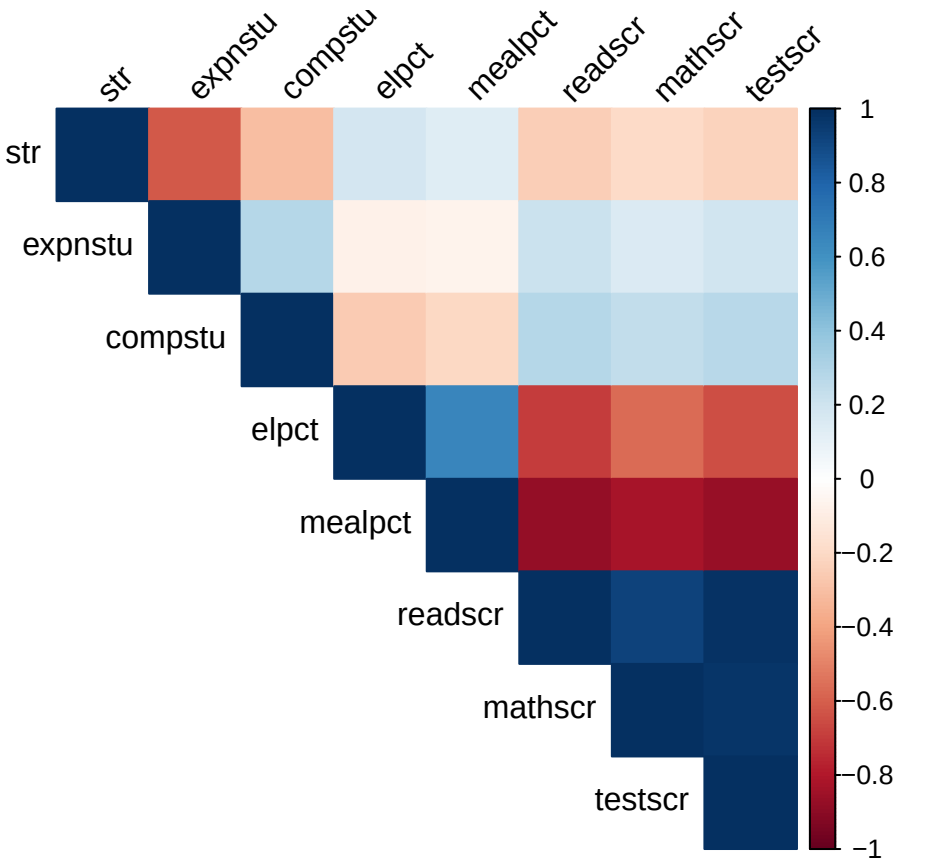
```
melt(path_vars) %>%
  ggplot(., aes(x=value, label=variable)) +
  geom_density(aes(fill = variable),
               alpha = .5, show.legend = FALSE) +
  facet_wrap(~variable, scales = "free")  +
  theme_minimal()
```



---

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

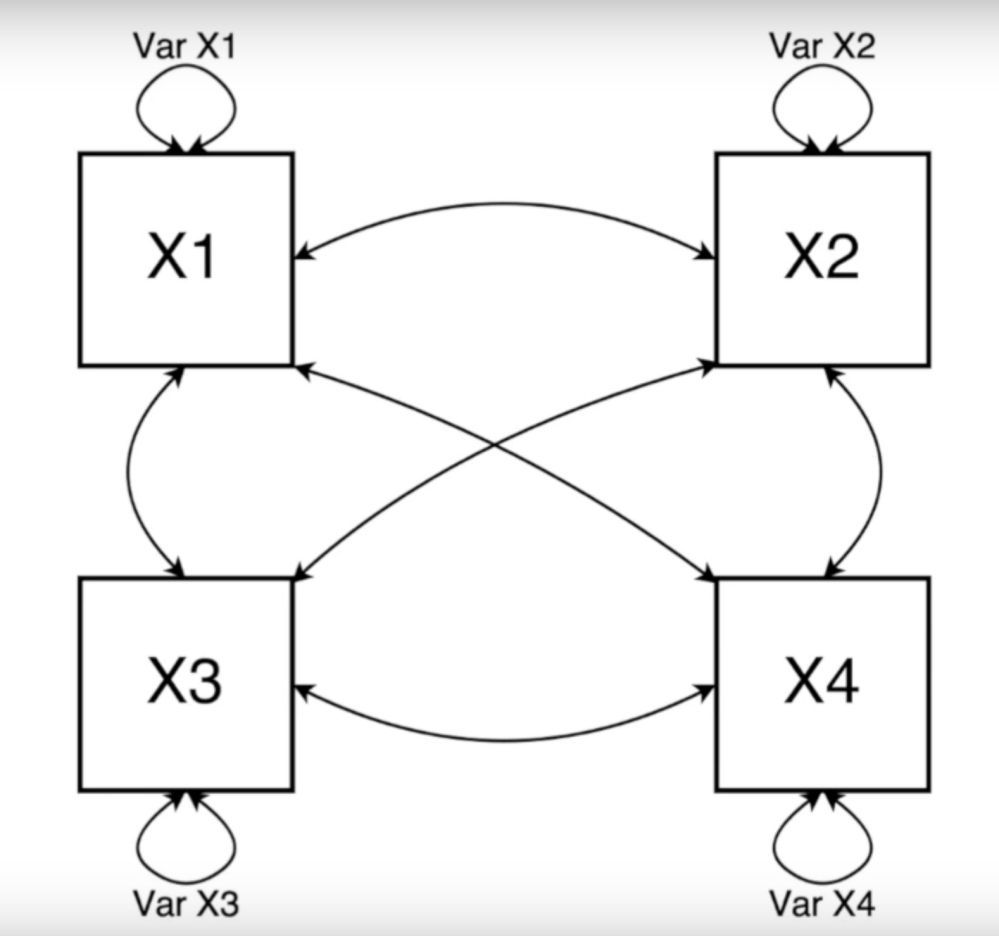


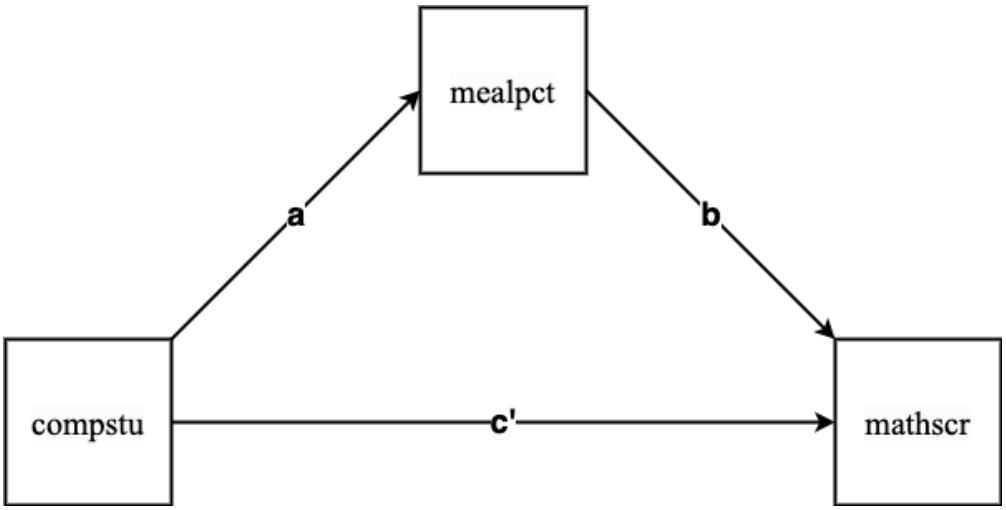
figure. Unrestricted variance covariance matrix picture from {`openMX`} video tutorial.

Estimate model 1

Indirect path model:

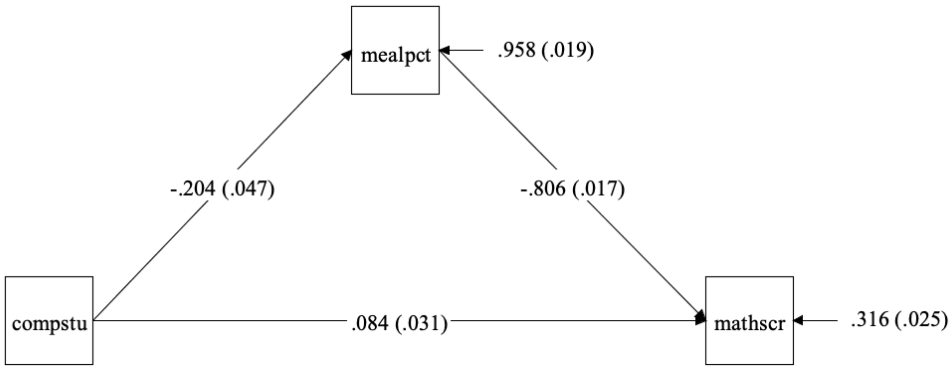
1. **covariate**: ratio of computers to students (`compstu`)
2. **mediator**: percent qualifying for reduced-price lunch (`mealpct`)
3. **outcome**: average math score (`mathscr`)

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("mplus_files", "CA_schls.dat"),
               modelout=here("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)



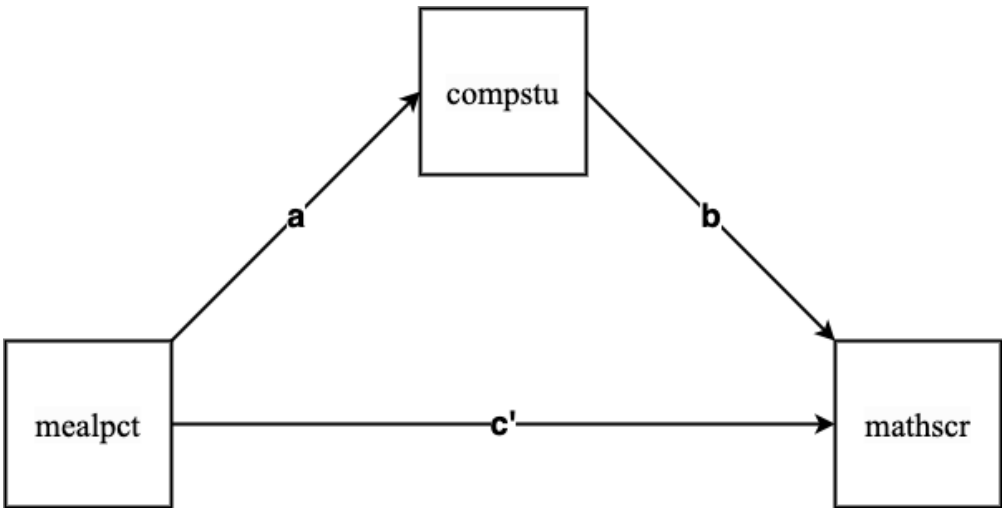
Estimate model 2

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

Indirect path model:

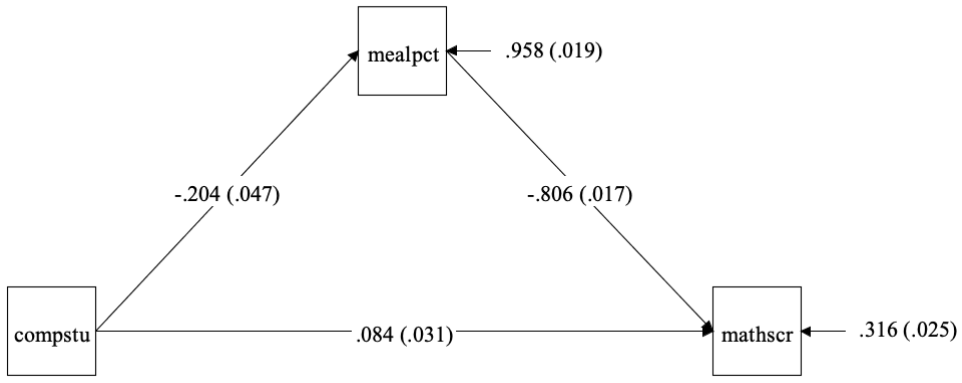
1. covariate: percent qualifying for reduced-price lunch (`mealpct`)
2. mediator: ratio of computers to students (`compstu`)
3. outcome: average math score (`mathscr`)

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("mplus_files", "CA_schls.dat"),
                    modelout=here("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)

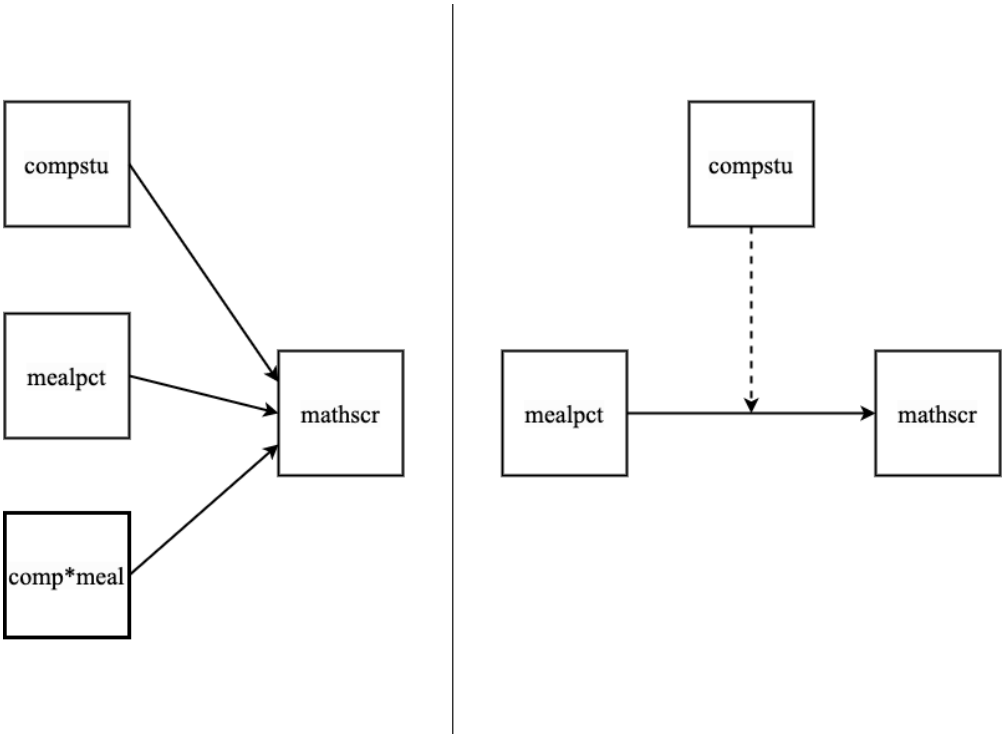


Estimate model 3

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`)

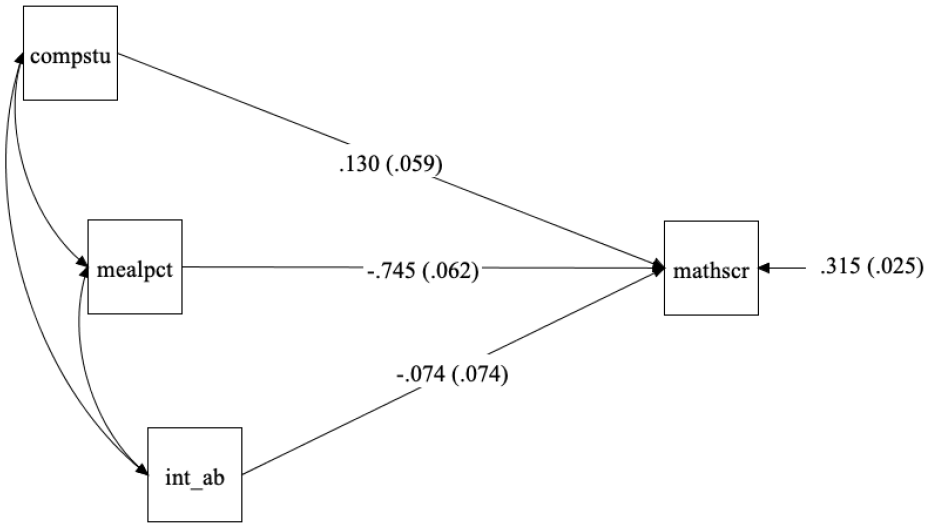
Path diagram model 3



```
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("mplus_files", "CA_schls.dat"),
                    modelout=here("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)



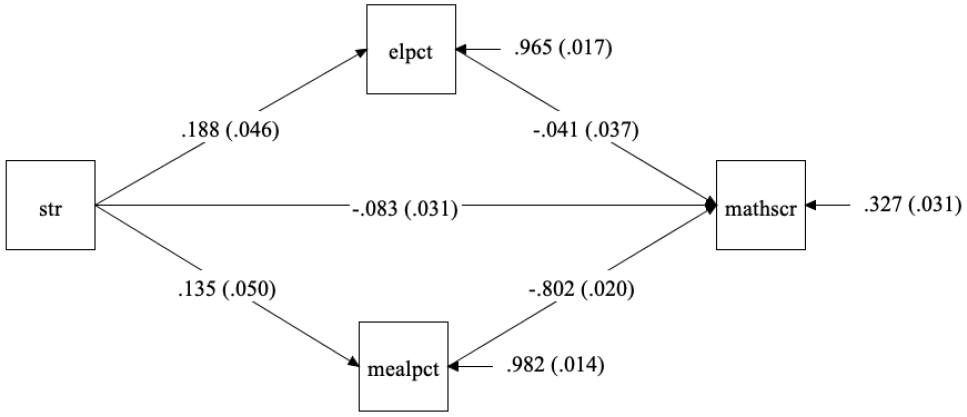
Estimate model 4

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("mplus_files", "CA_schls.dat"),
                    modelout=here("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)

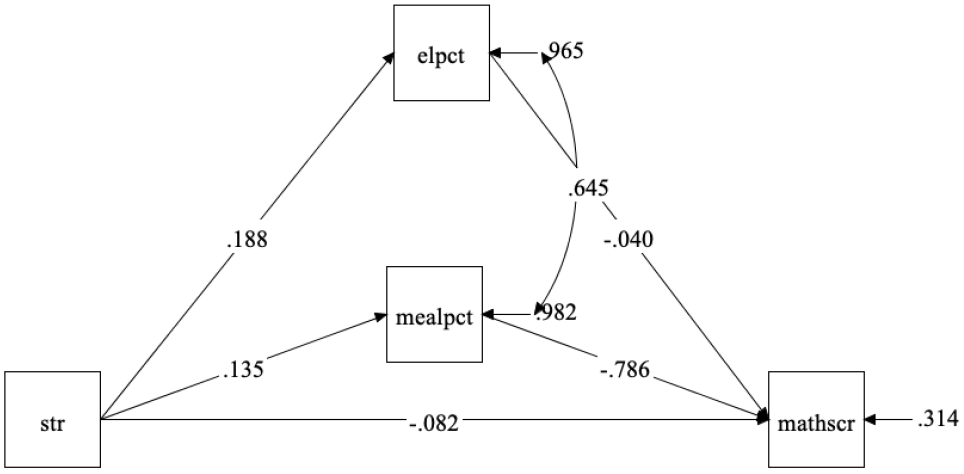


Estimate model 5

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("mplus_files", "CA_schls.dat"),
                    modelout=here("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.

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