Lab 2 - Competing Path Models

Structural Equation Modeling ED 216F - Instructor: Karen Nylund-Gibson

Adam Garber

April 09, 2020

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1 Lab preparation

1.1 Creating a version-controlled R-Project by downloading repository from Github

Download ropository here: https://github.com/garberadamc/SEM-Lab2

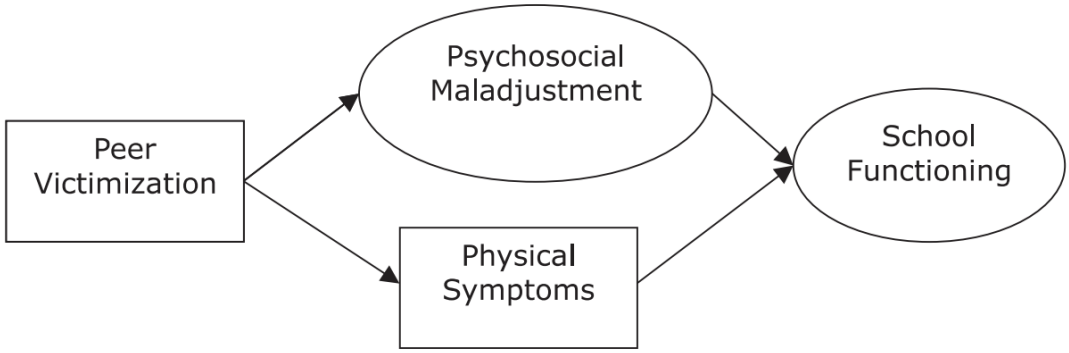
On the Github repository webpage:

a. `fork` your own `branch` of the lab repository
b. copy the repository web URL address from the `clone or download` menu

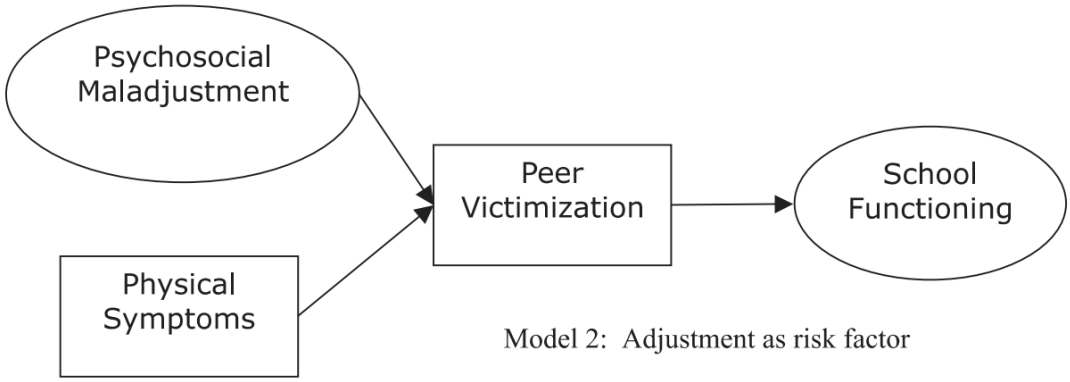
Within R-Studio:

c. click "NEW PROJECT" (upper right corner of window)
d. choose option `Version Control`
e. choose option `Git`
f. paste the repository web URL path coppied from the `clone or download` menu on Github page
g. choose location of the R-Project (too many nested folders will result in filepath error)

Example of competing path models study from Nishina, Juvonen, Witkow (2005)



Model 1: Peer harassment as stressor



Model 2: Adjustment as risk factor

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

1.2 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 demonstation only and are **not** theoretically justified or valid.

1.3 List of over 1000 datasets available in R packages

This list was compiled by Vincent Arel-Bundock and can be found here:

https://vincentarelbundock.github.io/Rdatasets/datasets.html

Install the "rhdf5" package to read gh5 files

```
if (!requireNamespace("BiocManager", quietly = TRUE))
    install.packages("BiocManager")
 BiocManager::install("rhdf5")
```

Load packages

```
library(MplusAutomation)
library(haven)
library(rhdf5)
library(tidyverse)
library(here)
library(corrplot)
library(kableExtra)
library(reshape2)
library(janitor)
library(ggridges)
library(DiagrammeR)
library(semPlot)
library(sjPlot)
library(Ecdat)
library(gt)
library(gtsummary)
```

---

2 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)
```

---

3 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 %>%
  kable(booktabs = T, linesep = "") %>%
  kable_styling(latex_options = c("striped"),
                full_width = F,
                position = "left")
```

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

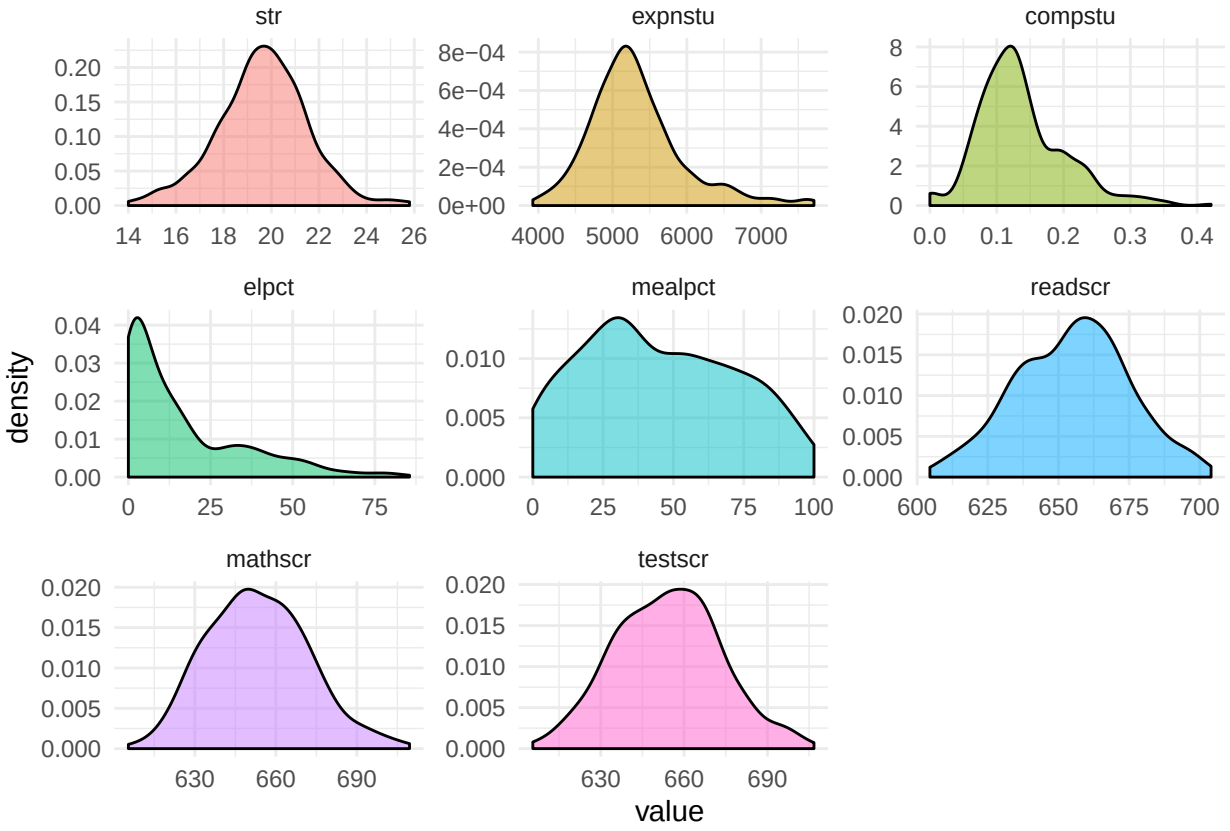
```
table1 <- tbl_summary(path_vars,
                      statistic = list(all_continuous() ~ "{mean} ({sd})"),
                      missing = "no" ) %>%
  bold_labels()

table1
```

Characteristic	**N = 420**[1]
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)

[1]Statistics presented: mean (SD)

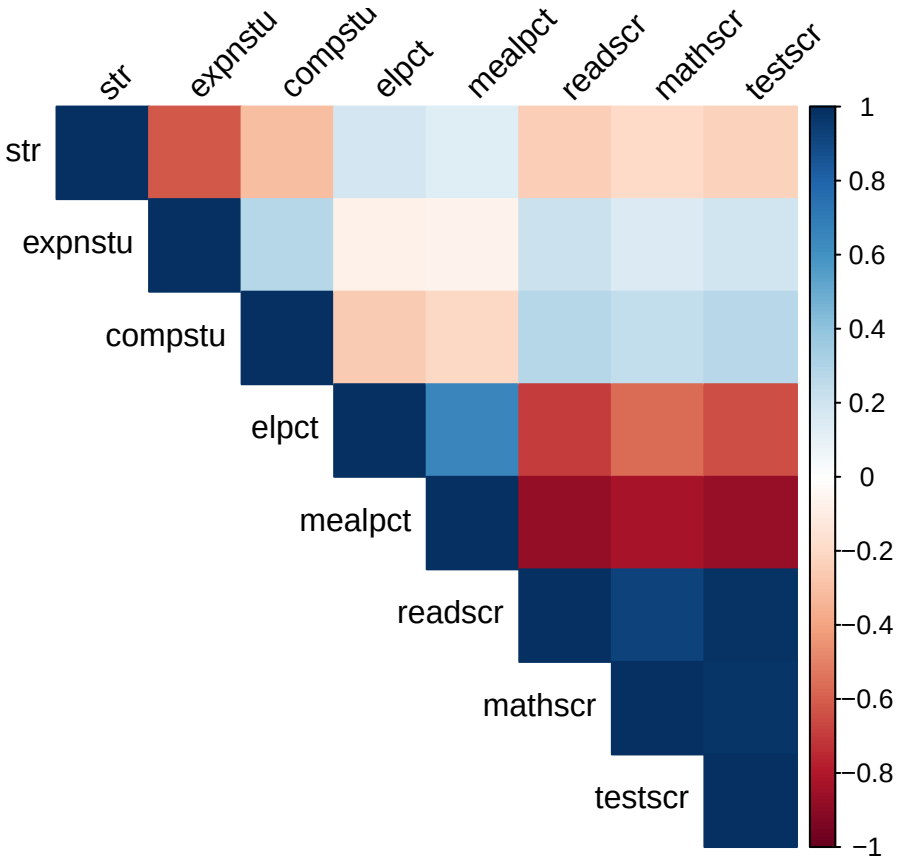
look at shape of variable distributions

```
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)
```



---

4 Specifying path models using {`MplusAutomation`}

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

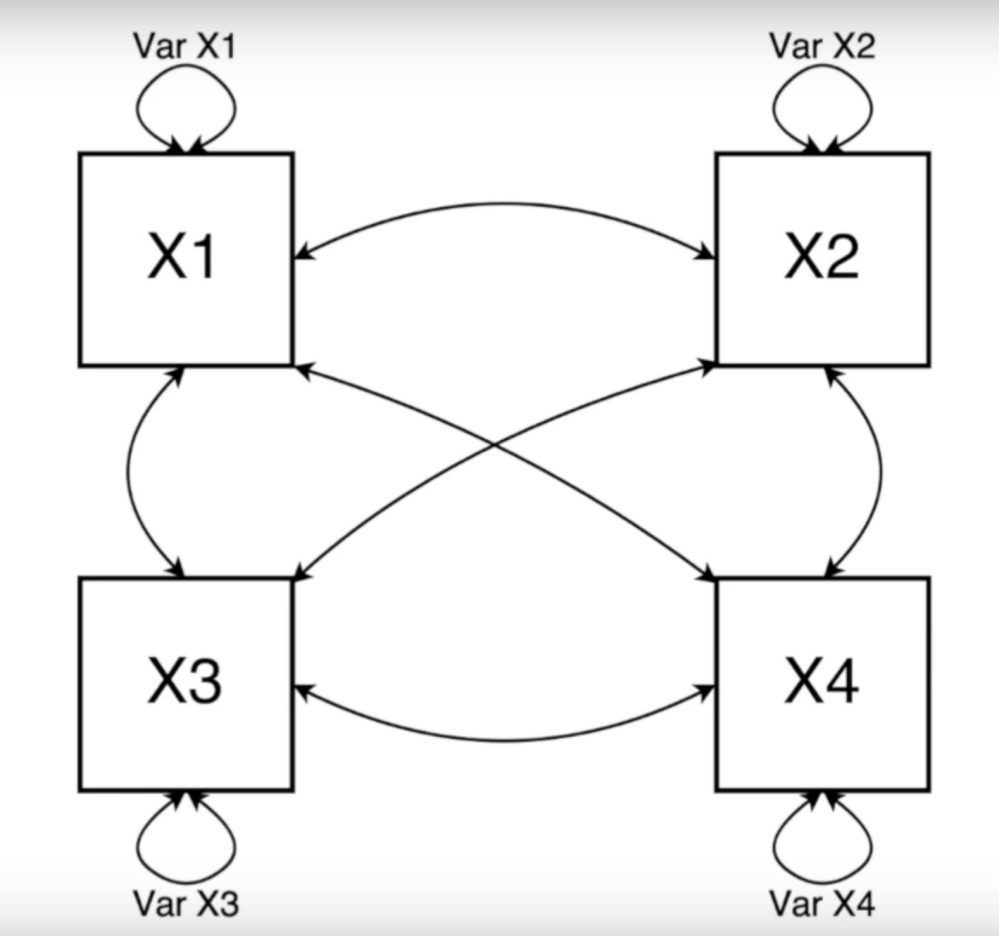


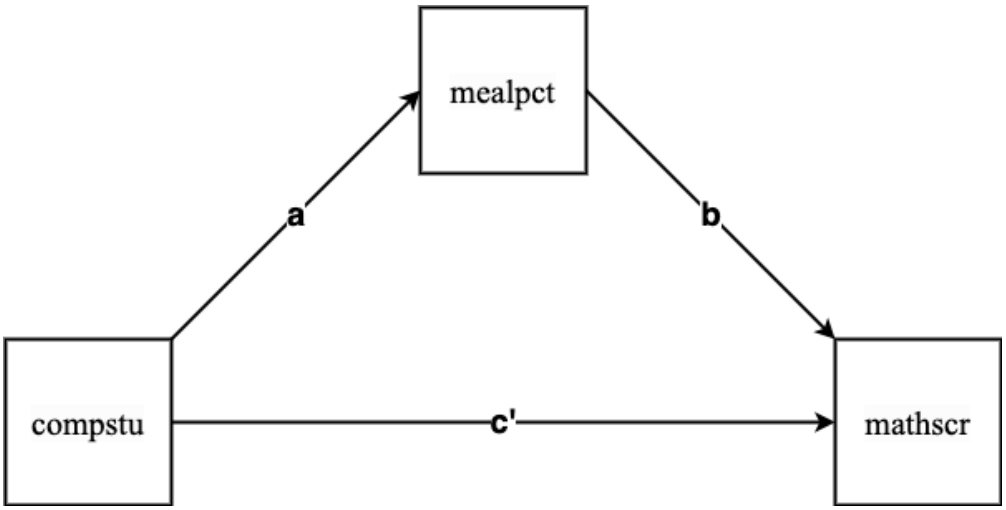
figure. Unrestricted variance covariance matrix picture from {`openMX`} video tutorial.

4.1 Estimate model 1

Indirect path model:

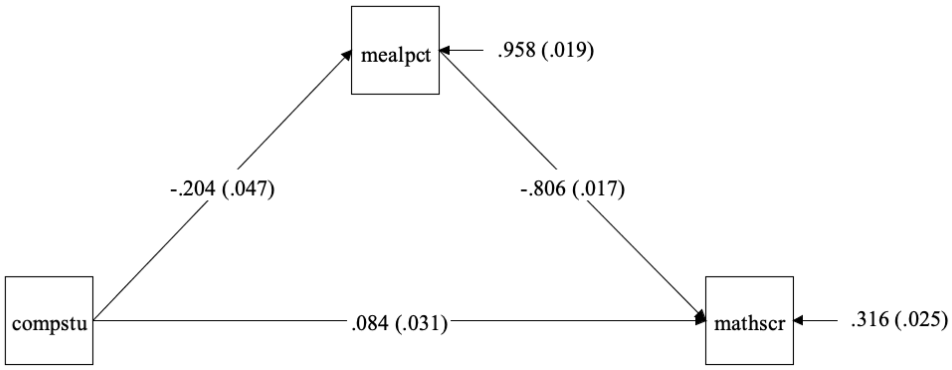
1. covariate: ratio of computers to students (`compstu`)
2. mediator: percent qualifying for reduced-price lunch (`mealpct`)
3. outcome: average math score (`mathscr`)

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", "Lab2.dat"),
                    modelout=here("mplus_files", "m1_path_Lab2.inp"),
                    check=TRUE, run = TRUE, hashfilename = FALSE)
```

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



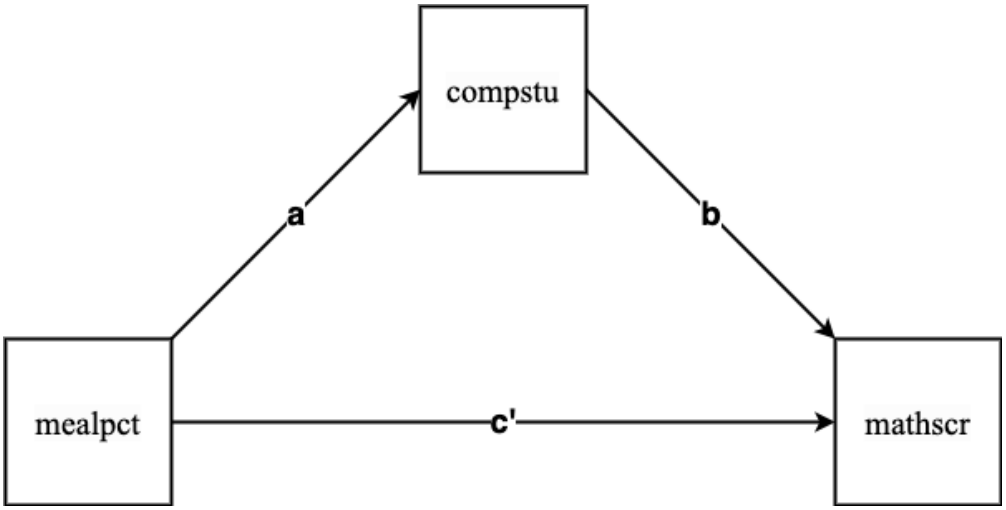
4.2 Estimate model 2

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

Indirect path model:

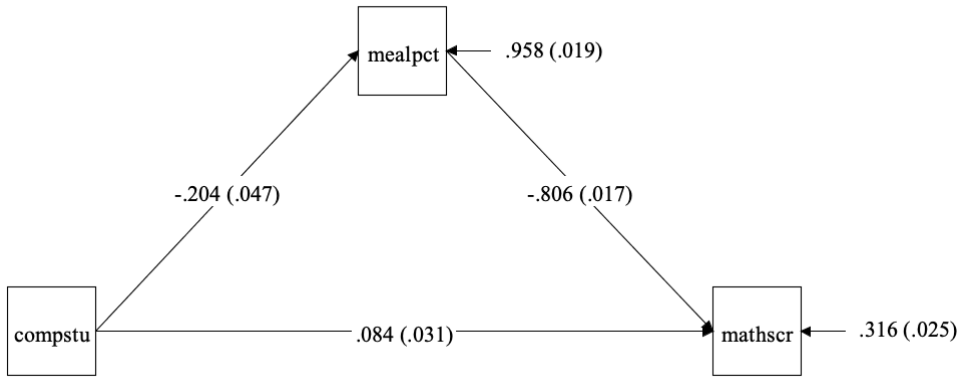
1. covariate: percent qualifying for reduced-price lunch (`mealpct`)
2. mediator: ratio of computers to students (`compstu`)
3. outcome: average math score (`mathscr`)

Path diagram model 2



```
m2_path  <- mplusObject(
  TITLE = "m1 model indirect - Lab 1",
  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", "Lab2.dat"),
                    modelout=here("mplus_files", "m2_path_Lab2.inp"),
                    check=TRUE, run = TRUE, hashfilename = FALSE)
```

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

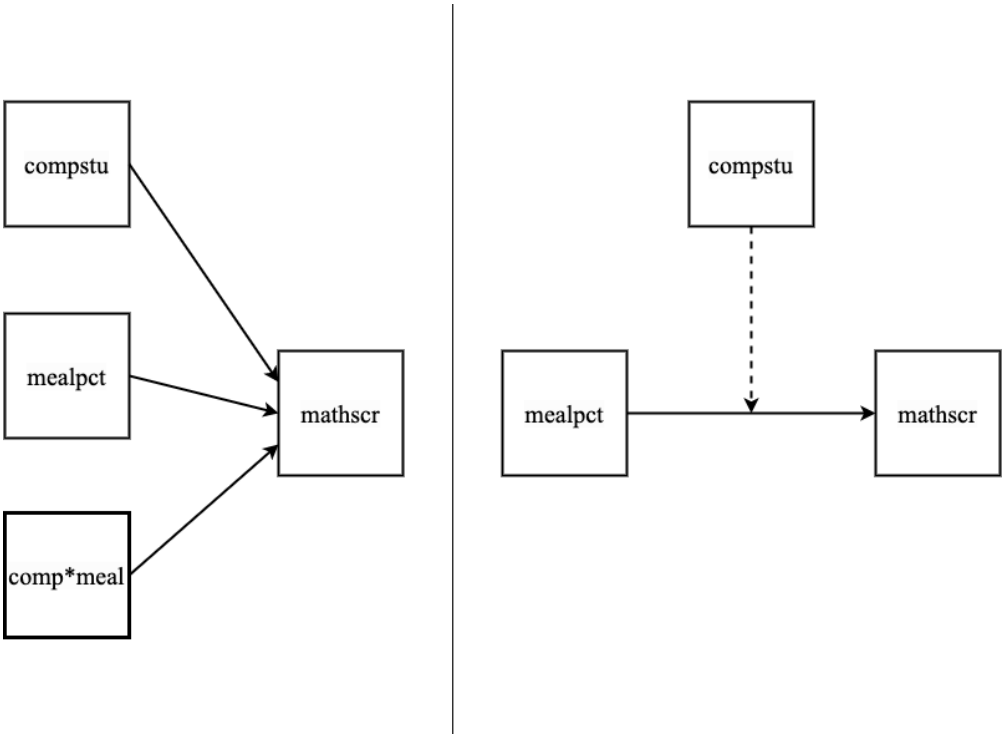


4.3 Estimate model 3

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`)

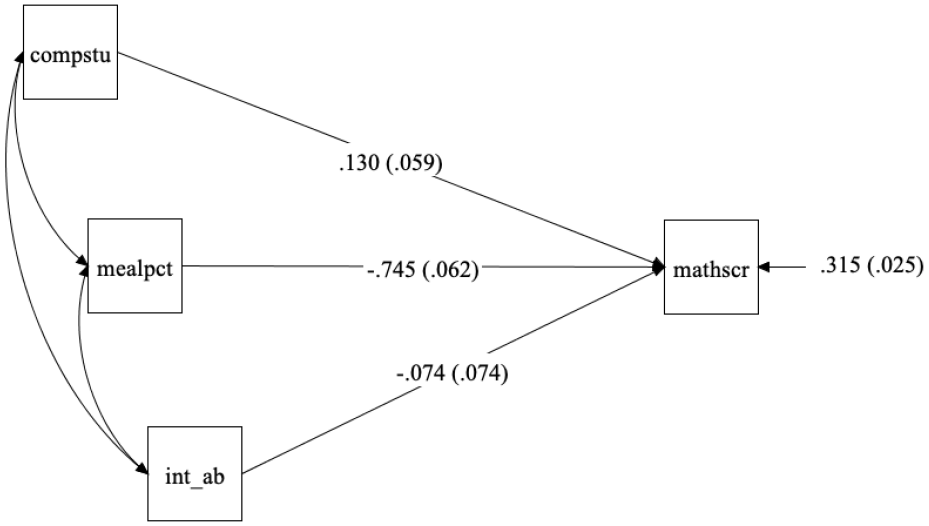
Path diagram model 3



```
m3_path  <- mplusObject(
  TITLE = "m1 model indirect - Lab 1",
  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", "Lab2.dat"),
                     modelout=here("mplus_files", "m3_path_Lab2.inp"),
                     check=TRUE, run = TRUE, hashfilename = FALSE)
```

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

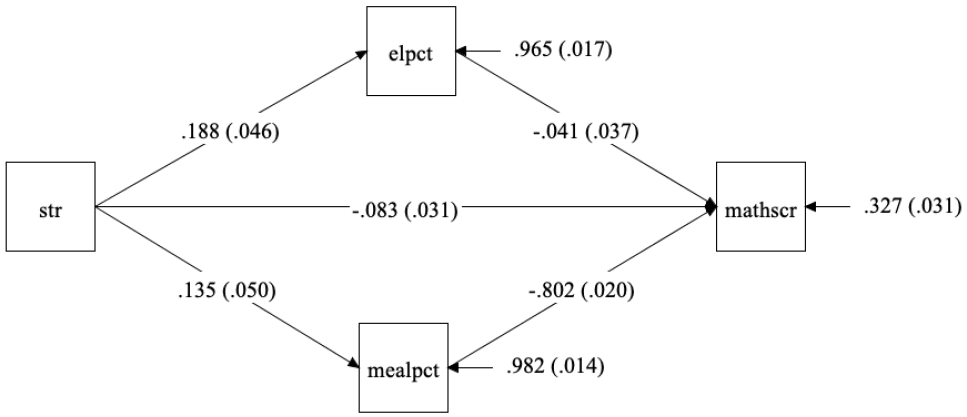


4.4 Estimate model 4

```
m4_path  <- mplusObject(
  TITLE = "m4 model indirect - Lab 1",
  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", "Lab2.dat"),
                     modelout=here("mplus_files", "m4_path_Lab2.inp"),
                     check=TRUE, run = TRUE, hashfilename = FALSE)
```

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



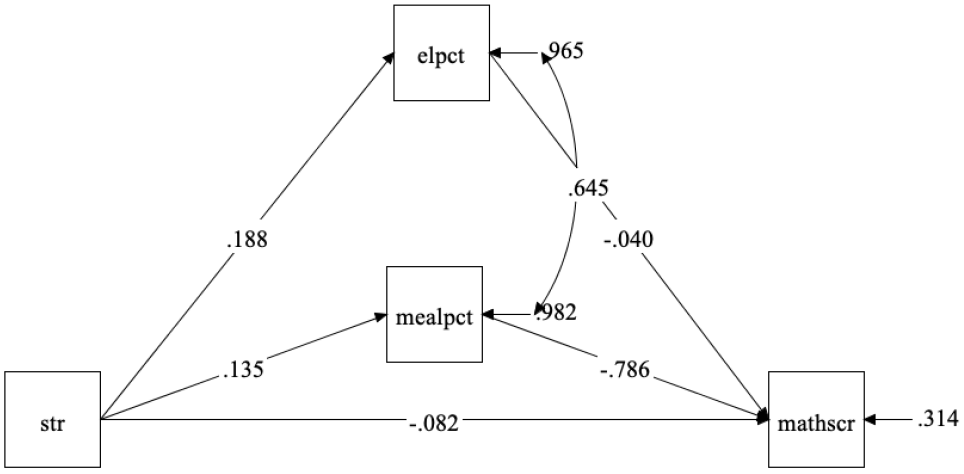
4.5 Estimate model 5

---

add modification statement - correlate mediators `mealpct with elpct`

```
m5_path  <- mplusObject(
  TITLE = "m5 model indirect - Lab 1",
  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", "Lab2.dat"),
                    modelout=here("mplus_files", "m5_path_Lab2.inp"),
                    check=TRUE, run = TRUE, hashfilename = FALSE)
```

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



---

5 Compare model fit

Read into R summary of all models

```
all_models <- readModels(here("mplus_files"))
```

Extract fit indice data from output files

```
summary_fit <- LatexSummaryTable(all_models,
                 keepCols=c("Filename", "Parameters","ChiSqM_Value", "CFI","TLI",
                            "SRMR", "RMSEA_Estimate", "RMSEA_90CI_LB", "RMSEA_90CI_UB"),
                 sortBy = "Filename")
```

Create a customizable table using the {gt} package

```
model_table <- summary_fit %>%
  gt() %>%
  tab_header(
    title = "Fit Indices",  # Add a title
    subtitle = ""           # And a subtitle
  ) %>%
  tab_options(
    table.width = pct(80)
  ) %>%
  tab_footnote(
    footnote = "California Test Score Data Set 1998-1999",
    location = cells_title()
  ) %>%
```

```
  cols_label(
    Filename = "Model",
    Parameters =  "Par",
    ChiSqM_Value = "ChiSq",
    RMSEA_Estimate = "RMSEA",
    RMSEA_90CI_LB = "Lower CI",
    RMSEA_90CI_UB = "Upper CI")

model_table
```

---

6 End of Lab 2

---

7 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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Wickham et al., (2019). Welcome to the tidyverse. Journal of Open Source Software, 4(43), 1686, https://doi.org/10.21105/joss.01686

UC SANTA BARBARA