COS-D419 Factor Analysis and Structural Equation Models 2023, Assignment 5

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2023-02-17

CFA invariance & teacher burnout

Exercise 5.1

Specify and estimate the initial baseline models for the two groups.

Present a brief summary of the model fit and make the first step of the modification by including **(exceptionally, at the same time!)** all the four parameters known to be required for improving the model fit of both models.

Fine-tune the models step by step following the guidelines given in the lecture material, i.e., implement the modifications **(as usually, one change at a time)** testing and studying each step.

Present the final baseline models of each group and draw the graphs.

Maria's notes:

Tässä tehtävässä tarkoituksena on tutkia onko kahden populaation (elementary and secondary teachers) faktorimuuttumattomuus (faktorisvastaavuus) samanlainen.

Yleensä ollaan kiinnostuneita: 1. Toimiiko mittari (esim. MBI-kysely) samanlaisesti kaikissa populaatioissa, vaikka olisi eri sukupuolta, ikäluokkaa, kulttuuria? 2. Onko faktorirakenne (factorial structure) samanlainen populaatioiden välillä vai esim. jääkö joitain itemsejä pois yms. 3. Ovatko kausaaliset polut (= regressiot eli vaikuttaako joku johonkin) 4. Ovatko "latent means" samanlaisia populaatioiden välillä? 5. Onko cross-validation samassa populaatiossa mahdollista? Eli voiko mittaria käyttää samassa populaatiossa ja faktorirakenne pysyy silti samanlaisena?

Testatessa monen ryhmän muuttumattomuutta aloitetaan population kovarianssien (=ISO SIGMA = kuinka läheisesti muuttujat vaihtelemat yhdessä, jos yhteys on = korrelaatio) matriksin tarkastelulla. Jos ne ovat samat, ei tarvita lisätestejä. Silloin voidaan laittaa ryhmät yhteen ja käyttää single-group metodeja. Ongelmana on, ettei ole baseline mallia ja siksi testaus voidaan suorittaa liian rajoittavasti.

Sen sijaan, tehdään hyvä **multigroup baseline model**, jolla voidaan TEHDÄ MITÄ???

Read in the data set:

```
library(tidyverse)
```

```
## -- Attaching packages --------------------------------------- tidyverse 1.3.2 --
## v ggplot2 3.3.6      v purrr   1.0.1
## v tibble  3.1.6      v dplyr   1.0.10
## v tidyr   1.2.1      v stringr 1.4.1
## v readr   2.1.1      v forcats 0.5.2
## -- Conflicts ------------------------------------------ tidyverse_conflicts() --
## x dplyr::filter() masks stats::filter()
## x dplyr::lag()    masks stats::lag()
```

```
library(readr)

MBIelm <- read_csv("MBIELM1.CSV", show_col_types = FALSE)
glimpse(MBIelm)
```

```
## Rows: 580
## Columns: 22
## $ ITEM1  <dbl> 1, 5, 3, 6, 1, 5, 3, 6, 2, 4, 5, 2, 3, 2, 5, 6, 5, 4, 6, 3, 1, ~
## $ ITEM2  <dbl> 1, 5, 4, 6, 1, 5, 5, 6, 1, 4, 5, 1, 5, 3, 5, 6, 5, 5, 6, 5, 1, ~
## $ ITEM3  <dbl> 0, 6, 3, 6, 1, 5, 2, 5, 1, 3, 3, 2, 1, 2, 5, 3, 2, 3, 6, 2, 1, ~
## $ ITEM4  <dbl> 6, 6, 6, 6, 6, 6, 6, 6, 5, 6, 5, 6, 3, 6, 6, 6, 5, 6, 6, 6, 6, ~
## $ ITEM5  <dbl> 1, 2, 3, 0, 5, 1, 1, 4, 1, 0, 4, 0, 1, 0, 0, 3, 0, 1, 0, 0, 0, ~
## $ ITEM6  <dbl> 0, 4, 2, 0, 1, 6, 2, 3, 0, 0, 5, 0, 1, 1, 2, 4, 2, 3, 3, 0, 0, ~
## $ ITEM7  <dbl> 6, 5, 6, 6, 6, 6, 6, 5, 6, 5, 6, 6, 5, 6, 6, 6, 5, 6, 6, 6, 6, ~
## $ ITEM8  <dbl> 1, 5, 2, 6, 0, 6, 2, 6, 1, 2, 3, 0, 0, 1, 5, 1, 5, 3, 5, 0, 0, ~
## $ ITEM9  <dbl> 6, 4, 6, 6, 6, 3, 6, 3, 6, 6, 6, 6, 6, 6, 6, 6, 5, 6, 6, 6, 6, ~
## $ ITEM10 <dbl> 0, 3, 2, 0, 0, 0, 2, 4, 0, 1, 3, 0, 1, 0, 0, 0, 3, 0, 0, 3, 0, ~
## $ ITEM11 <dbl> 0, 4, 2, 0, 0, 0, 2, 6, 0, 1, 1, 0, 1, 1, 0, 0, 0, 0, 0, 3, 0, ~
## $ ITEM12 <dbl> 3, 3, 6, 0, 6, 0, 5, 0, 5, 5, 5, 5, 5, 5, 4, 6, 5, 5, 3, 6, 6, ~
## $ ITEM13 <dbl> 1, 3, 2, 0, 2, 5, 2, 5, 1, 1, 4, 0, 2, 1, 5, 2, 5, 1, 5, 0, 0, ~
## $ ITEM14 <dbl> 1, 3, 2, 3, 1, 5, 2, 3, 1, 1, 6, 1, 4, 2, 6, 6, 3, 3, 6, 2, 0, ~
## $ ITEM15 <dbl> 0, 1, 2, 0, 0, 0, 2, 4, 1, 2, 1, 0, 0, 0, 0, 1, 0, 1, 0, 0, 0, ~
## $ ITEM16 <dbl> 0, 4, 2, 0, 1, 6, 2, 3, 0, 1, 3, 0, 1, 0, 2, 2, 1, 3, 3, 0, 0, ~
## $ ITEM17 <dbl> 6, 4, 2, 6, 6, 5, 6, 4, 6, 6, 5, 6, 5, 5, 6, 6, 5, 6, 6, 6, 6, ~
## $ ITEM18 <dbl> 3, 5, 5, 4, 5, 1, 5, 1, 6, 6, 4, 5, 5, 4, 6, 6, 3, 5, 5, 6, 6, ~
## $ ITEM19 <dbl> 5, 5, 6, 6, 4, 3, 5, 1, 6, 6, 5, 6, 5, 3, 5, 6, 4, 5, 6, 5, 6, ~
## $ ITEM20 <dbl> 0, 1, 1, 3, 1, 1, 1, 5, 1, 0, 1, 0, 1, 0, 1, 4, 4, 2, 3, 0, 0, ~
## $ ITEM21 <dbl> 5, 3, 3, 6, 5, 5, 5, 3, 1, 5, 6, 5, 1, 5, 6, 5, 4, 5, 6, 6, 6, ~
## $ ITEM22 <dbl> 0, 2, 2, 0, 1, 0, 5, 1, 0, 1, 4, 1, 1, 1, 0, 0, 0, 5, 1, 0, 0, ~
```

```
MBIsec <- read_csv("MBISEC1.CSV", show_col_types = FALSE)
glimpse(MBIsec)
```

```
## Rows: 692
## Columns: 22
## $ ITEM1  <dbl> 3, 3, 5, 5, 1, 2, 5, 5, 1, 3, 5, 0, 1, 4, 4, 4, 5, 1, 2, 3, 2, ~
## $ ITEM2  <dbl> 4, 5, 5, 5, 2, 4, 5, 5, 3, 5, 5, 0, 3, 4, 5, 4, 5, 2, 2, 4, 3, ~
## $ ITEM3  <dbl> 0, 3, 5, 3, 1, 0, 2, 1, 3, 5, 4, 0, 1, 5, 3, 2, 3, 0, 2, 4, 0, ~
## $ ITEM4  <dbl> 6, 5, 5, 4, 6, 6, 5, 6, 3, 5, 6, 6, 6, 6, 4, 6, 6, 3, 6, 6, 4, ~
## $ ITEM5  <dbl> 0, 1, 0, 1, 1, 1, 0, 1, 1, 1, 2, 1, 0, 1, 5, 0, 0, 0, 1, 1, 0, ~
## $ ITEM6  <dbl> 2, 1, 5, 3, 3, 2, 3, 2, 1, 2, 4, 0, 0, 2, 5, 3, 1, 1, 0, 1, 1, ~
## $ ITEM7  <dbl> 6, 3, 5, 5, 5, 5, 5, 6, 5, 5, 5, 5, 6, 6, 3, 5, 4, 3, 4, 6, 6, ~
## $ ITEM8  <dbl> 1, 2, 5, 2, 1, 2, 2, 1, 1, 3, 1, 0, 1, 3, 3, 3, 3, 2, 0, 1, 1, ~
## $ ITEM9  <dbl> 5, 3, 4, 5, 5, 5, 5, 6, 6, 3, 6, 6, 6, 5, 1, 3, 4, 4, 5, 5, 6, ~
```

```
## $ ITEM10 <dbl> 1, 2, 1, 1, 0, 4, 2, 1, 1, 0, 0, 0, 0, 2, 2, 2, 0, 1, 1, 0, 0, ~
## $ ITEM11 <dbl> 2, 2, 2, 1, 0, 2, 1, 0, 1, 0, 0, 0, 0, 3, 1, 2, 0, 0, 0, 0, 1, ~
## $ ITEM12 <dbl> 5, 5, 5, 4, 2, 5, 5, 5, 5, 2, 4, 6, 6, 6, 4, 4, 4, 3, 4, 5, 6, ~
## $ ITEM13 <dbl> 1, 3, 5, 2, 1, 2, 4, 2, 1, 2, 6, 0, 0, 5, 5, 4, 3, 3, 2, 1, 1, ~
## $ ITEM14 <dbl> 3, 3, 4, 4, 1, 0, 3, 4, 1, 5, 4, 0, 1, 3, 4, 2, 4, 4, 1, 2, 1, ~
## $ ITEM15 <dbl> 0, 2, 0, 0, 1, 1, 1, 0, 0, 1, 1, 0, 0, 1, 2, 0, 0, 2, 1, 0, 0, ~
## $ ITEM16 <dbl> 3, 2, 1, 1, 3, 1, 3, 1, 1, 3, 4, 0, 0, 1, 3, 3, 3, 1, 1, 1, 1, ~
## $ ITEM17 <dbl> 6, 5, 5, 5, 4, 5, 5, 6, 6, 6, 5, 6, 6, 6, 4, 6, 6, 5, 5, 5, 6, ~
## $ ITEM18 <dbl> 5, 5, 4, 4, 4, 5, 5, 5, 5, 4, 6, 6, 6, 6, 5, 4, 6, 4, 5, 5, 6, ~
## $ ITEM19 <dbl> 5, 5, 4, 5, 5, 4, 3, 5, 6, 4, 5, 6, 6, 6, 3, 3, 4, 5, 4, 5, 6, ~
## $ ITEM20 <dbl> 1, 0, 4, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0, 1, 2, 0, 2, 0, 1, 1, 0, ~
## $ ITEM21 <dbl> 5, 5, 4, 3, 4, 3, 5, 6, 3, 3, 5, 3, 6, 6, 4, 6, 0, 1, 5, 6, 6, ~
## $ ITEM22 <dbl> 1, 1, 0, 1, 5, 2, 1, 1, 2, 2, 2, 1, 2, 1, 4, 0, 0, 0, 1, 0, 1, ~
```

Explore the data (always do that!):

```
library(psych)
```

```
##
## Attaching package: 'psych'
```

```
## The following objects are masked from 'package:ggplot2':
##
##     %+%, alpha
```

```
library(dplyr)
library(knitr)
library(tidyr)
library(corrplot)
```

```
## corrplot 0.92 loaded
```

```
# basic statistics of Elementary teachers:
MBIelm %>% describe() %>%
  as.data.frame() %>%
  select(mean, sd, min, max) %>%
  kable(digits = 2)
```

	mean	sd	min	max
ITEM1	3.41	1.66	0	6
ITEM2	3.98	1.57	0	6
ITEM3	2.57	1.71	0	6
ITEM4	5.41	0.93	0	6
ITEM5	1.05	1.48	0	6
ITEM6	1.68	1.66	0	6
ITEM7	5.34	0.88	1	6
ITEM8	2.18	1.81	0	6
ITEM9	5.03	1.33	0	6
ITEM10	1.16	1.48	0	6

	mean	sd	min	max
ITEM11	1.12	1.51	0	6
ITEM12	4.69	1.29	0	6
ITEM13	2.55	1.72	0	6
ITEM14	3.12	1.82	0	6
ITEM15	0.54	1.12	0	6
ITEM16	1.43	1.52	0	6
ITEM17	5.42	0.88	1	6
ITEM18	4.88	1.22	0	6
ITEM19	5.01	1.13	1	6
ITEM20	1.28	1.44	0	6
ITEM21	4.84	1.29	0	6
ITEM22	1.33	1.54	0	6

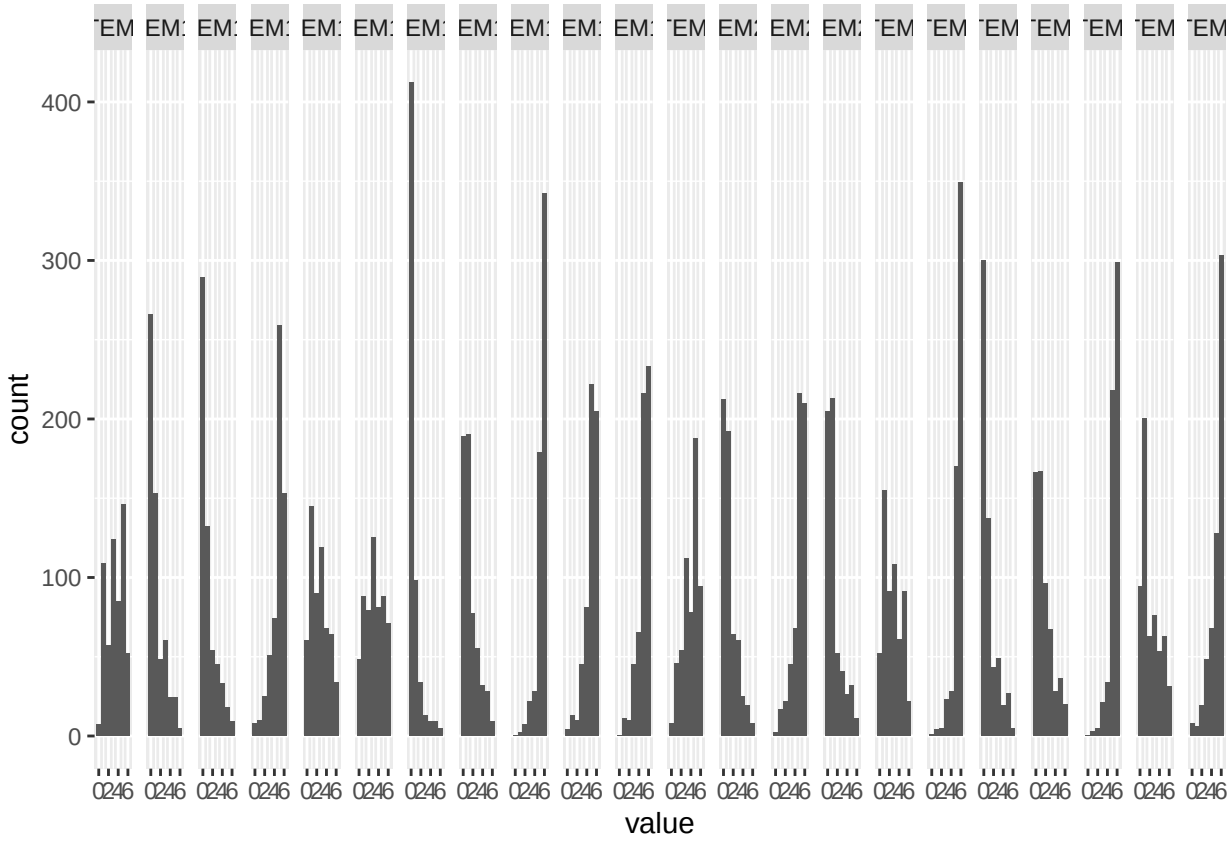
```
# basic statistics of Secondary teachers:
MBIsec %>% describe() %>%
  as.data.frame() %>%
  select(mean, sd, min, max) %>%
  kable(digits = 2)
```

	mean	sd	min	max
ITEM1	3.37	1.59	0	6
ITEM2	3.89	1.53	0	6
ITEM3	2.53	1.70	0	6
ITEM4	5.17	1.10	0	6
ITEM5	1.22	1.47	0	6
ITEM6	2.00	1.65	0	6
ITEM7	5.01	1.14	0	6
ITEM8	2.14	1.71	0	6
ITEM9	4.70	1.49	0	6
ITEM10	1.27	1.57	0	6
ITEM11	1.17	1.57	0	6
ITEM12	4.53	1.34	0	6
ITEM13	2.65	1.67	0	6
ITEM14	3.15	1.77	0	6
ITEM15	1.08	1.42	0	6
ITEM16	1.55	1.45	0	6
ITEM17	5.30	0.96	0	6
ITEM18	4.71	1.17	0	6
ITEM19	4.60	1.30	0	6
ITEM20	1.21	1.40	0	6
ITEM21	4.46	1.51	0	6
ITEM22	1.79	1.60	0	6

```
nrow(MBIelm)
```

```
## [1] 580
```

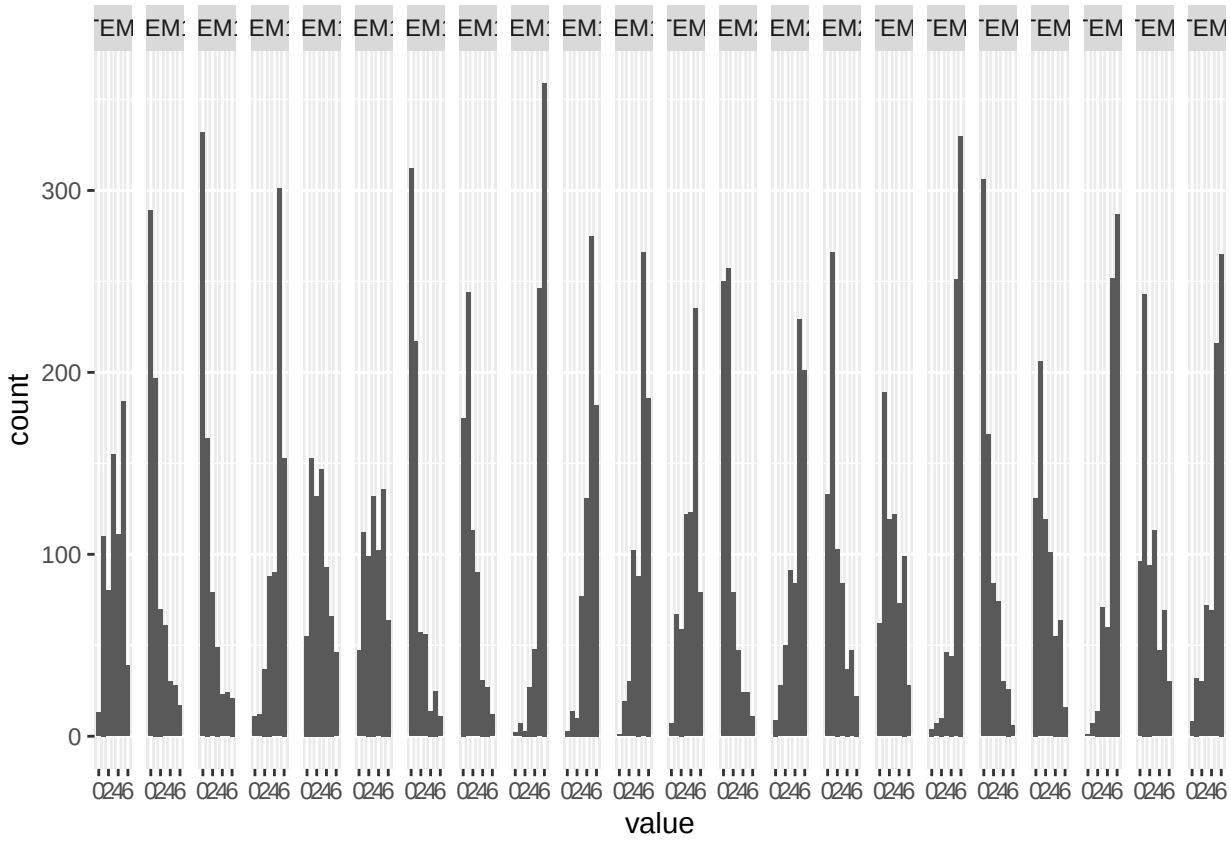
```
# histogram of Elementary Teachers:
MBIelm %>% pivot_longer(cols = everything()) %>%
  ggplot(aes(x = value)) +
  geom_histogram(binwidth = 1) +
  facet_wrap(~name, nrow = 580, ncol = 22)
```




```
nrow(MBIsec)
```

```
## [1] 692
```

```
# histogram of Secondary Teachers:
MBIsec %>% pivot_longer(cols = everything()) %>%
  ggplot(aes(x = value)) +
  geom_histogram(binwidth = 1) +
  facet_wrap(~name, nrow = 692, ncol = 22)
```




```
# correlation matrix of Elementary Teachers:
MBIelm %>% cor() %>% round(digits = 2)
```

```
##        ITEM1 ITEM2 ITEM3 ITEM4 ITEM5 ITEM6 ITEM7 ITEM8 ITEM9 ITEM10 ITEM11
## ITEM1   1.00  0.73  0.60 -0.04  0.25  0.44 -0.07  0.67 -0.15   0.31   0.34
## ITEM2   0.73  1.00  0.57 -0.05  0.22  0.42 -0.06  0.65 -0.12   0.28   0.31
## ITEM3   0.60  0.57  1.00 -0.09  0.34  0.48 -0.15  0.65 -0.23   0.30   0.36
## ITEM4  -0.04 -0.05 -0.09  1.00 -0.15 -0.07  0.42 -0.12  0.22  -0.16  -0.17
## ITEM5   0.25  0.22  0.34 -0.15  1.00  0.41 -0.23  0.30 -0.20   0.43   0.39
## ITEM6   0.44  0.42  0.48 -0.07  0.41  1.00 -0.17  0.51 -0.13   0.36   0.35
## ITEM7  -0.07 -0.06 -0.15  0.42 -0.23 -0.17  1.00 -0.18  0.29  -0.16  -0.18
## ITEM8   0.67  0.65  0.65 -0.12  0.30  0.51 -0.18  1.00 -0.25   0.36   0.44
## ITEM9  -0.15 -0.12 -0.23  0.22 -0.20 -0.13  0.29 -0.25  1.00  -0.19  -0.18
## ITEM10  0.31  0.28  0.30 -0.16  0.43  0.36 -0.16  0.36 -0.19   1.00   0.68
## ITEM11  0.34  0.31  0.36 -0.17  0.39  0.35 -0.18  0.44 -0.18   0.68   1.00
## ITEM12 -0.36 -0.35 -0.51  0.19 -0.23 -0.36  0.26 -0.49  0.39  -0.28  -0.32
## ITEM13  0.56  0.53  0.53 -0.13  0.34  0.46 -0.18  0.63 -0.28   0.40   0.44
## ITEM14  0.53  0.56  0.49 -0.02  0.21  0.35 -0.08  0.53 -0.08   0.23   0.30
## ITEM15  0.25  0.22  0.27 -0.20  0.43  0.32 -0.24  0.31 -0.15   0.36   0.35
## ITEM16  0.42  0.40  0.42 -0.11  0.42  0.72 -0.16  0.54 -0.14   0.40   0.39
## ITEM17 -0.21 -0.23 -0.25  0.38 -0.28 -0.28  0.36 -0.33  0.38  -0.35  -0.26
## ITEM18 -0.12 -0.09 -0.21  0.24 -0.19 -0.19  0.27 -0.23  0.32  -0.26  -0.19
## ITEM19 -0.11 -0.12 -0.21  0.23 -0.23 -0.23  0.31 -0.16  0.44  -0.23  -0.18
## ITEM20  0.51  0.49  0.52 -0.13  0.31  0.43 -0.16  0.67 -0.24   0.38   0.40
## ITEM21 -0.10 -0.11 -0.16  0.26 -0.18 -0.19  0.31 -0.18  0.30  -0.17  -0.18
## ITEM22  0.24  0.21  0.21 -0.07  0.30  0.22 -0.15  0.19 -0.06   0.24   0.25
```

```
##        ITEM12 ITEM13 ITEM14 ITEM15 ITEM16 ITEM17 ITEM18 ITEM19 ITEM20 ITEM21
## ITEM1   -0.36   0.56   0.53   0.25   0.42  -0.21  -0.12  -0.11   0.51  -0.10
## ITEM2   -0.35   0.53   0.56   0.22   0.40  -0.23  -0.09  -0.12   0.49  -0.11
## ITEM3   -0.51   0.53   0.49   0.27   0.42  -0.25  -0.21  -0.21   0.52  -0.16
## ITEM4    0.19  -0.13  -0.02  -0.20  -0.11   0.38   0.24   0.23  -0.13   0.26
## ITEM5   -0.23   0.34   0.21   0.43   0.42  -0.28  -0.19  -0.23   0.31  -0.18
## ITEM6   -0.36   0.46   0.35   0.32   0.72  -0.28  -0.19  -0.23   0.43  -0.19
## ITEM7    0.26  -0.18  -0.08  -0.24  -0.16   0.36   0.27   0.31  -0.16   0.31
## ITEM8   -0.49   0.63   0.53   0.31   0.54  -0.33  -0.23  -0.16   0.67  -0.18
## ITEM9    0.39  -0.28  -0.08  -0.15  -0.14   0.38   0.32   0.44  -0.24   0.30
## ITEM10  -0.28   0.40   0.23   0.36   0.40  -0.35  -0.26  -0.23   0.38  -0.17
## ITEM11  -0.32   0.44   0.30   0.35   0.39  -0.26  -0.19  -0.18   0.40  -0.18
## ITEM12   1.00  -0.34  -0.26  -0.19  -0.38   0.39   0.38   0.37  -0.42   0.27
## ITEM13  -0.34   1.00   0.56   0.27   0.47  -0.28  -0.24  -0.22   0.62  -0.16
## ITEM14  -0.26   0.56   1.00   0.18   0.39  -0.14  -0.05  -0.03   0.47  -0.07
## ITEM15  -0.19   0.27   0.18   1.00   0.34  -0.24  -0.18  -0.18   0.28  -0.15
## ITEM16  -0.38   0.47   0.39   0.34   1.00  -0.29  -0.18  -0.17   0.48  -0.19
## ITEM17   0.39  -0.28  -0.14  -0.24  -0.29   1.00   0.45   0.40  -0.31   0.25
## ITEM18   0.38  -0.24  -0.05  -0.18  -0.18   0.45   1.00   0.54  -0.21   0.21
## ITEM19   0.37  -0.22  -0.03  -0.18  -0.17   0.40   0.54   1.00  -0.18   0.23
## ITEM20  -0.42   0.62   0.47   0.28   0.48  -0.31  -0.21  -0.18   1.00  -0.15
## ITEM21   0.27  -0.16  -0.07  -0.15  -0.19   0.25   0.21   0.23  -0.15   1.00
## ITEM22  -0.10   0.25   0.16   0.20   0.24  -0.21  -0.07  -0.15   0.22  -0.02
##        ITEM22
## ITEM1    0.24
## ITEM2    0.21
## ITEM3    0.21
## ITEM4   -0.07
## ITEM5    0.30
## ITEM6    0.22
## ITEM7   -0.15
## ITEM8    0.19
## ITEM9   -0.06
## ITEM10   0.24
## ITEM11   0.25
## ITEM12  -0.10
## ITEM13   0.25
## ITEM14   0.16
## ITEM15   0.20
## ITEM16   0.24
## ITEM17  -0.21
## ITEM18  -0.07
## ITEM19  -0.15
## ITEM20   0.22
## ITEM21  -0.02
## ITEM22   1.00
```

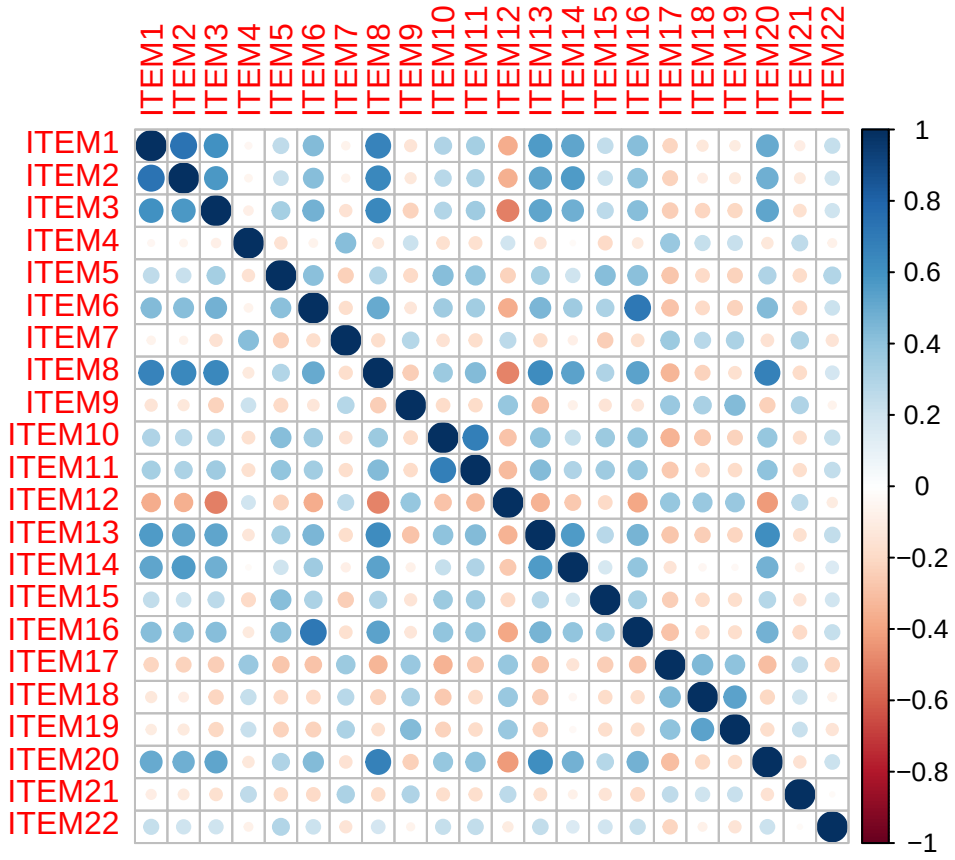
```
# correlation matrix of Secondary Teachers:
MBIsec %>% cor() %>% round(digits = 2)
```

```
##        ITEM1 ITEM2 ITEM3 ITEM4 ITEM5 ITEM6 ITEM7 ITEM8 ITEM9 ITEM10 ITEM11
## ITEM1   1.00  0.74  0.59  0.02  0.14  0.44 -0.05  0.60 -0.11   0.23   0.31
## ITEM2   0.74  1.00  0.59  0.00  0.17  0.44 -0.05  0.58 -0.09   0.19   0.25
## ITEM3   0.59  0.59  1.00 -0.05  0.19  0.41 -0.08  0.62 -0.18   0.26   0.36
```

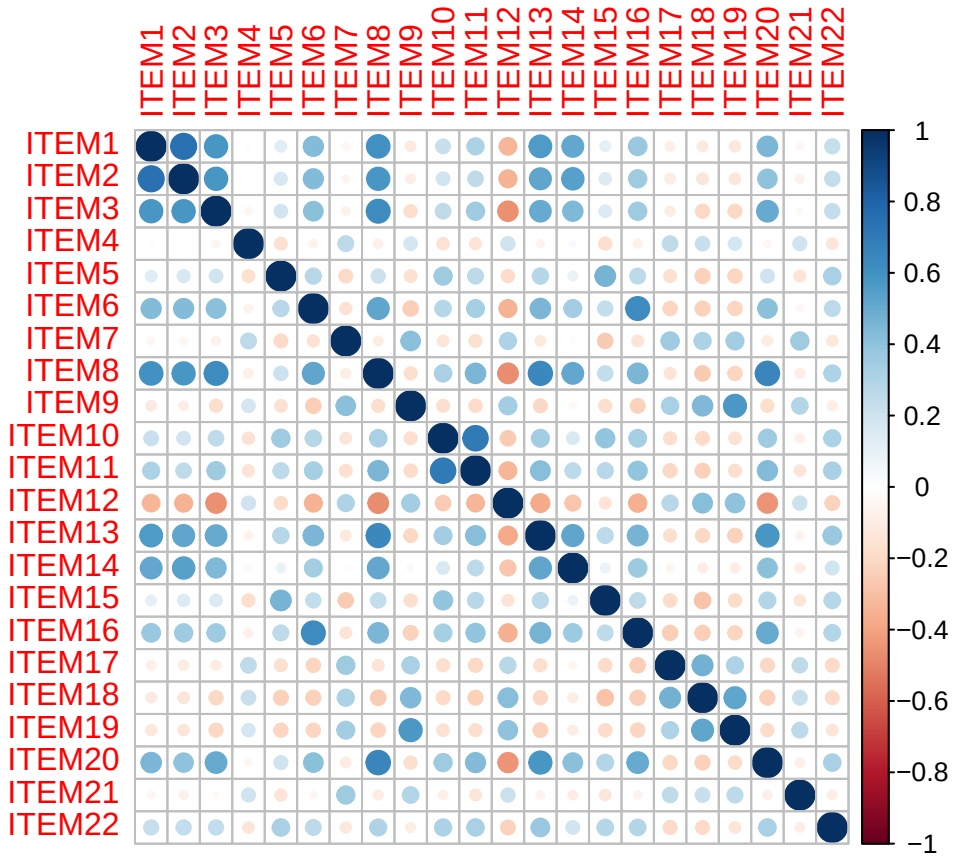
```
## ITEM4   0.02  0.00 -0.05  1.00 -0.17 -0.07  0.26 -0.09  0.19  -0.16  -0.15
## ITEM5   0.14  0.17  0.19 -0.17  1.00  0.28 -0.20  0.21 -0.17   0.36   0.27
## ITEM6   0.44  0.44  0.41 -0.07  0.28  1.00 -0.15  0.52 -0.25   0.29   0.34
## ITEM7  -0.05 -0.05 -0.08  0.26 -0.20 -0.15  1.00 -0.09  0.41  -0.14  -0.17
## ITEM8   0.60  0.58  0.62 -0.09  0.21  0.52 -0.09  1.00 -0.17   0.32   0.45
## ITEM9  -0.11 -0.09 -0.18  0.19 -0.17 -0.25  0.41 -0.17  1.00  -0.17  -0.18
## ITEM10  0.23  0.19  0.26 -0.16  0.36  0.29 -0.14  0.32 -0.17   1.00   0.71
## ITEM11  0.31  0.25  0.36 -0.15  0.27  0.34 -0.17  0.45 -0.18   0.71   1.00
## ITEM12 -0.33 -0.35 -0.45  0.21 -0.18 -0.34  0.31 -0.46  0.35  -0.25  -0.34
## ITEM13  0.56  0.52  0.50 -0.07  0.28  0.45 -0.11  0.64 -0.20   0.34   0.42
## ITEM14  0.52  0.54  0.44  0.04  0.09  0.34  0.01  0.51 -0.04   0.16   0.26
## ITEM15  0.11  0.15  0.16 -0.18  0.46  0.24 -0.25  0.25 -0.18   0.39   0.27
## ITEM16  0.37  0.36  0.36 -0.08  0.27  0.63 -0.14  0.46 -0.23   0.33   0.39
## ITEM17 -0.09 -0.11 -0.10  0.26 -0.17 -0.22  0.36 -0.14  0.32  -0.18  -0.21
## ITEM18 -0.11 -0.14 -0.21  0.22 -0.24 -0.24  0.31 -0.25  0.45  -0.20  -0.23
## ITEM19 -0.13 -0.13 -0.20  0.18 -0.21 -0.21  0.34 -0.22  0.58  -0.16  -0.17
## ITEM20  0.45  0.40  0.51 -0.05  0.20  0.41 -0.11  0.65 -0.18   0.35   0.44
## ITEM21 -0.05 -0.07 -0.04  0.20 -0.15 -0.05  0.36 -0.10  0.29  -0.09  -0.14
## ITEM22  0.24  0.24  0.24 -0.14  0.33  0.26 -0.13  0.31 -0.10   0.31   0.32
##        ITEM12 ITEM13 ITEM14 ITEM15 ITEM16 ITEM17 ITEM18 ITEM19 ITEM20 ITEM21
## ITEM1   -0.33   0.56   0.52   0.11   0.37  -0.09  -0.11  -0.13   0.45  -0.05
## ITEM2   -0.35   0.52   0.54   0.15   0.36  -0.11  -0.14  -0.13   0.40  -0.07
## ITEM3   -0.45   0.50   0.44   0.16   0.36  -0.10  -0.21  -0.20   0.51  -0.04
## ITEM4    0.21  -0.07   0.04  -0.18  -0.08   0.26   0.22   0.18  -0.05   0.20
## ITEM5   -0.18   0.28   0.09   0.46   0.27  -0.17  -0.24  -0.21   0.20  -0.15
## ITEM6   -0.34   0.45   0.34   0.24   0.63  -0.22  -0.24  -0.21   0.41  -0.05
## ITEM7    0.31  -0.11   0.01  -0.25  -0.14   0.36   0.31   0.34  -0.11   0.36
## ITEM8   -0.46   0.64   0.51   0.25   0.46  -0.14  -0.25  -0.22   0.65  -0.10
## ITEM9    0.35  -0.20  -0.04  -0.18  -0.23   0.32   0.45   0.58  -0.18   0.29
## ITEM10  -0.25   0.34   0.16   0.39   0.33  -0.18  -0.20  -0.16   0.35  -0.09
## ITEM11  -0.34   0.42   0.26   0.27   0.39  -0.21  -0.23  -0.17   0.44  -0.14
## ITEM12   1.00  -0.38  -0.27  -0.14  -0.36   0.28   0.42   0.40  -0.44   0.21
## ITEM13  -0.38   1.00   0.53   0.27   0.46  -0.17  -0.21  -0.22   0.58  -0.07
## ITEM14  -0.27   0.53   1.00   0.09   0.36  -0.05  -0.10  -0.10   0.41  -0.09
## ITEM15  -0.14   0.27   0.09   1.00   0.26  -0.19  -0.29  -0.18   0.30  -0.13
## ITEM16  -0.36   0.46   0.36   0.26   1.00  -0.25  -0.24  -0.22   0.51  -0.06
## ITEM17   0.28  -0.17  -0.05  -0.19  -0.25   1.00   0.47   0.31  -0.21   0.25
## ITEM18   0.42  -0.21  -0.10  -0.29  -0.24   0.47   1.00   0.52  -0.23   0.23
## ITEM19   0.40  -0.22  -0.10  -0.18  -0.22   0.31   0.52   1.00  -0.18   0.27
## ITEM20  -0.44   0.58   0.41   0.30   0.51  -0.21  -0.23  -0.18   1.00  -0.08
## ITEM21   0.21  -0.07  -0.09  -0.13  -0.06   0.25   0.23   0.27  -0.08   1.00
## ITEM22  -0.23   0.37   0.20   0.29   0.29  -0.20  -0.20  -0.14   0.32  -0.09
##        ITEM22
## ITEM1    0.24
## ITEM2    0.24
## ITEM3    0.24
## ITEM4   -0.14
## ITEM5    0.33
## ITEM6    0.26
## ITEM7   -0.13
## ITEM8    0.31
## ITEM9   -0.10
## ITEM10   0.31
## ITEM11   0.32
```

```
## ITEM12  -0.23
## ITEM13   0.37
## ITEM14   0.20
## ITEM15   0.29
## ITEM16   0.29
## ITEM17  -0.20
## ITEM18  -0.20
## ITEM19  -0.14
## ITEM20   0.32
## ITEM21  -0.09
## ITEM22   1.00
```

```
# correlation plot of Elementary Teachers:
MBIelm %>% cor() %>% corrplot()
```




```
# correlation plot of Secondary Teachers:
MBIsec %>% cor() %>% corrplot()
```



Results from Exploratory Data Analysis (EDA) - Elementary teacher scores vary from 0 or 1 to 6 - Secondary teachers scores vary from 0 to 6 - histograms of each items of both populations are very skewed to one or other direction - Item 1, 2 and 3 clustered with correlation among Elementary Teachers AND Secondary teachers - Item 12, 13 an 14 clustered in both populations - Correlation plots of populations visually represent each other

Define and estimate the initial baseline models (for elementary and secondary teachers):

Complete the model definition first (see Assignment 3).

```
library(lavaan)
```

```
## This is lavaan 0.6-13
## lavaan is FREE software! Please report any bugs.

##
## Attaching package: 'lavaan'

## The following object is masked from 'package:psych':
##
##     cor2cov
```

```
# Define a CFA model using the lavaan (Latent Variable Analysis) syntax:
# see https://lavaan.ugent.be/tutorial/syntax1.html
```

```
BLmodel <- '
# CFA model for the burnout, the baseline model:
# EE: EmotionalExhaustion
# DP: Depersonalization
# PA: PersonalAccomplishment
  EE =~ ITEM1 + ITEM2 + ITEM3 + ITEM6 + ITEM8 + ITEM13 + ITEM14 + ITEM16 + ITEM20
  DP =~ ITEM5 + ITEM10 + ITEM11 + ITEM15 + ITEM22
  PA =~ ITEM4 + ITEM7 + ITEM9 + ITEM12 + ITEM17 + ITEM18 + ITEM19 + ITEM21
'
```

The initial baseline model (BLmodel above) is the same for both groups, but the data sets are of course different.

Now, begin by estimating the model **separately for both groups**.

Then follow the instructions above (Exercise 5.1) until you have the final baseline models for each group.

This time I will give you much more detailed instructions, as you will see...

```
# Use a robust (MLM) estimator:
cfaELM1<- cfa(BLmodel, data = MBIelm, estimator = "MLM")

# Numerical summary of the model:
summary(cfaELM1, fit.measures = TRUE, standardized = TRUE)
```

Initial Baseline Model for Elementary Teachers (Model 1)

```
## lavaan 0.6.13 ended normally after 51 iterations
##
##   Estimator                                         ML
##   Optimization method                           NLMINB
##   Number of model parameters                        47
##
##   Number of observations                           580
##
## Model Test User Model:
##                                              Standard      Scaled
##   Test Statistic                             1012.654     802.743
##   Degrees of freedom                              206         206
##   P-value (Chi-square)                          0.000       0.000
##   Scaling correction factor                                 1.261
##     Satorra-Bentler correction
##
## Model Test Baseline Model:
##
##   Test statistic                             5608.130    4354.842
##   Degrees of freedom                              231         231
##   P-value                                       0.000       0.000
##   Scaling correction factor                                 1.288
##
## User Model versus Baseline Model:
##
```

```
##   Comparative Fit Index (CFI)                    0.850       0.855
##   Tucker-Lewis Index (TLI)                       0.832       0.838
##
##   Robust Comparative Fit Index (CFI)                         0.858
##   Robust Tucker-Lewis Index (TLI)                            0.841
##
## Loglikelihood and Information Criteria:
##
##   Loglikelihood user model (H0)             -19894.031  -19894.031
##   Loglikelihood unrestricted model (H1)     -19387.704  -19387.704
##
##   Akaike (AIC)                               39882.062   39882.062
##   Bayesian (BIC)                             40087.125   40087.125
##   Sample-size adjusted Bayesian (SABIC)      39937.918   39937.918
##
## Root Mean Square Error of Approximation:
##
##   RMSEA                                          0.082       0.071
##   90 Percent confidence interval - lower         0.077       0.066
##   90 Percent confidence interval - upper         0.087       0.075
##   P-value H_0: RMSEA <= 0.050                    0.000       0.000
##   P-value H_0: RMSEA >= 0.080                    0.764       0.000
##
##   Robust RMSEA                                               0.079
##   90 Percent confidence interval - lower                     0.074
##   90 Percent confidence interval - upper                     0.085
##   P-value H_0: Robust RMSEA <= 0.050                         0.000
##   P-value H_0: Robust RMSEA >= 0.080                         0.437
##
## Standardized Root Mean Square Residual:
##
##   SRMR                                           0.071       0.071
##
## Parameter Estimates:
##
##   Standard errors                             Robust.sem
##   Information                                   Expected
##   Information saturated (h1) model          Structured
##
## Latent Variables:
##                    Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
##   EE =~
##     ITEM1             1.000                               1.287    0.776
##     ITEM2             0.921    0.032   28.706    0.000    1.185    0.754
##     ITEM3             0.983    0.044   22.313    0.000    1.266    0.740
##     ITEM6             0.812    0.054   14.952    0.000    1.045    0.631
##     ITEM8             1.204    0.043   27.901    0.000    1.550    0.855
##     ITEM13            1.009    0.045   22.419    0.000    1.299    0.754
##     ITEM14            0.927    0.046   20.274    0.000    1.193    0.655
##     ITEM16            0.755    0.052   14.433    0.000    0.972    0.640
##     ITEM20            0.820    0.048   16.960    0.000    1.055    0.734
##   DP =~
##     ITEM5             1.000                               0.850    0.576
##     ITEM10            1.378    0.126   10.979    0.000    1.172    0.794
```

```
##     ITEM11            1.409    0.129   10.922    0.000    1.198    0.793
##     ITEM15            0.666    0.082    8.143    0.000    0.566    0.505
##     ITEM22            0.637    0.093    6.859    0.000    0.541    0.351
##   PA =~
##     ITEM4             1.000                               0.417    0.447
##     ITEM7             1.081    0.152    7.093    0.000    0.451    0.516
##     ITEM9             1.855    0.299    6.203    0.000    0.774    0.581
##     ITEM12            1.885    0.321    5.867    0.000    0.787    0.611
##     ITEM17            1.443    0.194    7.431    0.000    0.602    0.681
##     ITEM18            1.828    0.288    6.343    0.000    0.763    0.628
##     ITEM19            1.745    0.268    6.503    0.000    0.728    0.643
##     ITEM21            1.314    0.194    6.773    0.000    0.548    0.425
##
## Covariances:
##                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
##   EE ~~
##     DP               0.688    0.084    8.188    0.000    0.628    0.628
##     PA              -0.254    0.038   -6.695    0.000   -0.473   -0.473
##   DP ~~
##     PA              -0.184    0.037   -4.942    0.000   -0.518   -0.518
##
## Variances:
##                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
##    .ITEM1             1.095    0.072   15.314    0.000    1.095    0.398
##    .ITEM2             1.067    0.068   15.711    0.000    1.067    0.432
##    .ITEM3             1.322    0.105   12.529    0.000    1.322    0.452
##    .ITEM6             1.655    0.120   13.818    0.000    1.655    0.602
##    .ITEM8             0.886    0.075   11.838    0.000    0.886    0.269
##    .ITEM13            1.281    0.104   12.284    0.000    1.281    0.431
##    .ITEM14            1.897    0.123   15.429    0.000    1.897    0.571
##    .ITEM16            1.363    0.098   13.966    0.000    1.363    0.591
##    .ITEM20            0.954    0.096    9.923    0.000    0.954    0.461
##    .ITEM5             1.459    0.138   10.539    0.000    1.459    0.669
##    .ITEM10            0.806    0.100    8.061    0.000    0.806    0.370
##    .ITEM11            0.848    0.113    7.539    0.000    0.848    0.372
##    .ITEM15            0.934    0.128    7.323    0.000    0.934    0.745
##    .ITEM22            2.086    0.159   13.152    0.000    2.086    0.877
##    .ITEM4             0.696    0.085    8.233    0.000    0.696    0.800
##    .ITEM7             0.562    0.073    7.714    0.000    0.562    0.734
##    .ITEM9             1.176    0.131    9.007    0.000    1.176    0.662
##    .ITEM12            1.039    0.109    9.546    0.000    1.039    0.627
##    .ITEM17            0.418    0.055    7.643    0.000    0.418    0.536
##    .ITEM18            0.894    0.120    7.447    0.000    0.894    0.606
##    .ITEM19            0.753    0.075   10.101    0.000    0.753    0.587
##    .ITEM21            1.360    0.130   10.435    0.000    1.360    0.819
##     EE                1.657    0.112   14.736    0.000    1.000    1.000
##     DP                0.723    0.129    5.608    0.000    1.000    1.000
##     PA                0.174    0.047    3.686    0.000    1.000    1.000
```

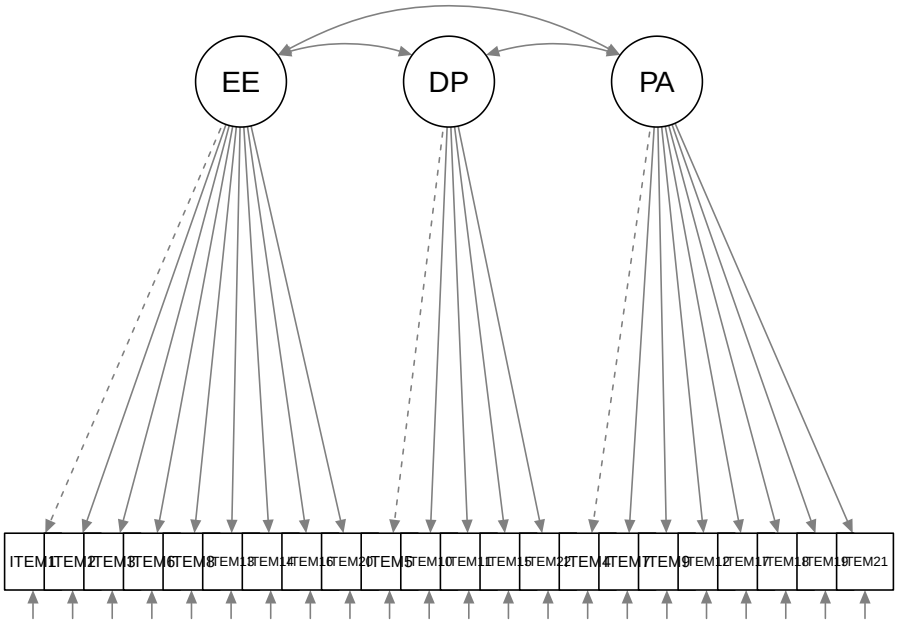
```r
# Model results to a convenient table format
library(knitr)
fit_elm1 <- fitMeasures(cfaELM1, c("chisq.scaled", "cfi.robust", "tli.robust", "rmsea.robust", "rmsea.c
ELM1 <- as.data.frame(t(fit_elm1))
colnames(ELM1) <- c("Chisq", "CFI", "TLI", "RMSEA", "CI lower", "CI upper")
```

```
fit_table <- rbind(ELM1)
rownames(fit_table) <- c("ELM1")
kable(fit_table, digits = 3, align = "lcccc", booktabs = TRUE,
             caption = "Multigroup baseline model for both groups")
```

Table 3: Multigroup baseline model for both groups

	Chisq	CFI	TLI	RMSEA	CI lower	CI upper
ELM1	802.743	0.858	0.841	0.079	0.074	0.085

```
# Visualize the CFA model
library(semPlot)
semPaths(cfaELM1, style = "lisrel")
```




```
# Use a robust (MLM) estimator:
cfaSEC1<- cfa(BLmodel, data = MBIsec, estimator = "MLM")

# Numerical summary of the model:
summary(cfaSEC1, fit.measures = TRUE, standardized = TRUE)
```

Initial Baseline Model for Secondary Teachers (Model 1)

```
## lavaan 0.6.13 ended normally after 52 iterations
##
##   Estimator                                         ML
##   Optimization method                           NLMINB
##   Number of model parameters                        47
##
##   Number of observations                           692
##
## Model Test User Model:
##                                              Standard      Scaled
##   Test Statistic                             1283.053     971.064
##   Degrees of freedom                              206         206
##   P-value (Chi-square)                          0.000       0.000
##   Scaling correction factor                                 1.321
##     Satorra-Bentler correction
##
## Model Test Baseline Model:
##
##   Test statistic                             6432.706    4901.792
##   Degrees of freedom                              231         231
##   P-value                                       0.000       0.000
##   Scaling correction factor                                 1.312
##
## User Model versus Baseline Model:
##
##   Comparative Fit Index (CFI)                   0.826       0.836
##   Tucker-Lewis Index (TLI)                      0.805       0.816
##
##   Robust Comparative Fit Index (CFI)                        0.835
##   Robust Tucker-Lewis Index (TLI)                           0.815
##
## Loglikelihood and Information Criteria:
##
##   Loglikelihood user model (H0)            -24601.135  -24601.135
##   Loglikelihood unrestricted model (H1)    -23959.608  -23959.608
##
##   Akaike (AIC)                              49296.269   49296.269
##   Bayesian (BIC)                            49509.630   49509.630
##   Sample-size adjusted Bayesian (SABIC)     49360.397   49360.397
##
## Root Mean Square Error of Approximation:
##
##   RMSEA                                         0.087       0.073
##   90 Percent confidence interval - lower        0.082       0.069
##   90 Percent confidence interval - upper        0.092       0.077
##   P-value H_0: RMSEA <= 0.050                   0.000       0.000
##   P-value H_0: RMSEA >= 0.080                   0.994       0.003
##
##   Robust RMSEA                                              0.084
##   90 Percent confidence interval - lower                    0.079
##   90 Percent confidence interval - upper                    0.090
##   P-value H_0: Robust RMSEA <= 0.050                        0.000
##   P-value H_0: Robust RMSEA >= 0.080                        0.905
##
```

```
## Standardized Root Mean Square Residual:
##
##   SRMR                                           0.080       0.080
##
## Parameter Estimates:
##
##   Standard errors                             Robust.sem
##   Information                                   Expected
##   Information saturated (h1) model          Structured
##
## Latent Variables:
##                    Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
##   EE =~
##     ITEM1             1.000                               1.198    0.756
##     ITEM2             0.938    0.033   28.647    0.000    1.124    0.736
##     ITEM3             1.024    0.045   22.585    0.000    1.227    0.722
##     ITEM6             0.861    0.055   15.747    0.000    1.032    0.626
##     ITEM8             1.187    0.048   24.902    0.000    1.422    0.833
##     ITEM13            1.061    0.046   23.020    0.000    1.272    0.762
##     ITEM14            0.938    0.045   20.660    0.000    1.124    0.634
##     ITEM16            0.720    0.055   13.186    0.000    0.863    0.596
##     ITEM20            0.828    0.054   15.401    0.000    0.992    0.707
##   DP =~
##     ITEM5             1.000                               0.665    0.453
##     ITEM10            1.929    0.213    9.078    0.000    1.282    0.820
##     ITEM11            1.908    0.231    8.264    0.000    1.268    0.808
##     ITEM15            1.006    0.106    9.501    0.000    0.668    0.472
##     ITEM22            1.076    0.146    7.368    0.000    0.716    0.447
##   PA =~
##     ITEM4             1.000                               0.375    0.340
##     ITEM7             1.653    0.229    7.214    0.000    0.620    0.545
##     ITEM9             2.714    0.390    6.949    0.000    1.017    0.681
##     ITEM12            2.093    0.300    6.988    0.000    0.785    0.586
##     ITEM17            1.402    0.201    6.976    0.000    0.526    0.546
##     ITEM18            2.183    0.305    7.157    0.000    0.818    0.698
##     ITEM19            2.450    0.335    7.320    0.000    0.918    0.706
##     ITEM21            1.650    0.253    6.512    0.000    0.618    0.410
##
## Covariances:
##                    Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
##   EE ~~
##     DP                0.451    0.061    7.400    0.000    0.566    0.566
##     PA               -0.177    0.029   -6.017    0.000   -0.393   -0.393
##   DP ~~
##     PA               -0.106    0.024   -4.433    0.000   -0.425   -0.425
##
## Variances:
##                    Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
##    .ITEM1             1.078    0.067   16.068    0.000    1.078    0.429
##    .ITEM2             1.071    0.070   15.390    0.000    1.071    0.459
##    .ITEM3             1.383    0.091   15.211    0.000    1.383    0.479
##    .ITEM6             1.656    0.112   14.817    0.000    1.656    0.609
##    .ITEM8             0.890    0.069   12.918    0.000    0.890    0.306
##    .ITEM13            1.167    0.081   14.325    0.000    1.167    0.419
```

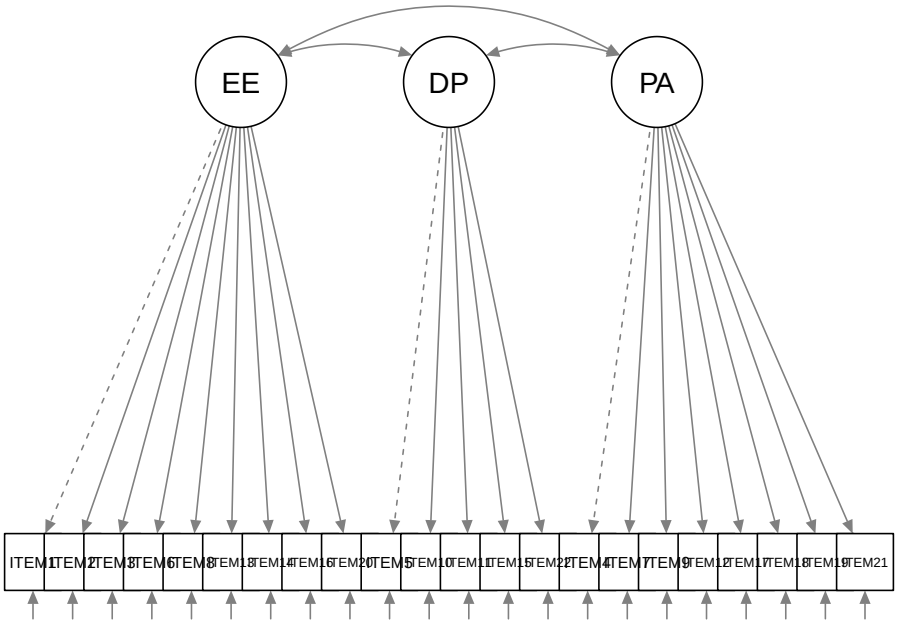
```
##    .ITEM14           1.883    0.116   16.262    0.000    1.883    0.599
##    .ITEM16           1.353    0.094   14.332    0.000    1.353    0.645
##    .ITEM20           0.983    0.068   14.431    0.000    0.983    0.500
##    .ITEM5            1.711    0.117   14.679    0.000    1.711    0.795
##    .ITEM10           0.803    0.093    8.668    0.000    0.803    0.328
##    .ITEM11           0.854    0.114    7.517    0.000    0.854    0.347
##    .ITEM15           1.562    0.134   11.628    0.000    1.562    0.778
##    .ITEM22           2.052    0.128   16.020    0.000    2.052    0.800
##    .ITEM4            1.074    0.111    9.652    0.000    1.074    0.884
##    .ITEM7            0.907    0.070   12.961    0.000    0.907    0.703
##    .ITEM9            1.194    0.114   10.436    0.000    1.194    0.536
##    .ITEM12           1.177    0.109   10.779    0.000    1.177    0.657
##    .ITEM17           0.649    0.076    8.553    0.000    0.649    0.701
##    .ITEM18           0.703    0.074    9.453    0.000    0.703    0.512
##    .ITEM19           0.847    0.080   10.618    0.000    0.847    0.501
##    .ITEM21           1.889    0.120   15.762    0.000    1.889    0.832
##     EE               1.436    0.103   13.950    0.000    1.000    1.000
##     DP               0.442    0.098    4.508    0.000    1.000    1.000
##     PA               0.141    0.036    3.936    0.000    1.000    1.000
```

```
# Model results to a convenient table format
library(knitr)
fit_sec1 <- fitMeasures(cfaSEC1, c("chisq.scaled", "cfi.robust", "tli.robust", "rmsea.robust", "rmsea.c
SEC1 <- as.data.frame(t(fit_sec1))
colnames(ELM1) <- colnames(SEC1) <- c("Chisq", "CFI", "TLI", "RMSEA", "CI lower", "CI upper")
fit_table <- rbind(ELM1, SEC1)
rownames(fit_table) <- c("ELM1", "SEC1")
kable(fit_table, digits = 3, align = "lcccc", booktabs = TRUE,
             caption = "Multigroup baseline model for both groups")
```

Table 4: Multigroup baseline model for both groups

	Chisq	CFI	TLI	RMSEA	CI lower	CI upper
ELM1	802.743	0.858	0.841	0.079	0.074	0.085
SEC1	971.064	0.835	0.815	0.084	0.079	0.090

```
# Visualize the CFA model
library(semPlot)
semPaths(cfaSEC1, style = "lisrel")
```



Results of initial baseline models - Quite similar to both groups - Not very good fits

Model 2's: The first four modifications to models (exceptionally all at the same time):

Post-hoc modifications can be made all at once due to the knowledge on male elementary teacher in Assigment 3 and

```
# here is a suggestion to use the paste() function for implementing
first4mods <- '
# first four modifications (common to the groups):
EE =~ ITEM12
ITEM6 ~~ ITEM16
ITEM10 ~~ ITEM11
ITEM1 ~~ ITEM2
'

BLmodelelm <- paste(BLmodel, first4mods, sep = "\n  ")

# and as they are (still) equal to both groups, we may just copy the whole model:
BLmodelsec <- BLmodelelm

## Model fitting for ELM model2 :
# Use a robust (MLM) estimator:
cfaELM2<- cfa(BLmodelelm, data = MBIelm, estimator = "MLM")

# Numerical summary of the model:
```

```
summary(cfaELM2, fit.measures = TRUE, standardized = TRUE)
```

```
## lavaan 0.6.13 ended normally after 53 iterations
##
##   Estimator                                         ML
##   Optimization method                           NLMINB
##   Number of model parameters                        51
##
##   Number of observations                           580
##
## Model Test User Model:
##                                              Standard      Scaled
##   Test Statistic                              584.871     470.377
##   Degrees of freedom                              202         202
##   P-value (Chi-square)                          0.000       0.000
##   Scaling correction factor                                 1.243
##     Satorra-Bentler correction
##
## Model Test Baseline Model:
##
##   Test statistic                             5608.130    4354.842
##   Degrees of freedom                              231         231
##   P-value                                       0.000       0.000
##   Scaling correction factor                                 1.288
##
## User Model versus Baseline Model:
##
##   Comparative Fit Index (CFI)                   0.929       0.935
##   Tucker-Lewis Index (TLI)                      0.919       0.926
##
##   Robust Comparative Fit Index (CFI)                        0.937
##   Robust Tucker-Lewis Index (TLI)                           0.928
##
## Loglikelihood and Information Criteria:
##
##   Loglikelihood user model (H0)            -19680.140  -19680.140
##   Loglikelihood unrestricted model (H1)    -19387.704  -19387.704
##
##   Akaike (AIC)                              39462.279   39462.279
##   Bayesian (BIC)                            39684.794   39684.794
##   Sample-size adjusted Bayesian (SABIC)     39522.888   39522.888
##
## Root Mean Square Error of Approximation:
##
##   RMSEA                                         0.057       0.048
##   90 Percent confidence interval - lower        0.052       0.043
##   90 Percent confidence interval - upper        0.063       0.053
##   P-value H_0: RMSEA <= 0.050                   0.015       0.751
##   P-value H_0: RMSEA >= 0.080                   0.000       0.000
##
##   Robust RMSEA                                              0.053
##   90 Percent confidence interval - lower                    0.047
##   90 Percent confidence interval - upper                    0.060
```

```
##   P-value H_0: Robust RMSEA <= 0.050                          0.184
##   P-value H_0: Robust RMSEA >= 0.080                          0.000
##
## Standardized Root Mean Square Residual:
##
##   SRMR                                             0.053       0.053
##
## Parameter Estimates:
##
##   Standard errors                             Robust.sem
##   Information                                   Expected
##   Information saturated (h1) model          Structured
##
## Latent Variables:
##                    Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
##   EE =~
##     ITEM1             1.000                               1.242    0.748
##     ITEM2             0.915    0.033   27.882    0.000    1.137    0.723
##     ITEM3             1.031    0.047   22.089    0.000    1.281    0.749
##     ITEM6             0.808    0.058   13.891    0.000    1.003    0.605
##     ITEM8             1.261    0.047   26.682    0.000    1.566    0.864
##     ITEM13            1.049    0.049   21.586    0.000    1.302    0.756
##     ITEM14            0.955    0.049   19.568    0.000    1.186    0.651
##     ITEM16            0.759    0.056   13.548    0.000    0.942    0.620
##     ITEM20            0.868    0.051   16.896    0.000    1.077    0.749
##   DP =~
##     ITEM5             1.000                               0.962    0.652
##     ITEM10            1.009    0.087   11.633    0.000    0.971    0.658
##     ITEM11            1.030    0.084   12.331    0.000    0.991    0.656
##     ITEM15            0.662    0.076    8.715    0.000    0.638    0.569
##     ITEM22            0.628    0.081    7.780    0.000    0.604    0.392
##   PA =~
##     ITEM4             1.000                               0.432    0.463
##     ITEM7             1.076    0.151    7.126    0.000    0.464    0.531
##     ITEM9             1.794    0.288    6.237    0.000    0.774    0.581
##     ITEM12            1.222    0.232    5.270    0.000    0.527    0.410
##     ITEM17            1.394    0.186    7.512    0.000    0.602    0.681
##     ITEM18            1.792    0.279    6.411    0.000    0.773    0.636
##     ITEM19            1.729    0.265    6.517    0.000    0.746    0.659
##     ITEM21            1.270    0.188    6.753    0.000    0.548    0.425
##   EE =~
##     ITEM12           -0.385    0.046   -8.425    0.000   -0.478   -0.371
##
## Covariances:
##                    Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
##  .ITEM6 ~~
##    .ITEM16           0.856    0.106    8.105    0.000    0.856    0.544
##  .ITEM10 ~~
##    .ITEM11           0.557    0.099    5.608    0.000    0.557    0.439
##  .ITEM1 ~~
##    .ITEM2            0.504    0.064    7.825    0.000    0.504    0.422
##   EE ~~
##     DP               0.802    0.085    9.392    0.000    0.671    0.671
##     PA              -0.220    0.035   -6.347    0.000   -0.411   -0.411
```

```
##   DP ~~
##     PA                -0.223    0.042   -5.377    0.000   -0.538   -0.538
##
## Variances:
##                    Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
##    .ITEM1             1.210    0.078   15.470    0.000    1.210    0.440
##    .ITEM2             1.180    0.074   16.002    0.000    1.180    0.477
##    .ITEM3             1.284    0.106   12.172    0.000    1.284    0.439
##    .ITEM6             1.741    0.127   13.711    0.000    1.741    0.634
##    .ITEM8             0.835    0.078   10.760    0.000    0.835    0.254
##    .ITEM13            1.273    0.107   11.891    0.000    1.273    0.429
##    .ITEM14            1.915    0.125   15.360    0.000    1.915    0.577
##    .ITEM16            1.420    0.104   13.682    0.000    1.420    0.615
##    .ITEM20            0.907    0.097    9.377    0.000    0.907    0.439
##    .ITEM5             1.255    0.134    9.347    0.000    1.255    0.575
##    .ITEM10            1.235    0.123   10.068    0.000    1.235    0.567
##    .ITEM11            1.300    0.128   10.174    0.000    1.300    0.570
##    .ITEM15            0.848    0.125    6.813    0.000    0.848    0.676
##    .ITEM22            2.014    0.156   12.884    0.000    2.014    0.846
##    .ITEM4             0.684    0.083    8.250    0.000    0.684    0.786
##    .ITEM7             0.550    0.071    7.724    0.000    0.550    0.718
##    .ITEM9             1.175    0.132    8.923    0.000    1.175    0.662
##    .ITEM12            0.944    0.094    9.999    0.000    0.944    0.570
##    .ITEM17            0.419    0.054    7.687    0.000    0.419    0.536
##    .ITEM18            0.878    0.119    7.367    0.000    0.878    0.595
##    .ITEM19            0.726    0.073   10.008    0.000    0.726    0.566
##    .ITEM21            1.361    0.130   10.458    0.000    1.361    0.819
##     EE                1.542    0.113   13.639    0.000    1.000    1.000
##     DP                0.926    0.142    6.533    0.000    1.000    1.000
##     PA                0.186    0.050    3.736    0.000    1.000    1.000
```

```
# Model results to a convenient table format
library(knitr)
fit_elm2<- fitMeasures(cfaELM2, c("chisq.scaled", "cfi.robust", "tli.robust", "rmsea.robust", "rmsea.ci
ELM2 <- as.data.frame(t(fit_elm2))
colnames(ELM1) <- colnames(SEC1) <- colnames(ELM2) <- c("Chisq", "CFI", "TLI", "RMSEA", "CI lower", "CI
fit_table <- rbind(ELM1, SEC1, ELM2)
rownames(fit_table) <- c("ELM1", "SEC1", "ELM2")
kable(fit_table, digits = 3, align = "lcccc", booktabs = TRUE,
             caption = "Model fits")
```

Table 5: Model fits

	Chisq	CFI	TLI	RMSEA	CI lower	CI upper
ELM1	802.743	0.858	0.841	0.079	0.074	0.085
SEC1	971.064	0.835	0.815	0.084	0.079	0.090
ELM2	470.377	0.937	0.928	0.053	0.047	0.060

```
# Model modification indices of ELM model2:
modindices(cfaELM2, standardized = TRUE, sort = TRUE, maximum.number = 25) %>%
  kable(digits = 3, align = "rclccccc")
```

	lhs	op	rhs	mi	epc	sepc.lv	sepc.all	sepc.nox
298	ITEM4	~~	ITEM7	38.931	0.174	0.174	0.284	0.284
323	ITEM18	~~	ITEM19	38.744	0.266	0.266	0.333	0.333
90	PA	=~	ITEM14	24.435	0.864	0.373	0.205	0.205
152	ITEM3	~~	ITEM12	23.978	-0.250	-0.250	-0.227	-0.227
202	ITEM13	~~	ITEM12	20.493	0.231	0.231	0.211	0.211
122	ITEM2	~~	ITEM14	16.441	0.245	0.245	0.163	0.163
74	DP	=~	ITEM16	15.733	0.310	0.299	0.197	0.197
191	ITEM13	~~	ITEM14	14.838	0.281	0.281	0.180	0.180
57	EE	=~	ITEM11	14.750	0.250	0.311	0.206	0.206
80	DP	=~	ITEM17	12.788	-0.173	-0.166	-0.188	-0.188
193	ITEM13	~~	ITEM20	11.649	0.179	0.179	0.167	0.167
73	DP	=~	ITEM14	11.255	-0.374	-0.360	-0.198	-0.198
142	ITEM3	~~	ITEM16	10.838	-0.168	-0.168	-0.124	-0.124
303	ITEM4	~~	ITEM19	10.693	-0.112	-0.112	-0.159	-0.159
63	EE	=~	ITEM17	10.627	-0.097	-0.121	-0.137	-0.137
79	DP	=~	ITEM12	9.317	0.279	0.268	0.208	0.208
178	ITEM8	~~	ITEM5	8.772	-0.161	-0.161	-0.157	-0.157
267	ITEM10	~~	ITEM17	8.758	-0.090	-0.090	-0.125	-0.125
310	ITEM7	~~	ITEM21	8.687	0.115	0.115	0.133	0.133
72	DP	=~	ITEM13	8.484	0.275	0.265	0.154	0.154
308	ITEM7	~~	ITEM18	8.461	-0.099	-0.099	-0.143	-0.143
251	ITEM5	~~	ITEM15	8.045	0.164	0.164	0.159	0.159
201	ITEM13	~~	ITEM9	8.027	-0.161	-0.161	-0.131	-0.131
161	ITEM6	~~	ITEM5	7.941	0.160	0.160	0.108	0.108
189	ITEM8	~~	ITEM19	7.879	0.113	0.113	0.146	0.146

```
## Model fitting for SEC model2 :
# Use a robust (MLM) estimator:
cfaSEC2<- cfa(BLmodelsec, data = MBIsec, estimator = "MLM")

# Numerical summary of the model:
summary(cfaSEC2, fit.measures = TRUE, standardized = TRUE)
```

```
## lavaan 0.6.13 ended normally after 51 iterations
##
##   Estimator                                         ML
##   Optimization method                           NLMINB
##   Number of model parameters                        51
##
##   Number of observations                           692
##
## Model Test User Model:
##                                              Standard      Scaled
##   Test Statistic                              750.857     572.552
##   Degrees of freedom                              202         202
##   P-value (Chi-square)                          0.000       0.000
##   Scaling correction factor                                 1.311
##     Satorra-Bentler correction
##
## Model Test Baseline Model:
##
```

```
##   Test statistic                                6432.706    4901.792
##   Degrees of freedom                             231         231
##   P-value                                       0.000       0.000
##   Scaling correction factor                                 1.312
##
## User Model versus Baseline Model:
##
##   Comparative Fit Index (CFI)                   0.911       0.921
##   Tucker-Lewis Index (TLI)                      0.899       0.909
##
##   Robust Comparative Fit Index (CFI)                        0.921
##   Robust Tucker-Lewis Index (TLI)                           0.909
##
## Loglikelihood and Information Criteria:
##
##   Loglikelihood user model (H0)              -24335.037  -24335.037
##   Loglikelihood unrestricted model (H1)      -23959.608  -23959.608
##
##   Akaike (AIC)                                48772.074   48772.074
##   Bayesian (BIC)                              49003.593   49003.593
##   Sample-size adjusted Bayesian (SABIC)       48841.659   48841.659
##
## Root Mean Square Error of Approximation:
##
##   RMSEA                                         0.063       0.051
##   90 Percent confidence interval - lower        0.058       0.047
##   90 Percent confidence interval - upper        0.067       0.056
##   P-value H_0: RMSEA <= 0.050                   0.000       0.280
##   P-value H_0: RMSEA >= 0.080                   0.000       0.000
##
##   Robust RMSEA                                              0.059
##   90 Percent confidence interval - lower                    0.053
##   90 Percent confidence interval - upper                    0.065
##   P-value H_0: Robust RMSEA <= 0.050                        0.005
##   P-value H_0: Robust RMSEA >= 0.080                        0.000
##
## Standardized Root Mean Square Residual:
##
##   SRMR                                          0.058       0.058
##
## Parameter Estimates:
##
##   Standard errors                             Robust.sem
##   Information                                   Expected
##   Information saturated (h1) model          Structured
##
## Latent Variables:
##                    Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
##   EE =~
##     ITEM1             1.000                               1.128    0.711
##     ITEM2             0.936    0.034   27.501    0.000    1.055    0.691
##     ITEM3             1.089    0.050   21.780    0.000    1.228    0.723
##     ITEM6             0.880    0.062   14.170    0.000    0.992    0.601
##     ITEM8             1.285    0.055   23.305    0.000    1.450    0.850
```

```
##     ITEM13            1.137    0.053   21.354    0.000    1.282    0.768
##     ITEM14            0.980    0.050   19.550    0.000    1.105    0.623
##     ITEM16            0.742    0.060   12.288    0.000    0.837    0.578
##     ITEM20            0.911    0.060   15.150    0.000    1.028    0.733
##   DP =~
##     ITEM5             1.000                               0.867    0.591
##     ITEM10            1.112    0.119    9.329    0.000    0.963    0.616
##     ITEM11            1.060    0.129    8.237    0.000    0.919    0.586
##     ITEM15            0.979    0.094   10.447    0.000    0.849    0.599
##     ITEM22            0.997    0.114    8.729    0.000    0.864    0.539
##   PA =~
##     ITEM4             1.000                               0.384    0.348
##     ITEM7             1.654    0.224    7.383    0.000    0.635    0.559
##     ITEM9             2.675    0.376    7.121    0.000    1.027    0.688
##     ITEM12            1.437    0.231    6.228    0.000    0.551    0.412
##     ITEM17            1.379    0.193    7.143    0.000    0.530    0.550
##     ITEM18            2.137    0.292    7.310    0.000    0.821    0.700
##     ITEM19            2.406    0.322    7.476    0.000    0.923    0.710
##     ITEM21            1.643    0.246    6.665    0.000    0.631    0.418
##   EE =~
##     ITEM12           -0.474    0.053   -8.908    0.000   -0.535   -0.400
##
## Covariances:
##                    Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
##  .ITEM6 ~~
##    .ITEM16            0.663    0.089    7.416    0.000    0.663    0.426
##  .ITEM10 ~~
##    .ITEM11            0.855    0.132    6.458    0.000    0.855    0.545
##  .ITEM1 ~~
##    .ITEM2             0.613    0.069    8.901    0.000    0.613    0.498
##   EE ~~
##     DP                0.591    0.065    9.067    0.000    0.605    0.605
##     PA               -0.144    0.026   -5.555    0.000   -0.332   -0.332
##   DP ~~
##     PA               -0.161    0.031   -5.145    0.000   -0.483   -0.483
##
## Variances:
##                    Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
##    .ITEM1             1.241    0.075   16.464    0.000    1.241    0.494
##    .ITEM2             1.221    0.077   15.940    0.000    1.221    0.523
##    .ITEM3             1.379    0.093   14.830    0.000    1.379    0.477
##    .ITEM6             1.737    0.120   14.474    0.000    1.737    0.638
##    .ITEM8             0.810    0.069   11.812    0.000    0.810    0.278
##    .ITEM13            1.141    0.083   13.693    0.000    1.141    0.410
##    .ITEM14            1.924    0.117   16.502    0.000    1.924    0.612
##    .ITEM16            1.396    0.100   14.030    0.000    1.396    0.666
##    .ITEM20            0.911    0.066   13.830    0.000    0.911    0.463
##    .ITEM5             1.401    0.118   11.885    0.000    1.401    0.651
##    .ITEM10            1.520    0.129   11.773    0.000    1.520    0.621
##    .ITEM11            1.618    0.142   11.377    0.000    1.618    0.657
##    .ITEM15            1.288    0.133    9.693    0.000    1.288    0.641
##    .ITEM22            1.818    0.131   13.833    0.000    1.818    0.709
##    .ITEM4             1.067    0.110    9.662    0.000    1.067    0.879
##    .ITEM7             0.888    0.070   12.778    0.000    0.888    0.688
```

```
##    .ITEM9            1.175    0.115   10.236    0.000    1.175    0.527
##    .ITEM12           1.006    0.081   12.456    0.000    1.006    0.561
##    .ITEM17           0.645    0.075    8.603    0.000    0.645    0.697
##    .ITEM18           0.699    0.074    9.493    0.000    0.699    0.510
##    .ITEM19           0.838    0.081   10.286    0.000    0.838    0.496
##    .ITEM21           1.874    0.121   15.509    0.000    1.874    0.825
##     EE               1.272    0.103   12.407    0.000    1.000    1.000
##     DP               0.751    0.128    5.883    0.000    1.000    1.000
##     PA               0.147    0.036    4.049    0.000    1.000    1.000
```

```
# Model results to a convenient table format
library(knitr)
fit_sec2<- fitMeasures(cfaSEC2, c("chisq.scaled", "cfi.robust", "tli.robust", "rmsea.robust", "rmsea.ci
SEC2 <- as.data.frame(t(fit_sec2))
colnames(ELM1) <- colnames(SEC1) <- colnames(ELM2) <- colnames(SEC2) <- c("Chisq", "CFI", "TLI", "RMSEA
fit_table <- rbind(ELM1, SEC1, ELM2, SEC2)
rownames(fit_table) <- c("ELM1", "SEC1", "ELM2", "SEC2")
kable(fit_table, digits = 3, align = "lcccc", booktabs = TRUE,
             caption = "Model fits")
```

Table 7: Model fits

	Chisq	CFI	TLI	RMSEA	CI lower	CI upper
ELM1	802.743	0.858	0.841	0.079	0.074	0.085
SEC1	971.064	0.835	0.815	0.084	0.079	0.090
ELM2	470.377	0.937	0.928	0.053	0.047	0.060
SEC2	572.552	0.921	0.909	0.059	0.053	0.065

```
#Model modification indices for SEC model 2
modindices(cfaSEC2, standardized = TRUE, sort = TRUE, maximum.number = 25) %>%
  kable(digits = 3, align = "rclcccccc")
```

	lhs	op	rhs	mi	epc	sepc.lv	sepc.all	sepc.nox
57	EE	=~	ITEM11	67.177	0.472	0.532	0.339	0.339
314	ITEM9	~~	ITEM19	43.690	0.355	0.355	0.357	0.357
251	ITEM5	~~	ITEM15	35.576	0.416	0.416	0.310	0.310
271	ITEM11	~~	ITEM15	29.016	-0.297	-0.297	-0.206	-0.206
222	ITEM16	~~	ITEM20	28.900	0.227	0.227	0.201	0.201
73	DP	=~	ITEM14	22.145	-0.490	-0.424	-0.239	-0.239
320	ITEM17	~~	ITEM18	21.583	0.147	0.147	0.219	0.219
310	ITEM7	~~	ITEM21	21.370	0.247	0.247	0.191	0.191
321	ITEM17	~~	ITEM19	20.742	-0.159	-0.159	-0.217	-0.217
124	ITEM2	~~	ITEM20	20.020	-0.171	-0.171	-0.162	-0.162
122	ITEM2	~~	ITEM14	19.166	0.234	0.234	0.153	0.153
308	ITEM7	~~	ITEM18	18.474	-0.160	-0.160	-0.203	-0.203
250	ITEM5	~~	ITEM11	18.314	-0.244	-0.244	-0.162	-0.162
74	DP	=~	ITEM16	17.916	0.330	0.286	0.198	0.198
55	EE	=~	ITEM5	17.616	-0.306	-0.345	-0.235	-0.235
261	ITEM10	~~	ITEM15	16.999	0.226	0.226	0.162	0.162
90	PA	=~	ITEM14	16.500	0.693	0.266	0.150	0.150

	lhs	op	rhs	mi	epc	sepc.lv	sepc.all	sepc.nox
72	DP	=~	ITEM13	16.072	0.339	0.294	0.176	0.176
58	EE	=~	ITEM15	16.013	-0.283	-0.319	-0.225	-0.225
285	ITEM15	~~	ITEM12	15.352	0.191	0.191	0.168	0.168
56	EE	=~	ITEM10	14.816	-0.221	-0.249	-0.159	-0.159
140	ITEM3	~~	ITEM13	13.692	-0.212	-0.212	-0.169	-0.169
160	ITEM6	~~	ITEM20	13.343	-0.173	-0.173	-0.137	-0.137
75	DP	=~	ITEM20	12.550	0.263	0.228	0.162	0.162
152	ITEM3	~~	ITEM12	11.924	-0.173	-0.173	-0.147	-0.147

Then continue fitting and modifying both two models separately, one step at a time (from now on, the two models can be different from each other: the principle of *Partial Measurement Invariance* lets them to differ while still making it possible to continue with multigroup analyses. **Just follow Byrne's ideas here. Do not implement any additional modifications.**

Model 3 Elementary School Teachers

- Adding term ITEM4 ~~ ITEM7 (MI 38.931, EPC 0.174)

```
ELM_model3 <- '
# CFA model for the burnout, the baseline model:
# EE: EmotionalExhaustion
# DP: Depersonalization
# PA: PersonalAccomplishment
  EE =~ ITEM1 + ITEM2 + ITEM3 + ITEM6 + ITEM8 + ITEM13 + ITEM14 + ITEM16 + ITEM20
  DP =~ ITEM5 + ITEM10 + ITEM11 + ITEM15 + ITEM22
  PA =~ ITEM4 + ITEM7 + ITEM9 + ITEM12 + ITEM17 + ITEM18 + ITEM19 + ITEM21
  EE =~ ITEM12
  ITEM6 ~~ ITEM16
  ITEM10 ~~ ITEM11
  ITEM1 ~~ ITEM2
  ITEM4 ~~ ITEM7
'

# Use a robust (MLM) estimator:
cfaELM3<- cfa(ELM_model3, data = MBIelm, estimator = "MLM")

# Numerical summary of the model:
summary(cfaELM3, fit.measures = TRUE, standardized = TRUE)
```

```
## lavaan 0.6.13 ended normally after 55 iterations
##
##   Estimator                                         ML
##   Optimization method                           NLMINB
##   Number of model parameters                        52
##
##   Number of observations                           580
##
## Model Test User Model:
##                                              Standard      Scaled
##   Test Statistic                               545.846     445.801
```

```
##   Degrees of freedom                                201         201
##   P-value (Chi-square)                            0.000       0.000
##   Scaling correction factor                                   1.224
##     Satorra-Bentler correction
##
## Model Test Baseline Model:
##
##   Test statistic                                5608.130    4354.842
##   Degrees of freedom                             231         231
##   P-value                                         0.000       0.000
##   Scaling correction factor                                   1.288
##
## User Model versus Baseline Model:
##
##   Comparative Fit Index (CFI)                     0.936       0.941
##   Tucker-Lewis Index (TLI)                        0.926       0.932
##
##   Robust Comparative Fit Index (CFI)                          0.944
##   Robust Tucker-Lewis Index (TLI)                             0.935
##
## Loglikelihood and Information Criteria:
##
##   Loglikelihood user model (H0)             -19660.627  -19660.627
##   Loglikelihood unrestricted model (H1)     -19387.704  -19387.704
##
##   Akaike (AIC)                               39425.255   39425.255
##   Bayesian (BIC)                             39652.132   39652.132
##   Sample-size adjusted Bayesian (SABIC)      39487.053   39487.053
##
## Root Mean Square Error of Approximation:
##
##   RMSEA                                           0.054       0.046
##   90 Percent confidence interval - lower          0.049       0.041
##   90 Percent confidence interval - upper          0.060       0.051
##   P-value H_0: RMSEA <= 0.050                     0.092       0.907
##   P-value H_0: RMSEA >= 0.080                     0.000       0.000
##
##   Robust RMSEA                                                0.051
##   90 Percent confidence interval - lower                      0.044
##   90 Percent confidence interval - upper                      0.057
##   P-value H_0: Robust RMSEA <= 0.050                          0.418
##   P-value H_0: Robust RMSEA >= 0.080                          0.000
##
## Standardized Root Mean Square Residual:
##
##   SRMR                                            0.051       0.051
##
## Parameter Estimates:
##
##   Standard errors                           Robust.sem
##   Information                                 Expected
##   Information saturated (h1) model          Structured
##
## Latent Variables:
```

```
##                    Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
##   EE =~
##     ITEM1             1.000                              1.242    0.748
##     ITEM2             0.915    0.033   27.878    0.000    1.137    0.723
##     ITEM3             1.031    0.047   22.087    0.000    1.280    0.749
##     ITEM6             0.808    0.058   13.891    0.000    1.003    0.605
##     ITEM8             1.262    0.047   26.682    0.000    1.566    0.864
##     ITEM13            1.049    0.049   21.590    0.000    1.302    0.756
##     ITEM14            0.955    0.049   19.565    0.000    1.186    0.651
##     ITEM16            0.759    0.056   13.548    0.000    0.942    0.620
##     ITEM20            0.868    0.051   16.896    0.000    1.077    0.749
##   DP =~
##     ITEM5             1.000                              0.962    0.651
##     ITEM10            1.011    0.087   11.577    0.000    0.973    0.659
##     ITEM11            1.031    0.084   12.256    0.000    0.992    0.657
##     ITEM15            0.661    0.076    8.693    0.000    0.636    0.568
##     ITEM22            0.628    0.081    7.774    0.000    0.604    0.392
##   PA =~
##     ITEM4             1.000                              0.392    0.420
##     ITEM7             1.107    0.169    6.546    0.000    0.434    0.496
##     ITEM9             1.997    0.342    5.848    0.000    0.783    0.588
##     ITEM12            1.374    0.279    4.922    0.000    0.539    0.418
##     ITEM17            1.523    0.226    6.747    0.000    0.597    0.676
##     ITEM18            2.012    0.341    5.898    0.000    0.789    0.649
##     ITEM19            1.944    0.326    5.967    0.000    0.762    0.673
##     ITEM21            1.370    0.213    6.435    0.000    0.537    0.417
##   EE =~
##     ITEM12           -0.379    0.046   -8.287    0.000   -0.471   -0.366
##
## Covariances:
##                    Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
##  .ITEM6 ~~
##    .ITEM16            0.856    0.106    8.105    0.000    0.856    0.544
##  .ITEM10 ~~
##    .ITEM11            0.554    0.099    5.596    0.000    0.554    0.438
##  .ITEM1 ~~
##    .ITEM2             0.504    0.064    7.827    0.000    0.504    0.422
##  .ITEM4 ~~
##    .ITEM7             0.175    0.060    2.938    0.003    0.175    0.272
##   EE ~~
##     DP                0.802    0.085    9.381    0.000    0.671    0.671
##     PA               -0.202    0.035   -5.853    0.000   -0.415   -0.415
##   DP ~~
##     PA               -0.201    0.041   -4.966    0.000   -0.534   -0.534
##
## Variances:
##                    Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
##    .ITEM1             1.210    0.078   15.471    0.000    1.210    0.440
##    .ITEM2             1.180    0.074   16.005    0.000    1.180    0.477
##    .ITEM3             1.284    0.106   12.174    0.000    1.284    0.439
##    .ITEM6             1.741    0.127   13.711    0.000    1.741    0.634
##    .ITEM8             0.835    0.078   10.763    0.000    0.835    0.254
##    .ITEM13            1.273    0.107   11.891    0.000    1.273    0.429
##    .ITEM14            1.915    0.125   15.361    0.000    1.915    0.577
```

```
##    .ITEM16           1.420    0.104   13.681    0.000    1.420    0.615
##    .ITEM20           0.907    0.097    9.375    0.000    0.907    0.438
##    .ITEM5            1.256    0.134    9.344    0.000    1.256    0.576
##    .ITEM10           1.232    0.123   10.047    0.000    1.232    0.566
##    .ITEM11           1.299    0.128   10.150    0.000    1.299    0.569
##    .ITEM15           0.850    0.125    6.814    0.000    0.850    0.677
##    .ITEM22           2.014    0.156   12.895    0.000    2.014    0.847
##    .ITEM4            0.716    0.089    8.040    0.000    0.716    0.823
##    .ITEM7            0.577    0.076    7.610    0.000    0.577    0.754
##    .ITEM9            1.162    0.131    8.902    0.000    1.162    0.655
##    .ITEM12           0.935    0.094    9.947    0.000    0.935    0.564
##    .ITEM17           0.424    0.056    7.631    0.000    0.424    0.544
##    .ITEM18           0.854    0.119    7.193    0.000    0.854    0.579
##    .ITEM19           0.702    0.072    9.737    0.000    0.702    0.547
##    .ITEM21           1.373    0.130   10.528    0.000    1.373    0.826
##     EE               1.542    0.113   13.636    0.000    1.000    1.000
##     DP               0.926    0.142    6.517    0.000    1.000    1.000
##     PA               0.154    0.046    3.333    0.001    1.000    1.000
```

```
# Model results to a convenient table format
library(knitr)
fit_elm3<- fitMeasures(cfaELM3, c("chisq.scaled", "cfi.robust", "tli.robust", "rmsea.robust", "rmsea.ci
ELM3 <- as.data.frame(t(fit_elm3))
colnames(ELM1) <- colnames(SEC1) <- colnames(ELM2) <- colnames(SEC2) <- colnames(ELM3)<- c("Chisq", "CF
fit_table <- rbind(ELM1, SEC1, ELM2, SEC2, ELM3)
rownames(fit_table) <- c("ELM1", "SEC1", "ELM2", "SEC2", "ELM3")
kable(fit_table, digits = 3, align = "lcccc", booktabs = TRUE,
             caption = "Model fits")
```

Table 9: Model fits

	Chisq	CFI	TLI	RMSEA	CI lower	CI upper
ELM1	802.743	0.858	0.841	0.079	0.074	0.085
SEC1	971.064	0.835	0.815	0.084	0.079	0.090
ELM2	470.377	0.937	0.928	0.053	0.047	0.060
SEC2	572.552	0.921	0.909	0.059	0.053	0.065
ELM3	445.801	0.944	0.935	0.051	0.044	0.057

```
#Model modification indices for ELM model 3
modindices(cfaELM3, standardized = TRUE, sort = TRUE, maximum.number = 25) %>%
  kable(digits = 3, align = "rclccccc")
```

	lhs	op	rhs	mi	epc	sepc.lv	sepc.all	sepc.nox
323	ITEM18	~~	ITEM19	32.503	0.247	0.247	0.319	0.319
91	PA	=~	ITEM14	25.403	0.977	0.383	0.210	0.210
153	ITEM3	~~	ITEM12	23.654	-0.248	-0.248	-0.226	-0.226
203	ITEM13	~~	ITEM12	20.844	0.232	0.232	0.213	0.213
123	ITEM2	~~	ITEM14	16.457	0.245	0.245	0.163	0.163
75	DP	=~	ITEM16	15.696	0.310	0.299	0.197	0.197
192	ITEM13	~~	ITEM14	14.844	0.282	0.282	0.180	0.180

	lhs	op	rhs	mi	epc	sepc.lv	sepc.all	sepc.nox
58	EE	=~	ITEM11	14.780	0.251	0.312	0.206	0.206
301	ITEM4	~~	ITEM17	14.165	0.096	0.096	0.174	0.174
81	DP	=~	ITEM17	13.820	-0.181	-0.174	-0.197	-0.197
194	ITEM13	~~	ITEM20	11.619	0.179	0.179	0.167	0.167
74	DP	=~	ITEM14	11.242	-0.374	-0.360	-0.198	-0.198
143	ITEM3	~~	ITEM16	10.833	-0.168	-0.168	-0.124	-0.124
64	EE	=~	ITEM17	10.426	-0.098	-0.121	-0.137	-0.137
321	ITEM17	~~	ITEM19	9.774	-0.099	-0.099	-0.181	-0.181
80	DP	=~	ITEM12	9.281	0.276	0.266	0.206	0.206
179	ITEM8	~~	ITEM5	8.714	-0.161	-0.161	-0.157	-0.157
73	DP	=~	ITEM13	8.447	0.275	0.264	0.153	0.153
313	ITEM9	~~	ITEM18	8.438	-0.149	-0.149	-0.150	-0.150
190	ITEM8	~~	ITEM19	8.321	0.116	0.116	0.151	0.151
252	ITEM5	~~	ITEM15	8.287	0.167	0.167	0.161	0.161
268	ITEM10	~~	ITEM17	8.275	-0.088	-0.088	-0.122	-0.122
202	ITEM13	~~	ITEM9	8.166	-0.162	-0.162	-0.133	-0.133
310	ITEM7	~~	ITEM21	7.933	0.106	0.106	0.119	0.119
162	ITEM6	~~	ITEM5	7.909	0.160	0.160	0.108	0.108

```
##THIS IS A GOOD BASELINE MODEL FOR ELEMENTARY TEACHERS!
```

Model 3 for Secondary School Teachers

- Adding term EE =~ ITEM11 (MI 67.177, EPC 0.472)

```
SEC_model3 <- '
# CFA model for the burnout, the baseline model:
# EE: EmotionalExhaustion
# DP: Depersonalization
# PA: PersonalAccomplishment
  EE =~ ITEM1 + ITEM2 + ITEM3 + ITEM6 + ITEM8 + ITEM13 + ITEM14 + ITEM16 + ITEM20
  DP =~ ITEM5 + ITEM10 + ITEM11 + ITEM15 + ITEM22
  PA =~ ITEM4 + ITEM7 + ITEM9 + ITEM12 + ITEM17 + ITEM18 + ITEM19 + ITEM21
  EE =~ ITEM12
  ITEM6 ~~ ITEM16
  ITEM10 ~~ ITEM11
  ITEM1 ~~ ITEM2
  EE =~ ITEM11
  '

# Use a robust (MLM) estimator:
cfaSEC3<- cfa(SEC_model3, data = MBIsec, estimator = "MLM")

# Numerical summary of the model:
summary(cfaSEC3, fit.measures = TRUE, standardized = TRUE)
```

```
## lavaan 0.6.13 ended normally after 51 iterations
##
##   Estimator                                         ML
##   Optimization method                           NLMINB
```

```
##   Number of model parameters                         52
##
##   Number of observations                            692
##
## Model Test User Model:
##                                                Standard      Scaled
##   Test Statistic                                683.314     522.982
##   Degrees of freedom                                201         201
##   P-value (Chi-square)                            0.000       0.000
##   Scaling correction factor                                   1.307
##     Satorra-Bentler correction
##
## Model Test Baseline Model:
##
##   Test statistic                               6432.706    4901.792
##   Degrees of freedom                                231         231
##   P-value                                         0.000       0.000
##   Scaling correction factor                                   1.312
##
## User Model versus Baseline Model:
##
##   Comparative Fit Index (CFI)                     0.922       0.931
##   Tucker-Lewis Index (TLI)                        0.911       0.921
##
##   Robust Comparative Fit Index (CFI)                          0.931
##   Robust Tucker-Lewis Index (TLI)                             0.921
##
## Loglikelihood and Information Criteria:
##
##   Loglikelihood user model (H0)              -24301.265  -24301.265
##   Loglikelihood unrestricted model (H1)      -23959.608  -23959.608
##
##   Akaike (AIC)                                48706.531   48706.531
##   Bayesian (BIC)                              48942.589   48942.589
##   Sample-size adjusted Bayesian (SABIC)       48777.481   48777.481
##
## Root Mean Square Error of Approximation:
##
##   RMSEA                                           0.059       0.048
##   90 Percent confidence interval - lower          0.054       0.044
##   90 Percent confidence interval - upper          0.064       0.053
##   P-value H_0: RMSEA <= 0.050                     0.001       0.753
##   P-value H_0: RMSEA >= 0.080                     0.000       0.000
##
##   Robust RMSEA                                                0.055
##   90 Percent confidence interval - lower                      0.049
##   90 Percent confidence interval - upper                      0.061
##   P-value H_0: Robust RMSEA <= 0.050                          0.076
##   P-value H_0: Robust RMSEA >= 0.080                          0.000
##
## Standardized Root Mean Square Residual:
##
##   SRMR                                            0.055       0.055
##
```

```
## Parameter Estimates:
##
##   Standard errors                           Robust.sem
##   Information                                 Expected
##   Information saturated (h1) model          Structured
##
## Latent Variables:
##                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
##   EE =~
##     ITEM1            1.000                               1.124    0.709
##     ITEM2            0.933    0.034   27.290    0.000    1.049    0.686
##     ITEM3            1.093    0.050   21.636    0.000    1.228    0.723
##     ITEM6            0.882    0.063   14.089    0.000    0.991    0.601
##     ITEM8            1.293    0.056   23.227    0.000    1.454    0.852
##     ITEM13           1.139    0.054   21.120    0.000    1.280    0.767
##     ITEM14           0.981    0.050   19.500    0.000    1.103    0.622
##     ITEM16           0.746    0.061   12.254    0.000    0.839    0.579
##     ITEM20           0.915    0.061   15.067    0.000    1.029    0.734
##   DP =~
##     ITEM5            1.000                               0.921    0.628
##     ITEM10           1.037    0.110    9.466    0.000    0.955    0.610
##     ITEM11           0.574    0.113    5.079    0.000    0.529    0.340
##     ITEM15           0.989    0.098   10.066    0.000    0.911    0.643
##     ITEM22           0.908    0.103    8.798    0.000    0.836    0.522
##   PA =~
##     ITEM4            1.000                               0.383    0.347
##     ITEM7            1.657    0.224    7.384    0.000    0.634    0.558
##     ITEM9            2.687    0.377    7.130    0.000    1.028    0.689
##     ITEM12           1.430    0.231    6.198    0.000    0.547    0.409
##     ITEM17           1.381    0.194    7.132    0.000    0.528    0.549
##     ITEM18           2.144    0.294    7.292    0.000    0.820    0.700
##     ITEM19           2.419    0.324    7.462    0.000    0.925    0.712
##     ITEM21           1.644    0.247    6.646    0.000    0.629    0.417
##   EE =~
##     ITEM12          -0.479    0.054   -8.939    0.000   -0.538   -0.402
##     ITEM11           0.419    0.064    6.545    0.000    0.471    0.303
##
## Covariances:
##                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
##  .ITEM6 ~~
##    .ITEM16           0.662    0.089    7.403    0.000    0.662    0.425
##  .ITEM10 ~~
##    .ITEM11           0.953    0.122    7.796    0.000    0.953    0.600
##  .ITEM1 ~~
##    .ITEM2            0.625    0.070    8.969    0.000    0.625    0.503
##   EE ~~
##     DP               0.560    0.066    8.462    0.000    0.541    0.541
##     PA              -0.145    0.026   -5.578    0.000   -0.337   -0.337
##   DP ~~
##     PA              -0.162    0.032   -5.075    0.000   -0.461   -0.461
##
## Variances:
##                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
##    .ITEM1            1.250    0.076   16.437    0.000    1.250    0.497
```

```
##    .ITEM2            1.235    0.077   15.981    0.000    1.235    0.529
##    .ITEM3            1.379    0.093   14.813    0.000    1.379    0.478
##    .ITEM6            1.739    0.120   14.520    0.000    1.739    0.639
##    .ITEM8            0.799    0.065   12.216    0.000    0.799    0.274
##    .ITEM13           1.146    0.084   13.654    0.000    1.146    0.412
##    .ITEM14           1.929    0.116   16.638    0.000    1.929    0.613
##    .ITEM16           1.394    0.099   14.083    0.000    1.394    0.665
##    .ITEM20           0.908    0.066   13.789    0.000    0.908    0.462
##    .ITEM5            1.305    0.122   10.667    0.000    1.305    0.606
##    .ITEM10           1.537    0.131   11.773    0.000    1.537    0.628
##    .ITEM11           1.642    0.130   12.679    0.000    1.642    0.680
##    .ITEM15           1.179    0.137    8.608    0.000    1.179    0.587
##    .ITEM22           1.865    0.136   13.735    0.000    1.865    0.727
##    .ITEM4            1.068    0.111    9.667    0.000    1.068    0.879
##    .ITEM7            0.890    0.070   12.782    0.000    0.890    0.689
##    .ITEM9            1.172    0.115   10.212    0.000    1.172    0.526
##    .ITEM12           1.005    0.081   12.451    0.000    1.005    0.561
##    .ITEM17           0.646    0.075    8.612    0.000    0.646    0.698
##    .ITEM18           0.699    0.074    9.487    0.000    0.699    0.510
##    .ITEM19           0.834    0.082   10.216    0.000    0.834    0.493
##    .ITEM21           1.876    0.121   15.529    0.000    1.876    0.826
##     EE               1.264    0.103   12.298    0.000    1.000    1.000
##     DP               0.848    0.137    6.180    0.000    1.000    1.000
##     PA               0.146    0.036    4.042    0.000    1.000    1.000
```

```
# Model results to a convenient table format
library(knitr)
fit_sec3<- fitMeasures(cfaSEC3, c("chisq.scaled", "cfi.robust", "tli.robust", "rmsea.robust", "rmsea.ci
SEC3 <- as.data.frame(t(fit_sec3))
colnames(ELM1) <- colnames(SEC1) <- colnames(ELM2) <- colnames(SEC2) <- colnames(ELM3) <- colnames(SEC3)
fit_table <- rbind(ELM1, SEC1, ELM2, SEC2, ELM3, SEC3)
rownames(fit_table) <- c("ELM1", "SEC1", "ELM2", "SEC2", "ELM3", "SEC3")
kable(fit_table, digits = 3, align = "lcccc", booktabs = TRUE,
             caption = "Model fits")
```

Table 11: Model fits

	Chisq	CFI	TLI	RMSEA	CI lower	CI upper
ELM1	802.743	0.858	0.841	0.079	0.074	0.085
SEC1	971.064	0.835	0.815	0.084	0.079	0.090
ELM2	470.377	0.937	0.928	0.053	0.047	0.060
SEC2	572.552	0.921	0.909	0.059	0.053	0.065
ELM3	445.801	0.944	0.935	0.051	0.044	0.057
SEC3	522.982	0.931	0.921	0.055	0.049	0.061

```
#Model modification indices for SEC model 3
modindices(cfaSEC3, standardized = TRUE, sort = TRUE, maximum.number = 25) %>%
  kable(digits = 3, align = "rclccccc")
```

	lhs	op	rhs	mi	epc	sepc.lv	sepc.all	sepc.nox
314	ITEM9	~~	ITEM19	42.687	0.351	0.351	0.355	0.355
222	ITEM16	~~	ITEM20	28.275	0.223	0.223	0.199	0.199
320	ITEM17	~~	ITEM18	21.951	0.148	0.148	0.221	0.221
310	ITEM7	~~	ITEM21	21.602	0.248	0.248	0.192	0.192
321	ITEM17	~~	ITEM19	20.837	-0.160	-0.160	-0.218	-0.218
59	EE	=~	ITEM22	20.306	0.321	0.360	0.225	0.225
73	DP	=~	ITEM14	20.142	-0.404	-0.372	-0.210	-0.210
122	ITEM2	~~	ITEM14	19.895	0.239	0.239	0.155	0.155
124	ITEM2	~~	ITEM20	18.463	-0.164	-0.164	-0.155	-0.155
308	ITEM7	~~	ITEM18	18.163	-0.159	-0.159	-0.202	-0.202
90	PA	=~	ITEM14	17.010	0.707	0.271	0.153	0.153
251	ITEM5	~~	ITEM15	16.437	0.304	0.304	0.245	0.245
72	DP	=~	ITEM13	16.092	0.293	0.270	0.162	0.162
74	DP	=~	ITEM16	14.922	0.261	0.240	0.166	0.166
285	ITEM15	~~	ITEM12	13.873	0.178	0.178	0.164	0.164
160	ITEM6	~~	ITEM20	13.217	-0.171	-0.171	-0.136	-0.136
140	ITEM3	~~	ITEM13	13.006	-0.206	-0.206	-0.164	-0.164
118	ITEM2	~~	ITEM3	11.553	0.159	0.159	0.122	0.122
176	ITEM8	~~	ITEM16	11.453	-0.149	-0.149	-0.141	-0.141
152	ITEM3	~~	ITEM12	11.434	-0.169	-0.169	-0.143	-0.143
58	EE	=~	ITEM15	11.358	-0.217	-0.244	-0.172	-0.172
75	DP	=~	ITEM20	10.859	0.211	0.194	0.138	0.138
56	EE	=~	ITEM5	10.839	-0.218	-0.245	-0.167	-0.167
283	ITEM15	~~	ITEM7	10.127	-0.143	-0.143	-0.140	-0.140
67	DP	=~	ITEM1	10.034	-0.196	-0.180	-0.114	-0.114

Model 4 for Secondary School Teachers

- Adding term ITEM9 ~~ ITEM19 (MI 42.687 EPC 0.351)

```
SEC_model4 <- '
# CFA model for the burnout, the baseline model:
# EE: EmotionalExhaustion
# DP: Depersonalization
# PA: PersonalAccomplishment
  EE =~ ITEM1 + ITEM2 + ITEM3 + ITEM6 + ITEM8 + ITEM13 + ITEM14 + ITEM16 + ITEM20
  DP =~ ITEM5 + ITEM10 + ITEM11 + ITEM15 + ITEM22
  PA =~ ITEM4 + ITEM7 + ITEM9 + ITEM12 + ITEM17 + ITEM18 + ITEM19 + ITEM21
  EE =~ ITEM12
  ITEM6 ~~ ITEM16
  ITEM10 ~~ ITEM11
  ITEM1 ~~ ITEM2
  EE =~ ITEM11
  ITEM9 ~~ ITEM19
  '

# Use a robust (MLM) estimator:
cfaSEC4<- cfa(SEC_model4, data = MBIsec, estimator = "MLM")

# Numerical summary of the model:
summary(cfaSEC4, fit.measures = TRUE, standardized = TRUE)
```

```
## lavaan 0.6.13 ended normally after 51 iterations
##
##   Estimator                                         ML
##   Optimization method                           NLMINB
##   Number of model parameters                        53
##
##   Number of observations                           692
##
## Model Test User Model:
##                                               Standard      Scaled
##   Test Statistic                               643.964     492.282
##   Degrees of freedom                               200         200
##   P-value (Chi-square)                           0.000       0.000
##   Scaling correction factor                                  1.308
##     Satorra-Bentler correction
##
## Model Test Baseline Model:
##
##   Test statistic                              6432.706    4901.792
##   Degrees of freedom                               231         231
##   P-value                                        0.000       0.000
##   Scaling correction factor                                  1.312
##
## User Model versus Baseline Model:
##
##   Comparative Fit Index (CFI)                    0.928       0.937
##   Tucker-Lewis Index (TLI)                       0.917       0.928
##
##   Robust Comparative Fit Index (CFI)                         0.938
##   Robust Tucker-Lewis Index (TLI)                            0.928
##
## Loglikelihood and Information Criteria:
##
##   Loglikelihood user model (H0)             -24281.590  -24281.590
##   Loglikelihood unrestricted model (H1)     -23959.608  -23959.608
##
##   Akaike (AIC)                               48669.181   48669.181
##   Bayesian (BIC)                             48909.779   48909.779
##   Sample-size adjusted Bayesian (SABIC)      48741.495   48741.495
##
## Root Mean Square Error of Approximation:
##
##   RMSEA                                          0.057       0.046
##   90 Percent confidence interval - lower         0.052       0.041
##   90 Percent confidence interval - upper         0.062       0.050
##   P-value H_0: RMSEA <= 0.050                    0.013       0.930
##   P-value H_0: RMSEA >= 0.080                    0.000       0.000
##
##   Robust RMSEA                                               0.053
##   90 Percent confidence interval - lower                     0.047
##   90 Percent confidence interval - upper                     0.058
##   P-value H_0: Robust RMSEA <= 0.050                         0.230
##   P-value H_0: Robust RMSEA >= 0.080                         0.000
##
```

```
## Standardized Root Mean Square Residual:
##
##   SRMR                                           0.054       0.054
##
## Parameter Estimates:
##
##   Standard errors                             Robust.sem
##   Information                                   Expected
##   Information saturated (h1) model          Structured
##
## Latent Variables:
##                    Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
##   EE =~
##     ITEM1             1.000                               1.125    0.709
##     ITEM2             0.933    0.034   27.301    0.000    1.049    0.687
##     ITEM3             1.092    0.050   21.638    0.000    1.229    0.723
##     ITEM6             0.881    0.063   14.086    0.000    0.991    0.601
##     ITEM8             1.292    0.056   23.234    0.000    1.454    0.852
##     ITEM13            1.138    0.054   21.122    0.000    1.280    0.767
##     ITEM14            0.981    0.050   19.512    0.000    1.103    0.622
##     ITEM16            0.745    0.061   12.249    0.000    0.838    0.579
##     ITEM20            0.915    0.061   15.068    0.000    1.029    0.734
##   DP =~
##     ITEM5             1.000                               0.920    0.627
##     ITEM10            1.036    0.109    9.470    0.000    0.953    0.609
##     ITEM11            0.580    0.113    5.147    0.000    0.534    0.344
##     ITEM15            0.991    0.098   10.144    0.000    0.912    0.643
##     ITEM22            0.912    0.103    8.840    0.000    0.839    0.524
##   PA =~
##     ITEM4             1.000                               0.407    0.369
##     ITEM7             1.588    0.216    7.334    0.000    0.646    0.568
##     ITEM9             2.283    0.325    7.020    0.000    0.929    0.622
##     ITEM12            1.369    0.219    6.239    0.000    0.557    0.416
##     ITEM17            1.378    0.192    7.181    0.000    0.561    0.583
##     ITEM18            2.057    0.280    7.335    0.000    0.837    0.714
##     ITEM19            2.073    0.276    7.515    0.000    0.844    0.649
##     ITEM21            1.573    0.235    6.705    0.000    0.640    0.425
##   EE =~
##     ITEM12           -0.474    0.054   -8.743    0.000   -0.533   -0.398
##     ITEM11            0.416    0.064    6.513    0.000    0.468    0.301
##
## Covariances:
##                    Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
##  .ITEM6 ~~
##    .ITEM16           0.663    0.089    7.411    0.000    0.663    0.426
##  .ITEM10 ~~
##    .ITEM11           0.952    0.122    7.789    0.000    0.952    0.599
##  .ITEM1 ~~
##    .ITEM2            0.624    0.070    8.962    0.000    0.624    0.503
##  .ITEM9 ~~
##    .ITEM19           0.340    0.078    4.383    0.000    0.340    0.294
##   EE ~~
##     DP               0.559    0.066    8.459    0.000    0.540    0.540
##     PA              -0.155    0.028   -5.602    0.000   -0.339   -0.339
```

```
##   DP ~~
##     PA               -0.181    0.035   -5.208    0.000   -0.483   -0.483
##
## Variances:
##                    Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
##    .ITEM1             1.249    0.076   16.431    0.000    1.249    0.497
##    .ITEM2             1.234    0.077   15.981    0.000    1.234    0.529
##    .ITEM3             1.379    0.093   14.811    0.000    1.379    0.477
##    .ITEM6             1.739    0.120   14.525    0.000    1.739    0.639
##    .ITEM8             0.798    0.065   12.204    0.000    0.798    0.274
##    .ITEM13            1.146    0.084   13.653    0.000    1.146    0.412
##    .ITEM14            1.928    0.116   16.635    0.000    1.928    0.613
##    .ITEM16            1.395    0.099   14.089    0.000    1.395    0.665
##    .ITEM20            0.908    0.066   13.787    0.000    0.908    0.462
##    .ITEM5             1.306    0.122   10.712    0.000    1.306    0.607
##    .ITEM10            1.540    0.130   11.820    0.000    1.540    0.629
##    .ITEM11            1.640    0.129   12.662    0.000    1.640    0.679
##    .ITEM15            1.177    0.136    8.659    0.000    1.177    0.586
##    .ITEM22            1.861    0.136   13.729    0.000    1.861    0.726
##    .ITEM4             1.049    0.110    9.523    0.000    1.049    0.864
##    .ITEM7             0.874    0.071   12.341    0.000    0.874    0.677
##    .ITEM9             1.366    0.129   10.558    0.000    1.366    0.613
##    .ITEM12            0.997    0.082   12.144    0.000    0.997    0.556
##    .ITEM17            0.611    0.072    8.530    0.000    0.611    0.660
##    .ITEM18            0.672    0.075    8.909    0.000    0.672    0.490
##    .ITEM19            0.979    0.088   11.153    0.000    0.979    0.579
##    .ITEM21            1.862    0.123   15.165    0.000    1.862    0.820
##     EE                1.265    0.103   12.306    0.000    1.000    1.000
##     DP                0.846    0.137    6.195    0.000    1.000    1.000
##     PA                0.166    0.040    4.133    0.000    1.000    1.000
```

```
# Model results to a convenient table format
library(knitr)
fit_sec4<- fitMeasures(cfaSEC4, c("chisq.scaled", "cfi.robust", "tli.robust", "rmsea.robust", "rmsea.ci
SEC4 <- as.data.frame(t(fit_sec4))
colnames(ELM1) <- colnames(SEC1) <- colnames(ELM2) <- colnames(SEC2) <- colnames(ELM3) <- colnames(SEC3)
fit_table <- rbind(ELM1, SEC1, ELM2, SEC2, ELM3, SEC3, SEC4)
rownames(fit_table) <- c("ELM1", "SEC1", "ELM2", "SEC2", "ELM3", "SEC3", "SEC4")
kable(fit_table, digits = 3, align = "lcccc", booktabs = TRUE,
             caption = "Model fits")
```

Table 13: Model fits

	Chisq	CFI	TLI	RMSEA	CI lower	CI upper
ELM1	802.743	0.858	0.841	0.079	0.074	0.085
SEC1	971.064	0.835	0.815	0.084	0.079	0.090
ELM2	470.377	0.937	0.928	0.053	0.047	0.060
SEC2	572.552	0.921	0.909	0.059	0.053	0.065
ELM3	445.801	0.944	0.935	0.051	0.044	0.057
SEC3	522.982	0.931	0.921	0.055	0.049	0.061
SEC4	492.282	0.938	0.928	0.053	0.047	0.058

```
#Model modification indices for SEC model 4
modindices(cfaSEC4, standardized = TRUE, sort = TRUE, maximum.number = 25) %>%
  kable(digits = 3, align = "rclccccc")
```

	lhs	op	rhs	mi	epc	sepc.lv	sepc.all	sepc.nox
309	ITEM7	~~	ITEM18	32.853	-0.227	-0.227	-0.296	-0.296
223	ITEM16	~~	ITEM20	28.373	0.224	0.224	0.199	0.199
74	DP	=~	ITEM14	20.163	-0.404	-0.371	-0.209	-0.209
311	ITEM7	~~	ITEM21	20.053	0.242	0.242	0.189	0.189
60	EE	=~	ITEM22	20.006	0.317	0.357	0.223	0.223
123	ITEM2	~~	ITEM14	19.860	0.239	0.239	0.155	0.155
125	ITEM2	~~	ITEM20	18.473	-0.164	-0.164	-0.155	-0.155
91	PA	=~	ITEM14	17.427	0.685	0.279	0.157	0.157
323	ITEM18	~~	ITEM19	17.273	0.168	0.168	0.208	0.208
252	ITEM5	~~	ITEM15	16.266	0.301	0.301	0.243	0.243
73	DP	=~	ITEM13	15.910	0.292	0.268	0.161	0.161
286	ITEM15	~~	ITEM12	15.779	0.190	0.190	0.176	0.176
324	ITEM18	~~	ITEM21	15.569	-0.208	-0.208	-0.186	-0.186
75	DP	=~	ITEM16	15.192	0.263	0.242	0.167	0.167
161	ITEM6	~~	ITEM20	13.179	-0.171	-0.171	-0.136	-0.136
141	ITEM3	~~	ITEM13	13.044	-0.206	-0.206	-0.164	-0.164
153	ITEM3	~~	ITEM12	12.453	-0.176	-0.176	-0.150	-0.150
80	DP	=~	ITEM12	12.355	0.265	0.244	0.182	0.182
320	ITEM17	~~	ITEM18	11.861	0.115	0.115	0.180	0.180
119	ITEM2	~~	ITEM3	11.532	0.159	0.159	0.122	0.122
59	EE	=~	ITEM15	11.522	-0.218	-0.245	-0.173	-0.173
177	ITEM8	~~	ITEM16	11.382	-0.148	-0.148	-0.141	-0.141
76	DP	=~	ITEM20	11.335	0.215	0.198	0.141	0.141
57	EE	=~	ITEM5	10.652	-0.215	-0.242	-0.165	-0.165
68	DP	=~	ITEM1	10.273	-0.198	-0.182	-0.115	-0.115

```
## THIS IS A GOOD BASELINE MODEL FOR SECONDARY TEACHERS!
```

Visualize the final baseline models for each group

At this stage, the elm and sec models have some differences.

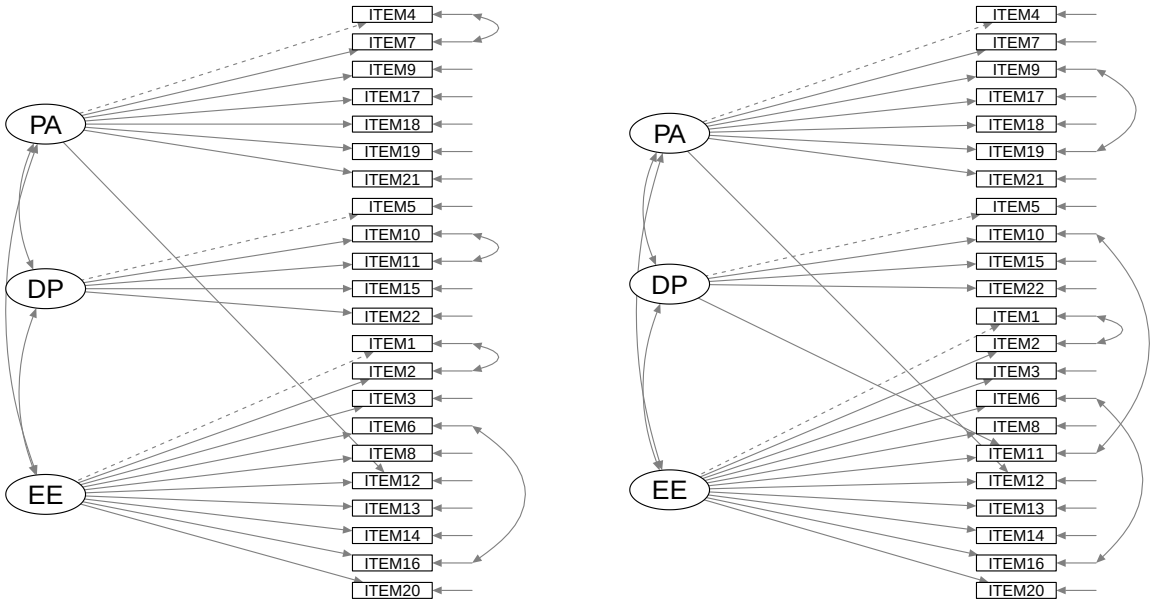
```
library(semPlot)
#install.packages("patchwork")
library(patchwork) #to display the two plots side by side, en lopulta käyttänyt
# create two plots (one for each baseline model)

par(mfrow=c(1,2))
#elementary teachers
semPaths(cfaELM3, style = "lisrel", layout = "tree2", what = "path", whatLabels = "name",
    intercepts = FALSE, residuals = TRUE, thresholds = FALSE, reorder = FALSE,
    rotation = 2,
    latents = c("EE","DP", "PA"),
    sizeLat = 10, sizeLat2 = 5,
    manifests = rev(colnames(MBIelm)),
    sizeMan = 10, sizeMan2 = 2
```

```
    )

#secondary teachers
semPaths(cfaSEC4, style = "lisrel", layout = "tree2", what = "path", whatLabels = "name",
    intercepts = FALSE, residuals = TRUE, thresholds = FALSE, reorder = FALSE,
    rotation = 2,
    latents = c("EE","DP", "PA"),
    sizeLat = 10, sizeLat2 = 5,
    manifests = rev(colnames(MBIsec)),
    sizeMan = 10, sizeMan2 = 2
    )
mtext("Hypotesized multigroup baseline model of MBI structure for elementary and secondary teachers", #
      side = 3,
      line = - 2,
      outer = TRUE)
```

otesized multigroup baseline model of MBI structure for elementary and secondary teacl




```
par(mfrow=c(1,1))
```

Exercise 5.2:

Now we are getting to the point of this Assignment: testing the invariance. See slide #14.

Note: To continue you have to combine the two data sets into one data set, so that it includes a variable for identifying the two groups.

As soon as you have the new data, go ahead and specify the *common baseline (configural) model*, and then begin the **invariance testing** by estimating that configural model and studying its output. See below! A lot of ready R code given! :)

Combine the data sets and establish the group variable accordingly

```
# There are many ways to do this in R, this is just one possibility:
# (merge() comes from the base R, it has a handy argument `group`)

MBIelmsec <- merge(data.frame(MBIelm, group = "elementary"),
                   data.frame(MBIsec, group = "secondary"),
                   all = TRUE, sort = FALSE)

# quickly check that the new group variable includes the specified values:
head(MBIelmsec[, 21:23])
```

```
##   ITEM21 ITEM22      group
## 1      5      0 elementary
## 2      3      2 elementary
## 3      3      2 elementary
## 4      6      0 elementary
## 5      5      1 elementary
## 6      5      0 elementary
```

```
tail(MBIelmsec[, 21:23])
```

```
##      ITEM21 ITEM22     group
## 1267      4      5 secondary
## 1268      5      0 secondary
## 1269      3      1 secondary
## 1270      6      0 secondary
## 1271      4      3 secondary
## 1272      5      2 secondary
```

```
# good - now we can identify the groups from the combined data, too!
```

Configural model (common baseline model for both groups simultaneously)

To get you going, I give you the complete, commented R code for the configural model below (see also https://lavaan.ugent.be/tutorial/syntax2.html).

NOTE: No equality constraints are imposed (see the end of my slide #18). Not yet! :)

This is the default in lavaan (and as you will see, everything is much simpler than in Mplus).

You should have **401 degrees of freedom** when fitting the multigroup version of the baseline models for the two teacher groups. Please check that you get it right before proceeding forward!

```
INV1model <- '
# CFA model for the burnout, the configural model:
#
```

```
# EE: EmotionalExhaustion
# DP: Depersonalization
# PA: PersonalAccomplishment
#
# The ones (1s) can be written explicitly (the default is the 1st one of each set):
# (this is "nice to know": would be easy to change the fixed item(s), if needed)

    EE =~ 1*ITEM1 + ITEM2 + ITEM3 + ITEM6 + ITEM8 + ITEM13 + ITEM14 + ITEM16 + ITEM20
    DP =~ 1*ITEM5 + ITEM10 + ITEM11 + ITEM15 + ITEM22
    PA =~ 1*ITEM4 + ITEM7 + ITEM9 + ITEM12 + ITEM17 + ITEM18 + ITEM19 + ITEM21

#LUENNOLTA MUISTIIN: first one with *1 because you want to have a good first item that is really lookin

# Common modifications (from baseline models built above)
    EE =~ ITEM12 # common cross-loading
 ITEM1 ~~ ITEM2  # common residual covariances (3)
 ITEM6 ~~ ITEM16
ITEM10 ~~ ITEM11

# Group-specific parameters for elementary teachers:
 ITEM4 ~~ c(NA, 0)*ITEM7  # specific residual covariance
# LUENNOLTA MUISTIIN: ^NA tarkoittaa että only for elementary teachers, fixed to 0 for secondary teache

# Group-specific parameters for secondary teachers:
    EE =~ c(0, NA)*ITEM11 # specific cross-loading
 ITEM9 ~~ c(0, NA)*ITEM19 # specific residual covariance
'
```

The configural model (the common baseline model for both groups) can now be estimated:

(Again, I am giving you more R code to keep you on the track.) :) You may, of course, always edit my code and add your own!

```
# From now on, we need the group argument in the cfa() function:
INV1fit <- cfa(INV1model, data = MBIelmsec, estimator = "MLM", group = "group")

# Numerical summary of the model (yes, it is getting longer...)
summary(INV1fit, fit.measures = TRUE, standardized = TRUE)
```

```
## lavaan 0.6.13 ended normally after 90 iterations
##
##   Estimator                                         ML
##   Optimization method                           NLMINB
##   Number of model parameters                       149
##
##   Number of observations per group:
##     elementary                                     580
##     secondary                                      692
##
## Model Test User Model:
##                                              Standard      Scaled
##   Test Statistic                             1189.811     939.696
##   Degrees of freedom                              401         401
##   P-value (Chi-square)                          0.000       0.000
```

```
##   Scaling correction factor                                  1.266
##     Satorra-Bentler correction
##   Test statistic for each group:
##     elementary                                 545.846     431.102
##     secondary                                  643.964     508.594
##
## Model Test Baseline Model:
##
##   Test statistic                             12040.836    9261.794
##   Degrees of freedom                               462         462
##   P-value                                        0.000       0.000
##   Scaling correction factor                                  1.300
##
## User Model versus Baseline Model:
##
##   Comparative Fit Index (CFI)                    0.932       0.939
##   Tucker-Lewis Index (TLI)                       0.922       0.929
##
##   Robust Comparative Fit Index (CFI)                         0.940
##   Robust Tucker-Lewis Index (TLI)                            0.931
##
## Loglikelihood and Information Criteria:
##
##   Loglikelihood user model (H0)              -43942.218  -43942.218
##   Loglikelihood unrestricted model (H1)      -43347.312  -43347.312
##
##   Akaike (AIC)                                88182.435   88182.435
##   Bayesian (BIC)                              88949.539   88949.539
##   Sample-size adjusted Bayesian (SABIC)       88476.243   88476.243
##
## Root Mean Square Error of Approximation:
##
##   RMSEA                                          0.056       0.046
##   90 Percent confidence interval - lower         0.052       0.043
##   90 Percent confidence interval - upper         0.059       0.049
##   P-value H_0: RMSEA <= 0.050                    0.006       0.975
##   P-value H_0: RMSEA >= 0.080                    0.000       0.000
##
##   Robust RMSEA                                               0.052
##   90 Percent confidence interval - lower                     0.047
##   90 Percent confidence interval - upper                     0.056
##   P-value H_0: Robust RMSEA <= 0.050                         0.251
##   P-value H_0: Robust RMSEA >= 0.080                         0.000
##
## Standardized Root Mean Square Residual:
##
##   SRMR                                           0.051       0.051
##
## Parameter Estimates:
##
##   Standard errors                            Robust.sem
##   Information                                  Expected
##   Information saturated (h1) model          Structured
##
```

```
##
## Group 1 [elementary]:
##
## Latent Variables:
##                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
##   EE =~
##     ITEM1            1.000                               1.242    0.748
##     ITEM2            0.915    0.033   27.877    0.000    1.137    0.723
##     ITEM3            1.031    0.047   22.087    0.000    1.280    0.749
##     ITEM6            0.808    0.058   13.891    0.000    1.003    0.605
##     ITEM8            1.262    0.047   26.682    0.000    1.566    0.864
##     ITEM13           1.049    0.049   21.589    0.000    1.302    0.756
##     ITEM14           0.955    0.049   19.565    0.000    1.186    0.651
##     ITEM16           0.759    0.056   13.548    0.000    0.942    0.620
##     ITEM20           0.868    0.051   16.896    0.000    1.077    0.749
##   DP =~
##     ITEM5            1.000                               0.962    0.651
##     ITEM10           1.011    0.087   11.577    0.000    0.973    0.659
##     ITEM11           1.031    0.084   12.255    0.000    0.992    0.657
##     ITEM15           0.661    0.076    8.693    0.000    0.636    0.568
##     ITEM22           0.628    0.081    7.774    0.000    0.604    0.392
##   PA =~
##     ITEM4            1.000                               0.392    0.420
##     ITEM7            1.107    0.169    6.546    0.000    0.434    0.496
##     ITEM9            1.997    0.342    5.848    0.000    0.783    0.588
##     ITEM12           1.374    0.279    4.922    0.000    0.539    0.418
##     ITEM17           1.523    0.226    6.747    0.000    0.597    0.676
##     ITEM18           2.012    0.341    5.898    0.000    0.789    0.649
##     ITEM19           1.944    0.326    5.966    0.000    0.762    0.673
##     ITEM21           1.370    0.213    6.435    0.000    0.537    0.417
##   EE =~
##     ITEM12          -0.379    0.046   -8.287    0.000   -0.471   -0.366
##     ITEM11           0.000                               0.000    0.000
##
## Covariances:
##                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
##  .ITEM1 ~~
##    .ITEM2            0.504    0.064    7.828    0.000    0.504    0.422
##  .ITEM6 ~~
##    .ITEM16           0.856    0.106    8.105    0.000    0.856    0.544
##  .ITEM10 ~~
##    .ITEM11           0.554    0.099    5.596    0.000    0.554    0.438
##  .ITEM4 ~~
##    .ITEM7            0.175    0.060    2.938    0.003    0.175    0.272
##  .ITEM9 ~~
##    .ITEM19           0.000                               0.000    0.000
##   EE ~~
##     DP               0.802    0.085    9.380    0.000    0.671    0.671
##     PA              -0.202    0.035   -5.853    0.000   -0.415   -0.415
##   DP ~~
##     PA              -0.201    0.041   -4.966    0.000   -0.534   -0.534
##
## Intercepts:
##                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
```

```
##    .ITEM1            3.409    0.069   49.484    0.000    3.409    2.055
##    .ITEM2            3.976    0.065   60.903    0.000    3.976    2.529
##    .ITEM3            2.572    0.071   36.229    0.000    2.572    1.504
##    .ITEM6            1.676    0.069   24.353    0.000    1.676    1.011
##    .ITEM8            2.184    0.075   29.012    0.000    2.184    1.205
##    .ITEM13           2.548    0.072   35.621    0.000    2.548    1.479
##    .ITEM14           3.122    0.076   41.262    0.000    3.122    1.713
##    .ITEM16           1.433    0.063   22.715    0.000    1.433    0.943
##    .ITEM20           1.281    0.060   21.456    0.000    1.281    0.891
##    .ITEM5            1.053    0.061   17.177    0.000    1.053    0.713
##    .ITEM10           1.164    0.061   18.990    0.000    1.164    0.789
##    .ITEM11           1.122    0.063   17.889    0.000    1.122    0.743
##    .ITEM15           0.545    0.047   11.713    0.000    0.545    0.486
##    .ITEM22           1.328    0.064   20.730    0.000    1.328    0.861
##    .ITEM4            5.412    0.039  139.751    0.000    5.412    5.803
##    .ITEM7            5.338    0.036  146.968    0.000    5.338    6.103
##    .ITEM9            5.031    0.055   90.946    0.000    5.031    3.776
##    .ITEM12           4.693    0.053   87.789    0.000    4.693    3.645
##    .ITEM17           5.416    0.037  147.600    0.000    5.416    6.129
##    .ITEM18           4.883    0.050   96.794    0.000    4.883    4.019
##    .ITEM19           5.007    0.047  106.468    0.000    5.007    4.421
##    .ITEM21           4.841    0.054   90.467    0.000    4.841    3.756
##     EE               0.000                              0.000    0.000
##     DP               0.000                              0.000    0.000
##     PA               0.000                              0.000    0.000
##
## Variances:
##                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
##    .ITEM1            1.210    0.078   15.471    0.000    1.210    0.440
##    .ITEM2            1.180    0.074   16.005    0.000    1.180    0.477
##    .ITEM3            1.284    0.106   12.174    0.000    1.284    0.439
##    .ITEM6            1.741    0.127   13.711    0.000    1.741    0.634
##    .ITEM8            0.835    0.078   10.763    0.000    0.835    0.254
##    .ITEM13           1.273    0.107   11.891    0.000    1.273    0.429
##    .ITEM14           1.915    0.125   15.361    0.000    1.915    0.577
##    .ITEM16           1.420    0.104   13.681    0.000    1.420    0.615
##    .ITEM20           0.907    0.097    9.375    0.000    0.907    0.438
##    .ITEM5            1.256    0.134    9.344    0.000    1.256    0.576
##    .ITEM10           1.232    0.123   10.047    0.000    1.232    0.566
##    .ITEM11           1.299    0.128   10.150    0.000    1.299    0.569
##    .ITEM15           0.850    0.125    6.814    0.000    0.850    0.677
##    .ITEM22           2.014    0.156   12.895    0.000    2.014    0.847
##    .ITEM4            0.716    0.089    8.040    0.000    0.716    0.823
##    .ITEM7            0.577    0.076    7.610    0.000    0.577    0.754
##    .ITEM9            1.162    0.131    8.902    0.000    1.162    0.655
##    .ITEM12           0.935    0.094    9.947    0.000    0.935    0.564
##    .ITEM17           0.424    0.056    7.631    0.000    0.424    0.544
##    .ITEM18           0.854    0.119    7.193    0.000    0.854    0.579
##    .ITEM19           0.702    0.072    9.737    0.000    0.702    0.547
##    .ITEM21           1.373    0.130   10.528    0.000    1.373    0.826
##     EE               1.541    0.113   13.636    0.000    1.000    1.000
##     DP               0.926    0.142    6.517    0.000    1.000    1.000
##     PA               0.154    0.046    3.333    0.001    1.000    1.000
##
```

```
##
## Group 2 [secondary]:
##
## Latent Variables:
##                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
##   EE =~
##     ITEM1            1.000                               1.125    0.709
##     ITEM2            0.933    0.034   27.301    0.000    1.049    0.687
##     ITEM3            1.092    0.050   21.638    0.000    1.229    0.723
##     ITEM6            0.881    0.063   14.086    0.000    0.991    0.601
##     ITEM8            1.292    0.056   23.234    0.000    1.454    0.852
##     ITEM13           1.138    0.054   21.123    0.000    1.280    0.767
##     ITEM14           0.981    0.050   19.512    0.000    1.103    0.622
##     ITEM16           0.745    0.061   12.249    0.000    0.838    0.579
##     ITEM20           0.915    0.061   15.069    0.000    1.029    0.734
##   DP =~
##     ITEM5            1.000                               0.920    0.627
##     ITEM10           1.036    0.109    9.470    0.000    0.953    0.609
##     ITEM11           0.580    0.113    5.147    0.000    0.534    0.344
##     ITEM15           0.991    0.098   10.144    0.000    0.912    0.643
##     ITEM22           0.912    0.103    8.840    0.000    0.839    0.524
##   PA =~
##     ITEM4            1.000                               0.407    0.369
##     ITEM7            1.588    0.216    7.334    0.000    0.646    0.568
##     ITEM9            2.283    0.325    7.020    0.000    0.929    0.622
##     ITEM12           1.369    0.219    6.239    0.000    0.557    0.416
##     ITEM17           1.378    0.192    7.181    0.000    0.561    0.583
##     ITEM18           2.057    0.280    7.336    0.000    0.837    0.714
##     ITEM19           2.073    0.276    7.515    0.000    0.844    0.649
##     ITEM21           1.573    0.235    6.705    0.000    0.640    0.425
##   EE =~
##     ITEM12          -0.474    0.054   -8.743    0.000   -0.533   -0.398
##     ITEM11           0.416    0.064    6.513    0.000    0.468    0.301
##
## Covariances:
##                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
##  .ITEM1 ~~
##    .ITEM2            0.624    0.070    8.962    0.000    0.624    0.503
##  .ITEM6 ~~
##    .ITEM16           0.663    0.089    7.411    0.000    0.663    0.426
##  .ITEM10 ~~
##    .ITEM11           0.952    0.122    7.789    0.000    0.952    0.599
##  .ITEM4 ~~
##    .ITEM7            0.000                               0.000    0.000
##  .ITEM9 ~~
##    .ITEM19           0.340    0.078    4.383    0.000    0.340    0.294
##   EE ~~
##     DP               0.559    0.066    8.459    0.000    0.540    0.540
##     PA              -0.155    0.028   -5.602    0.000   -0.339   -0.339
##   DP ~~
##     PA              -0.181    0.035   -5.208    0.000   -0.483   -0.483
##
## Intercepts:
##                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
```

```
##    .ITEM1            3.371    0.060   55.937    0.000    3.371    2.126
##    .ITEM2            3.890    0.058   66.973    0.000    3.890    2.546
##    .ITEM3            2.526    0.065   39.101    0.000    2.526    1.486
##    .ITEM6            1.999    0.063   31.871    0.000    1.999    1.212
##    .ITEM8            2.143    0.065   33.039    0.000    2.143    1.256
##    .ITEM13           2.653    0.063   41.827    0.000    2.653    1.590
##    .ITEM14           3.147    0.067   46.680    0.000    3.147    1.775
##    .ITEM16           1.548    0.055   28.112    0.000    1.548    1.069
##    .ITEM20           1.211    0.053   22.713    0.000    1.211    0.863
##    .ITEM5            1.217    0.056   21.817    0.000    1.217    0.829
##    .ITEM10           1.275    0.059   21.431    0.000    1.275    0.815
##    .ITEM11           1.166    0.060   19.550    0.000    1.166    0.751
##    .ITEM15           1.078    0.054   20.011    0.000    1.078    0.761
##    .ITEM22           1.790    0.061   29.412    0.000    1.790    1.118
##    .ITEM4            5.168    0.042  123.343    0.000    5.168    4.689
##    .ITEM7            5.014    0.043  116.064    0.000    5.014    4.412
##    .ITEM9            4.702    0.057   82.848    0.000    4.702    3.149
##    .ITEM12           4.527    0.051   88.954    0.000    4.527    3.382
##    .ITEM17           5.303    0.037  145.039    0.000    5.303    5.514
##    .ITEM18           4.705    0.045  105.646    0.000    4.705    4.016
##    .ITEM19           4.600    0.049   93.051    0.000    4.600    3.537
##    .ITEM21           4.462    0.057   77.884    0.000    4.462    2.961
##     EE               0.000                              0.000    0.000
##     DP               0.000                              0.000    0.000
##     PA               0.000                              0.000    0.000
##
## Variances:
##                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
##    .ITEM1            1.249    0.076   16.431    0.000    1.249    0.497
##    .ITEM2            1.234    0.077   15.981    0.000    1.234    0.529
##    .ITEM3            1.379    0.093   14.811    0.000    1.379    0.477
##    .ITEM6            1.739    0.120   14.525    0.000    1.739    0.639
##    .ITEM8            0.798    0.065   12.204    0.000    0.798    0.274
##    .ITEM13           1.146    0.084   13.653    0.000    1.146    0.412
##    .ITEM14           1.928    0.116   16.635    0.000    1.928    0.613
##    .ITEM16           1.395    0.099   14.089    0.000    1.395    0.665
##    .ITEM20           0.908    0.066   13.787    0.000    0.908    0.462
##    .ITEM5            1.306    0.122   10.712    0.000    1.306    0.607
##    .ITEM10           1.540    0.130   11.820    0.000    1.540    0.629
##    .ITEM11           1.640    0.129   12.662    0.000    1.640    0.679
##    .ITEM15           1.177    0.136    8.659    0.000    1.177    0.586
##    .ITEM22           1.861    0.136   13.729    0.000    1.861    0.726
##    .ITEM4            1.049    0.110    9.523    0.000    1.049    0.864
##    .ITEM7            0.874    0.071   12.341    0.000    0.874    0.677
##    .ITEM9            1.366    0.129   10.558    0.000    1.366    0.613
##    .ITEM12           0.997    0.082   12.144    0.000    0.997    0.556
##    .ITEM17           0.611    0.072    8.530    0.000    0.611    0.660
##    .ITEM18           0.672    0.075    8.909    0.000    0.672    0.490
##    .ITEM19           0.979    0.088   11.153    0.000    0.979    0.579
##    .ITEM21           1.862    0.123   15.165    0.000    1.862    0.820
##     EE               1.265    0.103   12.306    0.000    1.000    1.000
##     DP               0.846    0.137    6.195    0.000    1.000    1.000
##     PA               0.166    0.040    4.133    0.000    1.000    1.000
```

```
library(knitr)
fit_INV1 <- fitMeasures(INV1fit, c("chisq.scaled", "cfi.robust", "tli.robust", "rmsea.robust", "rmsea.c
INV1 <- as.data.frame(t(fit_INV1))
colnames(INV1) <- c("Chisq", "CFI", "TLI", "RMSEA", "CI lower", "CI upper")
fit_table <- rbind(INV1)
rownames(fit_table) <- c("INV1")
kable(fit_table, digits = 3, align = "lcccc", booktabs = TRUE,
             caption = " Testing for Invariance of MBI across Elementary/Secondary Teachers
 Common Baseline (Configural) Model")
```

Table 15: Testing for Invariance of MBI across Elementary/Secondary Teachers Common Baseline (Configural) Model

	Chisq	CFI	TLI	RMSEA	CI lower	CI upper
INV1	939.696	0.94	0.931	0.052	0.047	0.056

Study the output. Then, you will finally be ready for the point: **invariance testing** phase.

(Luckily it will all be quite much simpler than with Mplus! But there are many phases.)

Your task is to proceed *carefully* with the measurement model modifications for two TASKS: **TASK 1) Factor loadings** and **TASK 2) Residual covariances**.

In the end of this phase, Byrne has some unfortunate errors... (see slide #25). Check what you get!

```
# take a look at this web page: https://lavaan.ugent.be/tutorial/groups.html
# (see esp. under the heading "Constraining groups of parameters to be equal across groups")

# TASK 1) begins here!
# ####################
# to constrain the 20 common factor loadings equal,
# simply use `group.equal` in cfa() for "loadings",
# and
# to keep the one specific cross-loading ("EE =~ ITEM11") free,
# simply use `group.partial` in cfa() for that cross-loading:

INV2fit <- cfa(INV1model, data = MBIelmsec, estimator = "MLM",
               group = "group",
               group.equal = "loadings",
               group.partial = "EE =~ ITEM11"
              )

# Numerical summary of the model (yes, it is getting longer...)
summary(INV2fit, fit.measures = TRUE, standardized = TRUE)
```

```
## lavaan 0.6.13 ended normally after 68 iterations
##
##   Estimator                                         ML
##   Optimization method                           NLMINB
##   Number of model parameters                       149
##   Number of equality constraints                    20
##
```

```
##   Number of observations per group:
##     elementary                                580
##     secondary                                 692
##
## Model Test User Model:
##                                            Standard      Scaled
##   Test Statistic                           1257.662     995.433
##   Degrees of freedom                        421         421
##   P-value (Chi-square)                        0.000       0.000
##   Scaling correction factor                               1.263
##     Satorra-Bentler correction
##   Test statistic for each group:
##     elementary                              576.993     456.687
##     secondary                               680.669     538.746
##
## Model Test Baseline Model:
##
##   Test statistic                          12040.836    9261.794
##   Degrees of freedom                        462         462
##   P-value                                     0.000       0.000
##   Scaling correction factor                               1.300
##
## User Model versus Baseline Model:
##
##   Comparative Fit Index (CFI)                 0.928       0.935
##   Tucker-Lewis Index (TLI)                    0.921       0.928
##
##   Robust Comparative Fit Index (CFI)                      0.937
##   Robust Tucker-Lewis Index (TLI)                         0.930
##
## Loglikelihood and Information Criteria:
##
##   Loglikelihood user model (H0)           -43976.144  -43976.144
##   Loglikelihood unrestricted model (H1)   -43347.312  -43347.312
##
##   Akaike (AIC)                             88210.287   88210.287
##   Bayesian (BIC)                           88874.424   88874.424
##   Sample-size adjusted Bayesian (SABIC)    88464.658   88464.658
##
## Root Mean Square Error of Approximation:
##
##   RMSEA                                       0.056       0.046
##   90 Percent confidence interval - lower      0.052       0.043
##   90 Percent confidence interval - upper      0.059       0.050
##   P-value H_0: RMSEA <= 0.050                 0.003       0.967
##   P-value H_0: RMSEA >= 0.080                 0.000       0.000
##
##   Robust RMSEA                                            0.052
##   90 Percent confidence interval - lower                  0.048
##   90 Percent confidence interval - upper                  0.056
##   P-value H_0: Robust RMSEA <= 0.050                      0.205
##   P-value H_0: Robust RMSEA >= 0.080                      0.000
##
## Standardized Root Mean Square Residual:
```

```
##
##   SRMR                                           0.057       0.057
##
## Parameter Estimates:
##
##   Standard errors                             Robust.sem
##   Information                                   Expected
##   Information saturated (h1) model          Structured
##
##
## Group 1 [elementary]:
##
## Latent Variables:
##                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
##   EE =~
##     ITEM1             1.000                               1.217    0.741
##     ITEM2   (.p2.)    0.925    0.024   38.983    0.000    1.125    0.719
##     ITEM3   (.p3.)    1.061    0.034   30.912    0.000    1.291    0.752
##     ITEM6   (.p4.)    0.840    0.043   19.724    0.000    1.022    0.613
##     ITEM8   (.p5.)    1.274    0.036   35.059    0.000    1.550    0.860
##     ITEM13  (.p6.)    1.092    0.036   30.317    0.000    1.329    0.763
##     ITEM14  (.p7.)    0.968    0.035   27.721    0.000    1.177    0.648
##     ITEM16  (.p8.)    0.751    0.041   18.192    0.000    0.914    0.608
##     ITEM20  (.p9.)    0.889    0.039   22.516    0.000    1.082    0.751
##   DP =~
##     ITEM5             1.000                               0.903    0.626
##     ITEM10  (.11.)    1.038    0.073   14.236    0.000    0.938    0.640
##     ITEM11  (.12.)    0.862    0.074   11.605    0.000    0.779    0.542
##     ITEM15  (.13.)    0.805    0.061   13.295    0.000    0.727    0.628
##     ITEM22  (.14.)    0.797    0.067   11.855    0.000    0.720    0.455
##   PA =~
##     ITEM4             1.000                               0.389    0.417
##     ITEM7   (.16.)    1.285    0.135    9.509    0.000    0.500    0.554
##     ITEM9   (.17.)    2.083    0.233    8.936    0.000    0.810    0.603
##     ITEM12  (.18.)    1.331    0.171    7.804    0.000    0.518    0.398
##     ITEM17  (.19.)    1.413    0.143    9.866    0.000    0.549    0.637
##     ITEM18  (.20.)    1.987    0.215    9.258    0.000    0.773    0.639
##     ITEM19  (.21.)    1.952    0.208    9.408    0.000    0.759    0.672
##     ITEM21  (.22.)    1.431    0.154    9.268    0.000    0.556    0.430
##   EE =~
##     ITEM12  (.23.)   -0.426    0.036  -11.944    0.000   -0.518   -0.398
##     ITEM11            0.000                               0.000    0.000
##
## Covariances:
##                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
##  .ITEM1 ~~
##    .ITEM2             0.508    0.064    7.987    0.000    0.508    0.423
##  .ITEM6 ~~
##    .ITEM16            0.856    0.104    8.192    0.000    0.856    0.544
##  .ITEM10 ~~
##    .ITEM11            0.647    0.097    6.652    0.000    0.647    0.475
##  .ITEM4 ~~
##    .ITEM7             0.169    0.060    2.835    0.005    0.169    0.266
##  .ITEM9 ~~
```

```
##    .ITEM19            0.000                               0.000    0.000
##   EE ~~
##     DP                0.724    0.079    9.205    0.000    0.659    0.659
##     PA               -0.194    0.028   -6.836    0.000   -0.409   -0.409
##   DP ~~
##     PA               -0.187    0.031   -6.010    0.000   -0.533   -0.533
##
## Intercepts:
##                    Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
##    .ITEM1             3.409    0.069   49.484    0.000    3.409    2.076
##    .ITEM2             3.976    0.065   60.903    0.000    3.976    2.541
##    .ITEM3             2.572    0.071   36.229    0.000    2.572    1.499
##    .ITEM6             1.676    0.069   24.353    0.000    1.676    1.005
##    .ITEM8             2.184    0.075   29.012    0.000    2.184    1.212
##    .ITEM13            2.548    0.072   35.621    0.000    2.548    1.463
##    .ITEM14            3.122    0.076   41.262    0.000    3.122    1.718
##    .ITEM16            1.433    0.063   22.715    0.000    1.433    0.953
##    .ITEM20            1.281    0.060   21.456    0.000    1.281    0.889
##    .ITEM5             1.053    0.061   17.177    0.000    1.053    0.730
##    .ITEM10            1.164    0.061   18.990    0.000    1.164    0.793
##    .ITEM11            1.122    0.063   17.889    0.000    1.122    0.781
##    .ITEM15            0.545    0.047   11.713    0.000    0.545    0.470
##    .ITEM22            1.328    0.064   20.730    0.000    1.328    0.839
##    .ITEM4             5.412    0.039  139.751    0.000    5.412    5.808
##    .ITEM7             5.338    0.036  146.968    0.000    5.338    5.913
##    .ITEM9             5.031    0.055   90.946    0.000    5.031    3.745
##    .ITEM12            4.693    0.053   87.789    0.000    4.693    3.607
##    .ITEM17            5.416    0.037  147.600    0.000    5.416    6.283
##    .ITEM18            4.883    0.050   96.794    0.000    4.883    4.039
##    .ITEM19            5.007    0.047  106.468    0.000    5.007    4.434
##    .ITEM21            4.841    0.054   90.467    0.000    4.841    3.744
##     EE                0.000                               0.000    0.000
##     DP                0.000                               0.000    0.000
##     PA                0.000                               0.000    0.000
##
## Variances:
##                    Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
##    .ITEM1             1.216    0.076   15.969    0.000    1.216    0.451
##    .ITEM2             1.182    0.073   16.106    0.000    1.182    0.483
##    .ITEM3             1.278    0.103   12.407    0.000    1.278    0.434
##    .ITEM6             1.737    0.126   13.767    0.000    1.737    0.624
##    .ITEM8             0.844    0.076   11.042    0.000    0.844    0.260
##    .ITEM13            1.269    0.106   11.985    0.000    1.269    0.418
##    .ITEM14            1.918    0.122   15.754    0.000    1.918    0.580
##    .ITEM16            1.426    0.102   13.948    0.000    1.426    0.631
##    .ITEM20            0.905    0.096    9.469    0.000    0.905    0.436
##    .ITEM5             1.265    0.129    9.841    0.000    1.265    0.608
##    .ITEM10            1.271    0.118   10.777    0.000    1.271    0.591
##    .ITEM11            1.459    0.126   11.618    0.000    1.459    0.706
##    .ITEM15            0.814    0.125    6.506    0.000    0.814    0.606
##    .ITEM22            1.987    0.158   12.569    0.000    1.987    0.793
##    .ITEM4             0.717    0.089    8.033    0.000    0.717    0.826
##    .ITEM7             0.565    0.076    7.430    0.000    0.565    0.693
##    .ITEM9             1.149    0.130    8.863    0.000    1.149    0.637
```

```
##    .ITEM12           0.937    0.093   10.122    0.000    0.937    0.554
##    .ITEM17           0.441    0.057    7.771    0.000    0.441    0.594
##    .ITEM18           0.864    0.116    7.465    0.000    0.864    0.592
##    .ITEM19           0.699    0.071    9.882    0.000    0.699    0.548
##    .ITEM21           1.363    0.129   10.592    0.000    1.363    0.815
##     EE               1.480    0.101   14.682    0.000    1.000    1.000
##     DP               0.816    0.122    6.675    0.000    1.000    1.000
##     PA               0.151    0.032    4.775    0.000    1.000    1.000
##
##
## Group 2 [secondary]:
##
## Latent Variables:
##                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
##   EE =~
##     ITEM1             1.000                              1.151    0.719
##     ITEM2   (.p2.)    0.925    0.024   38.983    0.000    1.065    0.693
##     ITEM3   (.p3.)    1.061    0.034   30.912    0.000    1.221    0.721
##     ITEM6   (.p4.)    0.840    0.043   19.724    0.000    0.967    0.591
##     ITEM8   (.p5.)    1.274    0.036   35.059    0.000    1.466    0.855
##     ITEM13  (.p6.)    1.092    0.036   30.317    0.000    1.257    0.760
##     ITEM14  (.p7.)    0.968    0.035   27.721    0.000    1.114    0.627
##     ITEM16  (.p8.)    0.751    0.041   18.192    0.000    0.865    0.591
##     ITEM20  (.p9.)    0.889    0.039   22.516    0.000    1.024    0.731
##   DP =~
##     ITEM5             1.000                              0.961    0.642
##     ITEM10  (.11.)    1.038    0.073   14.236    0.000    0.997    0.632
##     ITEM11  (.12.)    0.862    0.074   11.605    0.000    0.828    0.511
##     ITEM15  (.13.)    0.805    0.061   13.295    0.000    0.773    0.562
##     ITEM22  (.14.)    0.797    0.067   11.855    0.000    0.765    0.487
##   PA =~
##     ITEM4             1.000                              0.431    0.388
##     ITEM7   (.16.)    1.285    0.135    9.509    0.000    0.554    0.502
##     ITEM9   (.17.)    2.083    0.233    8.936    0.000    0.897    0.604
##     ITEM12  (.18.)    1.331    0.171    7.804    0.000    0.573    0.432
##     ITEM17  (.19.)    1.413    0.143    9.866    0.000    0.608    0.618
##     ITEM18  (.20.)    1.987    0.215    9.258    0.000    0.856    0.728
##     ITEM19  (.21.)    1.952    0.208    9.408    0.000    0.841    0.646
##     ITEM21  (.22.)    1.431    0.154    9.268    0.000    0.616    0.410
##   EE =~
##     ITEM12  (.23.)   -0.426    0.036  -11.944    0.000   -0.490   -0.369
##     ITEM11            0.272    0.053    5.182    0.000    0.313    0.193
##
## Covariances:
##                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
##  .ITEM1 ~~
##    .ITEM2             0.613    0.068    8.984    0.000    0.613    0.498
##  .ITEM6 ~~
##    .ITEM16            0.664    0.088    7.541    0.000    0.664    0.426
##  .ITEM10 ~~
##    .ITEM11            0.856    0.127    6.748    0.000    0.856    0.561
##  .ITEM4 ~~
##    .ITEM7             0.000                              0.000    0.000
##  .ITEM9 ~~
```

```
##    .ITEM19           0.358    0.075    4.755    0.000    0.358    0.305
##   EE ~~
##     DP               0.612    0.067    9.170    0.000    0.553    0.553
##     PA              -0.170    0.027   -6.218    0.000   -0.342   -0.342
##   DP ~~
##     PA              -0.207    0.032   -6.391    0.000   -0.500   -0.500
##
## Intercepts:
##                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
##    .ITEM1            3.371    0.060   55.937    0.000    3.371    2.107
##    .ITEM2            3.890    0.058   66.973    0.000    3.890    2.533
##    .ITEM3            2.526    0.065   39.101    0.000    2.526    1.491
##    .ITEM6            1.999    0.063   31.871    0.000    1.999    1.221
##    .ITEM8            2.143    0.065   33.039    0.000    2.143    1.249
##    .ITEM13           2.653    0.063   41.827    0.000    2.653    1.605
##    .ITEM14           3.147    0.067   46.680    0.000    3.147    1.770
##    .ITEM16           1.548    0.055   28.112    0.000    1.548    1.057
##    .ITEM20           1.211    0.053   22.713    0.000    1.211    0.865
##    .ITEM5            1.217    0.056   21.817    0.000    1.217    0.813
##    .ITEM10           1.275    0.059   21.431    0.000    1.275    0.807
##    .ITEM11           1.166    0.060   19.550    0.000    1.166    0.719
##    .ITEM15           1.078    0.054   20.011    0.000    1.078    0.784
##    .ITEM22           1.790    0.061   29.412    0.000    1.790    1.140
##    .ITEM4            5.168    0.042  123.343    0.000    5.168    4.655
##    .ITEM7            5.014    0.043  116.064    0.000    5.014    4.543
##    .ITEM9            4.702    0.057   82.848    0.000    4.702    3.169
##    .ITEM12           4.527    0.051   88.954    0.000    4.527    3.412
##    .ITEM17           5.303    0.037  145.039    0.000    5.303    5.389
##    .ITEM18           4.705    0.045  105.646    0.000    4.705    4.003
##    .ITEM19           4.600    0.049   93.051    0.000    4.600    3.536
##    .ITEM21           4.462    0.057   77.884    0.000    4.462    2.969
##     EE               0.000                              0.000    0.000
##     DP               0.000                              0.000    0.000
##     PA               0.000                              0.000    0.000
##
## Variances:
##                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
##    .ITEM1            1.236    0.075   16.583    0.000    1.236    0.483
##    .ITEM2            1.225    0.076   16.165    0.000    1.225    0.519
##    .ITEM3            1.378    0.090   15.291    0.000    1.378    0.480
##    .ITEM6            1.745    0.115   15.185    0.000    1.745    0.651
##    .ITEM8            0.794    0.066   12.001    0.000    0.794    0.270
##    .ITEM13           1.153    0.081   14.190    0.000    1.153    0.422
##    .ITEM14           1.919    0.114   16.867    0.000    1.919    0.607
##    .ITEM16           1.395    0.099   14.115    0.000    1.395    0.651
##    .ITEM20           0.912    0.067   13.661    0.000    0.912    0.465
##    .ITEM5            1.317    0.120   11.009    0.000    1.317    0.588
##    .ITEM10           1.497    0.127   11.756    0.000    1.497    0.601
##    .ITEM11           1.559    0.138   11.310    0.000    1.559    0.593
##    .ITEM15           1.293    0.126   10.270    0.000    1.293    0.684
##    .ITEM22           1.879    0.125   15.028    0.000    1.879    0.762
##    .ITEM4            1.047    0.110    9.519    0.000    1.047    0.849
##    .ITEM7            0.912    0.071   12.848    0.000    0.912    0.748
##    .ITEM9            1.398    0.125   11.181    0.000    1.398    0.635
```

```
##    .ITEM12           1.000    0.082   12.137    0.000    1.000    0.568
##    .ITEM17           0.598    0.072    8.291    0.000    0.598    0.618
##    .ITEM18           0.650    0.073    8.870    0.000    0.650    0.470
##    .ITEM19           0.985    0.085   11.634    0.000    0.985    0.582
##    .ITEM21           1.879    0.121   15.574    0.000    1.879    0.832
##     EE               1.325    0.088   14.989    0.000    1.000    1.000
##     DP               0.923    0.122    7.558    0.000    1.000    1.000
##     PA               0.185    0.036    5.174    0.000    1.000    1.000
```

```
library(knitr)
fit_INV2 <- fitMeasures(INV2fit, c("chisq.scaled", "cfi.robust", "tli.robust", "rmsea.robust", "rmsea.c
INV2 <- as.data.frame(t(fit_INV2))
colnames(INV1) <- colnames(INV2) <- c("Chisq", "CFI", "TLI", "RMSEA", "CI lower", "CI upper")
fit_table <- rbind(INV1, INV2)
rownames(fit_table) <- c("INV1", "INV2")
kable(fit_table, digits = 3, align = "lcccc", booktabs = TRUE,
             caption = " Testing for Invariance of MBI across Elementary/Secondary Teachers
 Common Baseline (Configural) Model")
```

Table 16: Testing for Invariance of MBI across Elementary/Secondary Teachers Common Baseline (Configural) Model

	Chisq	CFI	TLI	RMSEA	CI lower	CI upper
INV1	939.696	0.940	0.931	0.052	0.047	0.056
INV2	995.433	0.937	0.930	0.052	0.048	0.056

```
# Study the output carefully to see the results of these simple operations.
#
# Write a short note of what you see! This is always recommended, to make
# it easier for me, for others and yourself to follow your steps afterwards.
#
# (compare with the tricky Mplus procedure on slides #19-#21... ugh...) 8~)

#Maria's notes:
#- isompi Chisq, koska factor-loadingit on rajoitettu
```

Testing two consecutive (nested) models using the χ^2 difference test:

```
# Maria's note: En tehnyt tätä R-blockia
# example of manual calcucations (cf. lecture material, part 3 and Assignment 3):
cd <- ((421*1.263)-(401*1.266))/(421-401)
cd
```

```
## [1] 1.20285
```

```
TRd <- (995.433*1.263 - 939.696*1.266)/cd
TRd
```

```
## [1] 56.18052
```

```
# select and activate the line (after #) to get help related to the chi^2 distribution:
# ?Chisquare
# use the distribution function pchisq() to find the corresponding p-value:
1-pchisq(TRd,(421-401)) # (tail probability)
```

```
## [1] 2.730413e-05
```

```
# 2.730413e-05
# (clear case: significantly better than the configural model)

# why not create an R function for these calculations? For example:
chisq_mlm <- function(fit_nested, fit_parent) {
    # scaling correction factors
      c0 <- fitMeasures(fit_nested, "chisq.scaling.factor") %>% as.numeric()
      c1 <- fitMeasures(fit_parent, "chisq.scaling.factor") %>% as.numeric()
    # scaling correction of the difference test
      d0 <- fitMeasures(fit_nested, "df") %>% as.numeric()
      d1 <- fitMeasures(fit_parent, "df") %>% as.numeric()
      cd <- ((d0 * c0) - (d1 * c1))/(d0 - d1)
    # MLM chi-square difference test
      T0 <- fitMeasures(fit_nested, "chisq.scaled") %>% as.numeric()
      T1 <- fitMeasures(fit_parent, "chisq.scaled") %>% as.numeric()
      TRd <- (T0*c0 - T1*c1)/cd
    # degrees of freedom
      df = d0 - d1
    return(c("TR_d" = TRd, "df" = df, "p_value" = pchisq(TRd, df, lower.tail = FALSE)))
}

# let us test it!
chisq_mlm(INV2fit, INV1fit)
```

```
##         TR_d           df      p_value
## 5.613955e+01 2.000000e+01 2.769524e-05
```

Then, the modification indices (MIs), again with some *new options* to reduce the output:

```
modindices(INV2fit, standardized = TRUE, minimum.value = 3.84, free.remove = FALSE,
           op = "=~", sort. = TRUE)
```

```
##     lhs op    rhs block group level     mi    epc sepc.lv sepc.all sepc.nox
## 28   EE =~ ITEM11     1     1     1 41.803  0.312   0.380    0.264    0.264
## 219  PA =~ ITEM14     1     1     1 21.396  0.840   0.327    0.180    0.180
## 456  EE =~ ITEM22     2     2     1 19.719  0.266   0.306    0.195    0.195
## 209  DP =~ ITEM17     1     1     1 19.666 -0.193  -0.174   -0.202   -0.202
## 453  EE =~  ITEM5     2     2     1 17.630 -0.239  -0.275   -0.184   -0.184
## 470  DP =~ ITEM14     2     2     1 15.691 -0.298  -0.286   -0.161   -0.161
## 469  DP =~ ITEM13     2     2     1 15.681  0.243   0.233    0.141    0.141
## 487  PA =~ ITEM14     2     2     1 15.592  0.585   0.252    0.142    0.142
## 192  EE =~ ITEM17     1     1     1 14.902 -0.108  -0.132   -0.153   -0.153
## 203  DP =~ ITEM16     1     1     1 14.675  0.244   0.221    0.147    0.147
## 12   DP =~ ITEM11     1     1     1 11.949  0.195   0.176    0.122    0.122
```

```
## 472  DP =~ ITEM20     2     2     1  9.624  0.166   0.159    0.114    0.114
## 187  EE =~ ITEM15     1     1     1  9.232 -0.142  -0.173   -0.150   -0.150
## 208  DP =~ ITEM12     1     1     1  8.811  0.196   0.177    0.136    0.136
## 94   DP =~ ITEM11     2     2     1  8.742 -0.142  -0.137   -0.084   -0.084
## 464  DP =~  ITEM1     2     2     1  8.671 -0.153  -0.147   -0.092   -0.092
## 471  DP =~ ITEM16     2     2     1  8.659  0.165   0.158    0.108    0.108
## 481  PA =~  ITEM1     2     2     1  8.372  0.295   0.127    0.079    0.079
## 488  PA =~ ITEM16     2     2     1  6.639 -0.286  -0.123   -0.084   -0.084
## 202  DP =~ ITEM14     1     1     1  6.277 -0.224  -0.202   -0.111   -0.111
## 10   DP =~  ITEM5     1     1     1  5.708  0.248   0.224    0.155    0.155
## 92   DP =~  ITEM5     2     2     1  5.708 -0.248  -0.238   -0.159   -0.159
## 493  PA =~ ITEM15     2     2     1  5.340 -0.325  -0.140   -0.102   -0.102
## 467  DP =~  ITEM6     2     2     1  4.996  0.140   0.134    0.082    0.082
## 484  PA =~  ITEM6     2     2     1  4.962 -0.277  -0.119   -0.073   -0.073
## 194  EE =~ ITEM19     1     1     1  4.794  0.079   0.096    0.085    0.085
## 186  EE =~ ITEM10     1     1     1  4.615 -0.100  -0.122   -0.083   -0.083
## 95   DP =~ ITEM15     2     2     1  4.514  0.116   0.111    0.081    0.081
## 98   PA =~  ITEM7     2     2     1  4.381  0.202   0.087    0.079    0.079
## 213  PA =~  ITEM1     1     1     1  4.167  0.264   0.103    0.063    0.063
## 226  PA =~ ITEM22     1     1     1  4.144  0.402   0.156    0.099    0.099
## 489  PA =~ ITEM20     2     2     1  4.076 -0.213  -0.092   -0.065   -0.065
```

Follow Byrne (slide #21) and estimate the next model:

```
# just ADD that modification ("DP =~ ITEM11") in the `group.partial`
# in the following - it will then be estimated separately instead
# of restricting it equal across the groups:

INV3fit <- cfa(INV1model, data = MBIelmsec, estimator = "MLM",
               group = "group",
               group.partial = "DP =~ ITEM11"
              )
#OISKO TÄHÄN PITÄNY LAITTAA MYÖS NE MUUT TERMIT, JOTKA OLI INV2:SSA

# Again, study the output to see how the results changed:
summary(INV3fit, fit.measures = TRUE, standardized = TRUE)
```

```
## lavaan 0.6.13 ended normally after 90 iterations
##
##   Estimator                                         ML
##   Optimization method                           NLMINB
##   Number of model parameters                       149
##
##   Number of observations per group:
##     elementary                                     580
##     secondary                                      692
##
## Model Test User Model:
##                                              Standard      Scaled
##   Test Statistic                             1189.811     939.696
##   Degrees of freedom                              401         401
##   P-value (Chi-square)                          0.000       0.000
##   Scaling correction factor                                 1.266
```

```
##     Satorra-Bentler correction
##   Test statistic for each group:
##     elementary                                545.846     431.102
##     secondary                                 643.964     508.594
##
## Model Test Baseline Model:
##
##   Test statistic                            12040.836    9261.794
##   Degrees of freedom                              462         462
##   P-value                                       0.000       0.000
##   Scaling correction factor                                 1.300
##
## User Model versus Baseline Model:
##
##   Comparative Fit Index (CFI)                   0.932       0.939
##   Tucker-Lewis Index (TLI)                      0.922       0.929
##
##   Robust Comparative Fit Index (CFI)                        0.940
##   Robust Tucker-Lewis Index (TLI)                           0.931
##
## Loglikelihood and Information Criteria:
##
##   Loglikelihood user model (H0)             -43942.218  -43942.218
##   Loglikelihood unrestricted model (H1)     -43347.312  -43347.312
##
##   Akaike (AIC)                               88182.435   88182.435
##   Bayesian (BIC)                             88949.539   88949.539
##   Sample-size adjusted Bayesian (SABIC)      88476.243   88476.243
##
## Root Mean Square Error of Approximation:
##
##   RMSEA                                         0.056       0.046
##   90 Percent confidence interval - lower        0.052       0.043
##   90 Percent confidence interval - upper        0.059       0.049
##   P-value H_0: RMSEA <= 0.050                   0.006       0.975
##   P-value H_0: RMSEA >= 0.080                   0.000       0.000
##
##   Robust RMSEA                                              0.052
##   90 Percent confidence interval - lower                    0.047
##   90 Percent confidence interval - upper                    0.056
##   P-value H_0: Robust RMSEA <= 0.050                        0.251
##   P-value H_0: Robust RMSEA >= 0.080                        0.000
##
## Standardized Root Mean Square Residual:
##
##   SRMR                                          0.051       0.051
##
## Parameter Estimates:
##
##   Standard errors                           Robust.sem
##   Information                                 Expected
##   Information saturated (h1) model          Structured
##
##
```

```
## Group 1 [elementary]:
##
## Latent Variables:
##                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
##   EE =~
##     ITEM1            1.000                               1.242    0.748
##     ITEM2            0.915    0.033   27.877    0.000    1.137    0.723
##     ITEM3            1.031    0.047   22.087    0.000    1.280    0.749
##     ITEM6            0.808    0.058   13.891    0.000    1.003    0.605
##     ITEM8            1.262    0.047   26.682    0.000    1.566    0.864
##     ITEM13           1.049    0.049   21.589    0.000    1.302    0.756
##     ITEM14           0.955    0.049   19.565    0.000    1.186    0.651
##     ITEM16           0.759    0.056   13.548    0.000    0.942    0.620
##     ITEM20           0.868    0.051   16.896    0.000    1.077    0.749
##   DP =~
##     ITEM5            1.000                               0.962    0.651
##     ITEM10           1.011    0.087   11.577    0.000    0.973    0.659
##     ITEM11           1.031    0.084   12.255    0.000    0.992    0.657
##     ITEM15           0.661    0.076    8.693    0.000    0.636    0.568
##     ITEM22           0.628    0.081    7.774    0.000    0.604    0.392
##   PA =~
##     ITEM4            1.000                               0.392    0.420
##     ITEM7            1.107    0.169    6.546    0.000    0.434    0.496
##     ITEM9            1.997    0.342    5.848    0.000    0.783    0.588
##     ITEM12           1.374    0.279    4.922    0.000    0.539    0.418
##     ITEM17           1.523    0.226    6.747    0.000    0.597    0.676
##     ITEM18           2.012    0.341    5.898    0.000    0.789    0.649
##     ITEM19           1.944    0.326    5.966    0.000    0.762    0.673
##     ITEM21           1.370    0.213    6.435    0.000    0.537    0.417
##   EE =~
##     ITEM12          -0.379    0.046   -8.287    0.000   -0.471   -0.366
##     ITEM11           0.000                               0.000    0.000
##
## Covariances:
##                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
##  .ITEM1 ~~
##    .ITEM2            0.504    0.064    7.828    0.000    0.504    0.422
##  .ITEM6 ~~
##    .ITEM16           0.856    0.106    8.105    0.000    0.856    0.544
##  .ITEM10 ~~
##    .ITEM11           0.554    0.099    5.596    0.000    0.554    0.438
##  .ITEM4 ~~
##    .ITEM7            0.175    0.060    2.938    0.003    0.175    0.272
##  .ITEM9 ~~
##    .ITEM19           0.000                               0.000    0.000
##   EE ~~
##     DP               0.802    0.085    9.380    0.000    0.671    0.671
##     PA              -0.202    0.035   -5.853    0.000   -0.415   -0.415
##   DP ~~
##     PA              -0.201    0.041   -4.966    0.000   -0.534   -0.534
##
## Intercepts:
##                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
##    .ITEM1            3.409    0.069   49.484    0.000    3.409    2.055
```

```
##    .ITEM2             3.976    0.065   60.903    0.000    3.976    2.529
##    .ITEM3             2.572    0.071   36.229    0.000    2.572    1.504
##    .ITEM6             1.676    0.069   24.353    0.000    1.676    1.011
##    .ITEM8             2.184    0.075   29.012    0.000    2.184    1.205
##    .ITEM13            2.548    0.072   35.621    0.000    2.548    1.479
##    .ITEM14            3.122    0.076   41.262    0.000    3.122    1.713
##    .ITEM16            1.433    0.063   22.715    0.000    1.433    0.943
##    .ITEM20            1.281    0.060   21.456    0.000    1.281    0.891
##    .ITEM5             1.053    0.061   17.177    0.000    1.053    0.713
##    .ITEM10            1.164    0.061   18.990    0.000    1.164    0.789
##    .ITEM11            1.122    0.063   17.889    0.000    1.122    0.743
##    .ITEM15            0.545    0.047   11.713    0.000    0.545    0.486
##    .ITEM22            1.328    0.064   20.730    0.000    1.328    0.861
##    .ITEM4             5.412    0.039  139.751    0.000    5.412    5.803
##    .ITEM7             5.338    0.036  146.968    0.000    5.338    6.103
##    .ITEM9             5.031    0.055   90.946    0.000    5.031    3.776
##    .ITEM12            4.693    0.053   87.789    0.000    4.693    3.645
##    .ITEM17            5.416    0.037  147.600    0.000    5.416    6.129
##    .ITEM18            4.883    0.050   96.794    0.000    4.883    4.019
##    .ITEM19            5.007    0.047  106.468    0.000    5.007    4.421
##    .ITEM21            4.841    0.054   90.467    0.000    4.841    3.756
##     EE                0.000                              0.000    0.000
##     DP                0.000                              0.000    0.000
##     PA                0.000                              0.000    0.000
##
## Variances:
##                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
##    .ITEM1             1.210    0.078   15.471    0.000    1.210    0.440
##    .ITEM2             1.180    0.074   16.005    0.000    1.180    0.477
##    .ITEM3             1.284    0.106   12.174    0.000    1.284    0.439
##    .ITEM6             1.741    0.127   13.711    0.000    1.741    0.634
##    .ITEM8             0.835    0.078   10.763    0.000    0.835    0.254
##    .ITEM13            1.273    0.107   11.891    0.000    1.273    0.429
##    .ITEM14            1.915    0.125   15.361    0.000    1.915    0.577
##    .ITEM16            1.420    0.104   13.681    0.000    1.420    0.615
##    .ITEM20            0.907    0.097    9.375    0.000    0.907    0.438
##    .ITEM5             1.256    0.134    9.344    0.000    1.256    0.576
##    .ITEM10            1.232    0.123   10.047    0.000    1.232    0.566
##    .ITEM11            1.299    0.128   10.150    0.000    1.299    0.569
##    .ITEM15            0.850    0.125    6.814    0.000    0.850    0.677
##    .ITEM22            2.014    0.156   12.895    0.000    2.014    0.847
##    .ITEM4             0.716    0.089    8.040    0.000    0.716    0.823
##    .ITEM7             0.577    0.076    7.610    0.000    0.577    0.754
##    .ITEM9             1.162    0.131    8.902    0.000    1.162    0.655
##    .ITEM12            0.935    0.094    9.947    0.000    0.935    0.564
##    .ITEM17            0.424    0.056    7.631    0.000    0.424    0.544
##    .ITEM18            0.854    0.119    7.193    0.000    0.854    0.579
##    .ITEM19            0.702    0.072    9.737    0.000    0.702    0.547
##    .ITEM21            1.373    0.130   10.528    0.000    1.373    0.826
##     EE                1.541    0.113   13.636    0.000    1.000    1.000
##     DP                0.926    0.142    6.517    0.000    1.000    1.000
##     PA                0.154    0.046    3.333    0.001    1.000    1.000
##
##
```

```
## Group 2 [secondary]:
##
## Latent Variables:
##                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
##   EE =~
##     ITEM1            1.000                               1.125    0.709
##     ITEM2            0.933    0.034   27.301    0.000    1.049    0.687
##     ITEM3            1.092    0.050   21.638    0.000    1.229    0.723
##     ITEM6            0.881    0.063   14.086    0.000    0.991    0.601
##     ITEM8            1.292    0.056   23.234    0.000    1.454    0.852
##     ITEM13           1.138    0.054   21.123    0.000    1.280    0.767
##     ITEM14           0.981    0.050   19.512    0.000    1.103    0.622
##     ITEM16           0.745    0.061   12.249    0.000    0.838    0.579
##     ITEM20           0.915    0.061   15.069    0.000    1.029    0.734
##   DP =~
##     ITEM5            1.000                               0.920    0.627
##     ITEM10           1.036    0.109    9.470    0.000    0.953    0.609
##     ITEM11           0.580    0.113    5.147    0.000    0.534    0.344
##     ITEM15           0.991    0.098   10.144    0.000    0.912    0.643
##     ITEM22           0.912    0.103    8.840    0.000    0.839    0.524
##   PA =~
##     ITEM4            1.000                               0.407    0.369
##     ITEM7            1.588    0.216    7.334    0.000    0.646    0.568
##     ITEM9            2.283    0.325    7.020    0.000    0.929    0.622
##     ITEM12           1.369    0.219    6.239    0.000    0.557    0.416
##     ITEM17           1.378    0.192    7.181    0.000    0.561    0.583
##     ITEM18           2.057    0.280    7.336    0.000    0.837    0.714
##     ITEM19           2.073    0.276    7.515    0.000    0.844    0.649
##     ITEM21           1.573    0.235    6.705    0.000    0.640    0.425
##   EE =~
##     ITEM12          -0.474    0.054   -8.743    0.000   -0.533   -0.398
##     ITEM11           0.416    0.064    6.513    0.000    0.468    0.301
##
## Covariances:
##                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
##  .ITEM1 ~~
##    .ITEM2             0.624    0.070    8.962    0.000    0.624    0.503
##  .ITEM6 ~~
##    .ITEM16            0.663    0.089    7.411    0.000    0.663    0.426
##  .ITEM10 ~~
##    .ITEM11            0.952    0.122    7.789    0.000    0.952    0.599
##  .ITEM4 ~~
##    .ITEM7             0.000                               0.000    0.000
##  .ITEM9 ~~
##    .ITEM19            0.340    0.078    4.383    0.000    0.340    0.294
##   EE ~~
##     DP                0.559    0.066    8.459    0.000    0.540    0.540
##     PA               -0.155    0.028   -5.602    0.000   -0.339   -0.339
##   DP ~~
##     PA                -0.181    0.035   -5.208    0.000   -0.483   -0.483
##
## Intercepts:
##                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
##    .ITEM1             3.371    0.060   55.937    0.000    3.371    2.126
```

```
##    .ITEM2            3.890    0.058   66.973    0.000    3.890    2.546
##    .ITEM3            2.526    0.065   39.101    0.000    2.526    1.486
##    .ITEM6            1.999    0.063   31.871    0.000    1.999    1.212
##    .ITEM8            2.143    0.065   33.039    0.000    2.143    1.256
##    .ITEM13           2.653    0.063   41.827    0.000    2.653    1.590
##    .ITEM14           3.147    0.067   46.680    0.000    3.147    1.775
##    .ITEM16           1.548    0.055   28.112    0.000    1.548    1.069
##    .ITEM20           1.211    0.053   22.713    0.000    1.211    0.863
##    .ITEM5            1.217    0.056   21.817    0.000    1.217    0.829
##    .ITEM10           1.275    0.059   21.431    0.000    1.275    0.815
##    .ITEM11           1.166    0.060   19.550    0.000    1.166    0.751
##    .ITEM15           1.078    0.054   20.011    0.000    1.078    0.761
##    .ITEM22           1.790    0.061   29.412    0.000    1.790    1.118
##    .ITEM4            5.168    0.042  123.343    0.000    5.168    4.689
##    .ITEM7            5.014    0.043  116.064    0.000    5.014    4.412
##    .ITEM9            4.702    0.057   82.848    0.000    4.702    3.149
##    .ITEM12           4.527    0.051   88.954    0.000    4.527    3.382
##    .ITEM17           5.303    0.037  145.039    0.000    5.303    5.514
##    .ITEM18           4.705    0.045  105.646    0.000    4.705    4.016
##    .ITEM19           4.600    0.049   93.051    0.000    4.600    3.537
##    .ITEM21           4.462    0.057   77.884    0.000    4.462    2.961
##     EE               0.000                              0.000    0.000
##     DP               0.000                              0.000    0.000
##     PA               0.000                              0.000    0.000
##
## Variances:
##                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
##    .ITEM1            1.249    0.076   16.431    0.000    1.249    0.497
##    .ITEM2            1.234    0.077   15.981    0.000    1.234    0.529
##    .ITEM3            1.379    0.093   14.811    0.000    1.379    0.477
##    .ITEM6            1.739    0.120   14.525    0.000    1.739    0.639
##    .ITEM8            0.798    0.065   12.204    0.000    0.798    0.274
##    .ITEM13           1.146    0.084   13.653    0.000    1.146    0.412
##    .ITEM14           1.928    0.116   16.635    0.000    1.928    0.613
##    .ITEM16           1.395    0.099   14.089    0.000    1.395    0.665
##    .ITEM20           0.908    0.066   13.787    0.000    0.908    0.462
##    .ITEM5            1.306    0.122   10.712    0.000    1.306    0.607
##    .ITEM10           1.540    0.130   11.820    0.000    1.540    0.629
##    .ITEM11           1.640    0.129   12.662    0.000    1.640    0.679
##    .ITEM15           1.177    0.136    8.659    0.000    1.177    0.586
##    .ITEM22           1.861    0.136   13.729    0.000    1.861    0.726
##    .ITEM4            1.049    0.110    9.523    0.000    1.049    0.864
##    .ITEM7            0.874    0.071   12.341    0.000    0.874    0.677
##    .ITEM9            1.366    0.129   10.558    0.000    1.366    0.613
##    .ITEM12           0.997    0.082   12.144    0.000    0.997    0.556
##    .ITEM17           0.611    0.072    8.530    0.000    0.611    0.660
##    .ITEM18           0.672    0.075    8.909    0.000    0.672    0.490
##    .ITEM19           0.979    0.088   11.153    0.000    0.979    0.579
##    .ITEM21           1.862    0.123   15.165    0.000    1.862    0.820
##     EE               1.265    0.103   12.306    0.000    1.000    1.000
##     DP               0.846    0.137    6.195    0.000    1.000    1.000
##     PA               0.166    0.040    4.133    0.000    1.000    1.000
```

```
fit_INV3 <- fitMeasures(INV3fit, c("chisq.scaled", "cfi.robust", "tli.robust", "rmsea.robust", "rmsea.c
INV3 <- as.data.frame(t(fit_INV3))
colnames(INV1) <- colnames(INV2) <- colnames(INV3) <- c("Chisq", "CFI", "TLI", "RMSEA", "CI lower", "CI
fit_table <- rbind(INV1, INV2, INV3)
rownames(fit_table) <- c("INV1", "INV2", "INV3")
kable(fit_table, digits = 3, align = "lcccc", booktabs = TRUE,
             caption = " Testing for Invariance of MBI across Elementary/Secondary Teachers
 Common Baseline (Configural) Model")
```

Table 17: Testing for Invariance of MBI across Elementary/Secondary Teachers Common Baseline (Configural) Model

	Chisq	CFI	TLI	RMSEA	CI lower	CI upper
INV1	939.696	0.940	0.931	0.052	0.047	0.056
INV2	995.433	0.937	0.930	0.052	0.048	0.056
INV3	939.696	0.940	0.931	0.052	0.047	0.056

Now you can proceed easily with the testing, using the R function:

```
# note that we are still comparing against the configural model INV1:
chisq_mlm(INV3fit, INV1fit)
```

```
##    TR_d      df p_value
##     NaN       0     NaN
```

According to Byrne, further improvement of the model is required.

So, take another round of MIs, similarly as above:

(you may have to fine-tune the 'minimum.value' a bit smaller to see more MIs)

```
modindices(INV3fit, standardized = TRUE, minimum.value = 3.84, free.remove = FALSE,
           op = "=~", sort. = TRUE)
```

```
##     lhs op    rhs block group level     mi    epc sepc.lv sepc.all sepc.nox
## 199  PA =~ ITEM14     1     1     1 25.403  0.977   0.383    0.210    0.210
## 450  DP =~ ITEM14     2     2     1 20.164 -0.404  -0.371   -0.209   -0.209
## 436  EE =~ ITEM22     2     2     1 20.007  0.317   0.357    0.223    0.223
## 467  PA =~ ITEM14     2     2     1 17.427  0.685   0.279    0.157    0.157
## 449  DP =~ ITEM13     2     2     1 15.910  0.292   0.268    0.161    0.161
## 183  DP =~ ITEM16     1     1     1 15.696  0.310   0.299    0.197    0.197
## 451  DP =~ ITEM16     2     2     1 15.192  0.263   0.242    0.167    0.167
## 28   EE =~ ITEM11     1     1     1 14.780  0.251   0.312    0.206    0.206
## 189  DP =~ ITEM17     1     1     1 13.819 -0.181  -0.174   -0.197   -0.197
## 456  DP =~ ITEM12     2     2     1 12.355  0.265   0.244    0.182    0.182
## 435  EE =~ ITEM15     2     2     1 11.522 -0.218  -0.245   -0.173   -0.173
## 452  DP =~ ITEM20     2     2     1 11.335  0.215   0.198    0.141    0.141
## 182  DP =~ ITEM14     1     1     1 11.243 -0.374  -0.360   -0.198   -0.198
## 433  EE =~  ITEM5     2     2     1 10.652 -0.216  -0.242   -0.165   -0.165
## 172  EE =~ ITEM17     1     1     1 10.426 -0.098  -0.121   -0.137   -0.137
## 444  DP =~  ITEM1     2     2     1 10.274 -0.198  -0.182   -0.115   -0.115
```

```
## 188  DP =~ ITEM12     1     1     1  9.281  0.276   0.266    0.206    0.206
## 434  EE =~ ITEM10     2     2     1  9.028  0.211   0.237    0.152    0.152
## 468  PA =~ ITEM16     2     2     1  8.584 -0.361  -0.147   -0.101   -0.101
## 181  DP =~ ITEM13     1     1     1  8.447  0.275   0.264    0.153    0.153
## 461  PA =~  ITEM1     2     2     1  8.023  0.319   0.130    0.082    0.082
## 472  PA =~ ITEM11     2     2     1  7.436 -0.371  -0.151   -0.097   -0.097
## 174  EE =~ ITEM19     1     1     1  7.254  0.105   0.130    0.115    0.115
## 177  DP =~  ITEM2     1     1     1  6.855 -0.205  -0.197   -0.125   -0.125
## 471  PA =~ ITEM10     2     2     1  6.234  0.366   0.149    0.095    0.095
## 193  PA =~  ITEM1     1     1     1  5.990  0.340   0.133    0.080    0.080
## 165  EE =~  ITEM5     1     1     1  5.697 -0.201  -0.250   -0.169   -0.169
## 438  EE =~  ITEM7     2     2     1  5.695  0.094   0.105    0.093    0.093
## 179  DP =~  ITEM6     1     1     1  5.646  0.206   0.198    0.119    0.119
## 198  PA =~ ITEM13     1     1     1  4.479 -0.347  -0.136   -0.079   -0.079
## 180  DP =~  ITEM8     1     1     1  4.057 -0.173  -0.166   -0.092   -0.092
## 464  PA =~  ITEM6     2     2     1  3.921 -0.273  -0.111   -0.067   -0.067
## 447  DP =~  ITEM6     2     2     1  3.901  0.149   0.137    0.083    0.083
```

#POISTIN EXTRATEHTÄVIEN RIVIT KOSKA KNITTING EI ONNISTUNUT ILMAN SITÄ