Reproducible R code for Multigroup CFA
Self-Efficacy Scale for Academic Writing

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#mutltigroup CFA with interdisciplinary sample

library(lavaan)
library(equaltestMI)
library(knitr)
library(semTools)
library(semPlot)
library(dplyr)


#creates labels for the TypeStudent category based on code of 1 or 2

master <- interdisciplinarydata

master$TypeStudent <- factor(master$TypeStudent,
                             levels = c(1,2),
                             labels = c("undergraduate", "graduate"))

#identify sample sizes for each group
table(master$TypeStudent)


#step 1 run the entire sample CFA without splitting the groups

SAWSESCFAmodel <- '
Relational.Reflective =~ meaning + improve + reflect + ideas + overall + wander + adapt +
feedback
Creative.Identity =~ creativity + spark + voice + original + discipline
Essentials =~ overcome + words + synthesize'

SAWSESCFAmodel.fit <- lavaan::cfa(SAWSESCFAmodel,estimator = "MLR", data = master,
meanstructure = TRUE, std.lv = TRUE)
#meanstructure adds intercepts and means to the model

summary(SAWSESCFAmodel.fit, standardized = TRUE, rsquare = TRUE, fit.measure = TRUE)

modindices(SAWSESCFAmodel.fit, sort. = TRUE) #to explore

#Pretty Picture of overall model

semPaths(SAWSESCFAmodel.fit,
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    whatLabels = "std",
    layout = "tree")


#Equivalence testing equaltestMI package to assess measurement invariance
#The first 4 lines run the CFAs in the background and then all the equaltests between the
groups.


MGSAWSES.model <- eqMI.main (model = SAWSESCFAmodel,
                    data = master,
                    estimator = "MLR",
                    group = "TypeStudent",
                    meanstructure = TRUE,
                    std.lv = TRUE,
                    output = "both",
                    equivalence.test = TRUE,
                    adjRMSEA = TRUE,
                    projection = TRUE,
                    bootstrap = FALSE)


#first examine each group separately to see fit.

#undergradaute -- this fits OK

summary(MGSAWSES.model$convention.sem$LavaanOut$fit.configural.g1,
    standardized = TRUE,
    rsquare = TRUE,
    fit.measure = TRUE)



#grad students fit less OK which is not a surprise but the next steps are supposed to help figure
out why

summary(MGSAWSES.model$convention.sem$LavaanOut$fit.configural.g2,
    standardized = TRUE,
    rsquare = TRUE,
    fit.measure = TRUE)


#all the remaining steps below are additive which means as you run the next one the previous
one is also being run
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#what you look for here from Configural onward is with each subsequent model test CFI drops by no more than .01
#configural invariance model – explores if factor structure the same in both groups

summary(MGSAWSES.model$convention.sem$LavaanOut$fit.combine.groups,
      standardized = TRUE,
      rsquare = TRUE,
      fit.measure = TRUE)

#Are the factor loadings the same? Do all the items have the same weight for each group.
#metric model

summary(MGSAWSES.model$convention.sem$LavaanOut$fit.metric,
      standardized = TRUE,
      rsquare = TRUE,
      fit.measure = TRUE)

#tests if the item intercepts are the same
#Scalar Model

summary(MGSAWSES.model$convention.sem$LavaanOut$fit.scalar,
      standardized = TRUE,
      rsquare = TRUE,
      fit.measure = TRUE)

#are the residuals the same. Does one group have more varability/variance than the other?
#strict error invariance is what is being tested here.
#does one group have more variability in their responses than the other

summary(MGSAWSES.model$convention.sem$LavaanOut$fit.strict.residuals,
      standardized = TRUE,
      rsquare = TRUE,
      fit.measure = TRUE)

#Can create a table of fit indices

table_fit <- matrix(NA, nrow = 7, ncol = 6)
colnames(table_fit) = c("Model", "X2", "df", "CFI", "RMSEA", "SRMR")
table_fit[1, ] <- c("Overall Model", round(fitmeasures(SAWSESCFAmodel.fit,
                                        c("chisq", "df", "cfi",
                                          "rmsea", "srmr")),3))

table_fit[2, ] <- c("Undergraduate Model",
round(fitmeasures(MGSAWSES.model$convention.sem$LavaanOut$fit.configural.g1,
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                                        c("chisq", "df", "cfi",
                                          "rmsea", "srmr")),3))
table_fit[3, ] <- c("Graduate Model",
round(fitmeasures(MGSAWSES.model$convention.sem$LavaanOut$fit.configural.g2,
                                       c("chisq", "df", "cfi",
                                         "rmsea", "srmr")),3))

table_fit[4, ] <- c("Configural Model",
round(fitmeasures(MGSAWSES.model$convention.sem$LavaanOut$fit.combine.groups,
                                       c("chisq", "df", "cfi",
                                         "rmsea", "srmr")),3))

table_fit[5, ] <- c("Metric Model",
round(fitmeasures(MGSAWSES.model$convention.sem$LavaanOut$fit.metric,
                                      c("chisq", "df", "cfi",
                                        "rmsea", "srmr")),3))

table_fit[6, ] <- c("Scalar Model",
round(fitmeasures(MGSAWSES.model$convention.sem$LavaanOut$fit.scalar,
                                      c("chisq", "df", "cfi",
                                        "rmsea", "srmr")),3))

table_fit[7, ] <- c("Strict Model",
round(fitmeasures(MGSAWSES.model$convention.sem$LavaanOut$fit.strict.residuals,
                                      c("chisq", "df", "cfi",
                                        "rmsea", "srmr")),3))
kable(table_fit)
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