Course Syllabus

Building and Testing Structural Equation Models (SEM)
In the Social Sciences

Course Description:
Since the early 80's, Structural Equation Modeling (SEM) analyses, first using LISREL and later using EQS, and AMOS user-friendly software packages, have gained prominence as they replaced the older traditional analytic methods of factor analysis and path analysis. SEM merges confirmatory factor analysis with path analysis and provides means for constructing, testing, and comparing comprehensive structural path models as well as comparing the goodness of fit of models and their adequacy across multiple groups (samples). Among the many advantages of SEM over the traditional path analysis is that it provides adjustment for the relative unreliability of the observed measures, overall goodness of fit measures and tests for comparing models. Without adjustment for reliability, results from traditional path analysis confound the substantive contribution of predictors with their relative methodological strength as indicated by their reliabilities. This confounding may lead to seriously flawed conclusions in the interpretation of the results.

This course will cover the conceptual and technical issues relevant to the application of Structural Equation Modeling (SEM). Following the presentation of major conceptual issues, five basic structural models will be described in detail. The models vary from simple to more complex ones. They also cover wide range of situations including longitudinal and mediation analyses, comparisons between groups, and analyses that include data from different sources such as from parents, teachers, supervisors, and co-workers. The description and discussion of the models will provide students with the knowledge and skills to apply SEM techniques using EQS software for analyzing, evaluating and reporting results produced by this analytic method. This knowledge is easily transferable to the use of LISREL or AMOS software. Course work will require the students to construct and test a structural model using their own data or data from available data sets and produce a paper reporting their analysis.

Prerequisites: One or more courses in statistics that included in-depth treatment of linear regression analysis, basic knowledge of the concepts of item analysis and internal reliability, and some familiarity with factor analysis. At least some hand-on experience with data analysis using SPSS, SAS or similar software for data analysis is also required.

Goals of the Course: The goal of this course are to have students able to construct, analyze, modify, and test the adequacy of variety of structural equation models and report the results of their analyses in a manner acceptable in refereed journals.

Course Requirements (Evaluation and Grades): Students who do NOT want or need a letter grade, that is, students who are NOT enrolled for credit, can receive a grade of PASS if they complete in a satisfactory way the first four assignments as described in section 1.

Section 1. All the students will receive the EQS software usable on private laptops or desktops for the limited period of 30 days. There will be four structured short assignments based on a data set and models that are already specified and will be provided to the students. The students will have to run the EQS software (or other, e.g., AMOS, Mplus) and record and submit the
results on available structured forms and adequately answer the specified questions in each assignment. Deadline for submission of each assignment: The Friday following the lab on each Tuesday.

**Students who are enrolled for credit** Must receive a letter grade based on completing the requirement in Section 1 above (i.e., submission of the four structured assignments), AND Section 2 below:

**Section 2.** The students will be required to submit a final paper (18 to 32 pages) based on empirical data analysis using SEM. Deadline for submission of the final paper: To be announced.

For detailed description and instructions for the preparations of these two types of assignment see the section at the end of the syllabus: “**Description of the Required Course Assignments**”

**The Course will be Conducted as a Lecture** with discussions. The last class meetings will be devoted to reviewing the course materials and for students’ presentations of the models they plan for their papers (voluntary). The students will have access to EQS software in the computer lab and at Mason Hall Computer site.

**Class Schedule:** July 5 - July 22: every working day from 1:30 to 3:45pm. Note: Classes will begin promptly at 1:40pm. {Classroom: 3448 Mason Hall} - NOTE, Class will begin 1:40pm.

**Lab Schedule:** Three structured lab sessions during regular class time on {July 11, 14 and 19}, will be conducted at the classroom with students working on their laptops under the guidance of the instructor.

**Office Hours:** Office hours will be held upon request at my Office at the ISR 3320 (email or approach the instructor). If you come to an office hour to get help on your computer work **BE SURE** to bring the following materials:

1. **ALWAYS** bring a good figure of the model (handwritten or drawn is OK) with all the latent and observed variables drawn, appropriately labeled and numbered.

2. **ALWAYS** bring a diskette or flashdrive with
   a. the setup of the model file.
   b. the SPSS data file.

3. **ALWAYS** bring a printout of the results file.
Required Resources

**Laptop/Notebook.** Each student will need a laptop (or Notebook) with a capacity to run Windows software (Many Apple laptops also can run windows program which is fine) to be able to participate in optimal way in the three lab sessions {(on July 11, 14 and 19)}.

**Software.** The software to be used in all course demonstrations will be EQS Version 6.2. Students will receive the EQS software usable on private laptops or desktops for the limited period of 30 days (July 1 to July 30). Students can purchase the EQS software from the company (Multivariate Software) at a special discount student price ($199). The EQS software discount is a full version of the software. To purchase the software online, go to: [http://www.mvsoft.com](http://www.mvsoft.com) then, Click on the following tabs: 1. EQS Software, then, 2. Order EQS then, 3.Multivariate Software Online, 4. Academic Licenses and 5. Student License. Or, contact the company through email (sales@mvsoft.com or call 1-800-301-4456 7am to 4pm PST). If you are not a formal student with a university student ID, you can still purchase the software at the student discount but will have to email to me the request. I will then contact the company to provide them with your email for their verification you are a student in my class.

With the exception of textbooks, all of the other resources for the class, including this syllabus, the assignments, required and suggested readings, all figures, and input/output models to be shown as PowerPoint displays during class presentations, are available to the students on the course workplace site at the University of Michigan CTOOLS ([https://ctools.umich.edu](https://ctools.umich.edu)). Once you log in click on Resources (under LSA box on the left, under Announcements) and you will see the various subdirectories of the resources. In addition, a week before the class, I will send you an email with information on the location of the classroom, other updates, and, a link to a folder in my DropBox where all the same information that is also available in CTOOLS. You could get it from either my DropBox or Ctools.
I. Course Outline (Overview of the Topics)

Note. Enclosed in pointed parentheses are the powerpoint slides as indexed in the Table of content in the powerpoint file in CTOOLS website. The file name is: Sem_pp2016.ppt

During the lectures I will present and discuss all the major principles, topics and issues involved in the application of SEM to construct, test, evaluate and report path, measurement and structural models. Most of the issues and principles will be presented and discussed with the presentation of a core set of five models. The models are listed below with their unique characteristics, and the slide number to the figure that represents each one.

Model A: A model with one indicator per factor. Work-Family Conflict model (Model A {PP8}).

Model B: A model with several indicators per factor, and with additional background variables as controls. Children's Adjustment model (Model B: {PP10}).

Model C: A model that includes two groups to allow comparisons between the groups. Job-Search Intention model (Model C; {PP16e2}).

Model D: A model based on longitudinal design of data collection with a variable that represents an experimental manipulation (intervention) and its mediation effects. JOBS II mediation Model (Model D: {PP15a}).

Model E: A model based on longitudinal design and data collected from different sources (e.g., husbands and wives). The Couples' Stress and Coping Model (Model E: {PP17b}).

Other types of models will also be presented and discussed including path analysis models, measurement models, and models with reciprocal causation.

1. What is Structural Equation Modeling (SEM)?
   a. Brief History of the roots of SEM
   b. Basics of regression {PP1a, PP1b} and factor analysis and the relationship of SEM to Path analysis and factor analysis {PP1c}
   c. The main advantages of SEM over path and factor analyses and traditional ANOVA and what can SEM be used for:
      1. Adjustment for unreliability of the indices {PP2a, PP2b, PP2c} (see Bedeian et al., 1997)
      2. Improved ability to handle multi-collinearity (compared with OLS regressions {PP3} (see for example Marshal and Lang, 1990).
      3. Availability of overall goodness of fit measures for the entire model.
      5. Comparisons of models and specific paths across several groups.
      6. Modeling various types of factors (formative and reflective factors).
      7. Conducting sensitivity analyses and various simulation analyses.
      8. Analysis of experiments/interventions that include mediator variables, that is, analysis of the mediation process.
      9. Using the results of meta-analyses as input to test SEM models.
d. Basic assumptions regarding scaling, distributions, errors and causal interpretations.
e. Choosing SEM Software: EQS, LISREL and AMOS (see Kline ch.4.6 pp. 77-85 on Similarities and differences).
   (For general reviews see Hoyle and Smith (1994) or Klem (2000). The article by Klem also includes all the terminologies and symbols used by LISREL users.)

2. Basic concepts and notations
   For a - e: {PP4a} (See Byrne, 1994, pp 3-12)
   a. Observable (measured) one item variable, or, index (based on several observed variables)
   b. Observables as indicators (outcomes) of a latent factor and their factor loadings
      - The need to establish internal reliability (alpha)
   c. Observables as determinants of a latent factor
   d. Errors of observables and residuals as errors of latent endogenous factors
   e. Relationships among latent factors, among errors and residuals

   For f-g: {PP4b}
   f. The measurement model and the structural model
   g. Exogenous and endogenous variables and latent factors
   h. Deduced (reflective) vs. induced (formative) latent Factors
   {PP5a, PP5b, PP5c} (see Edwards and Bagozzi, 2000).

3. Basic Concepts: the data, the estimates (model parameters)
   a. The empirical obtained correlations (S-matrix), the model implied ones (in $\Sigma$- matrix), and the fit of the model to the data (based on the difference between the S and $\Sigma$ matrix). {PP5d}
   b. Degrees of freedom, equations and identification. {PP6a}
   c. Identification by fixing factor variance to 1 vs. fixing one of the loadings to 1. {PP6b, PP6c, PP6d}.

4. The required input for SEM analysis using EQS
   a. Raw data. Raw data can be in the form of SPSS file that can be opened by EQS.
   b. Matrix of covariances (listwise and/or pairwise matrix)
   c. Matrix of correlations with means and standard deviation in the bottom two rows.

5. Types of models and their specification in a diagram
   a. Simple path model: {PP7a}
   b. Latent structural model with one indicator per factor: {PP7b}
   c. Latent structural model with multiple indicators per factor: {PP7c}
   d. Non-recursive longitudinal model with reciprocal causal influence: {PP7d}
   e. Second order factor structure {PP7e}
   f. Structural model with exogenous, endogenous factors and observed variables {PP7f}

   Reading for outline sections 2-5: Ch. 5, pp. 91-122.

6. Illustrating the basic elements of the EQS input setup using Baggozzi’s model {PP7i}
   a. /Title /Specifications /Labels /Equations /Variance /Covariance
b. Some basic rules of syntax: the estimate *, dependent variable to the left, starting values, fixed values, unlisted covariances are fixed to = 0.

(Information on these and other important options see the EQS manuals by Bentler, 1995 pp. 43-82, and the User Guide by Bentler and Wu, 2002, pp.238-267).

7. Illustrating the basic elements of the EQS output using Bagozzi’s Model {printout of Baggozzi_P.rtf can downloaded from the website section on models}

8. Testing the measurement model of Bagozzi’s structural model that is shown in slide PP7i.

9. Illustrating the input setup on the Work-Family Conflict model (Model A {PP8})
(a single indicator model as in PP7b). How the relative reliabilities of the measures are adjusted with one measured variable (that is, with one empirical indicator).

10. Continued: One indicator per factor model: Illustrating the output of the model using the output of the Work-Family Model. This will include the Basic elements of the EQS output (Empirical and estimated covariance matrix, residual matrix, RMR, measures of goodness of fit, measure of misfit, non standardized and standardized parameters, the measurement and structural equations, the program's output with suggestions for modification of the model to obtain better fit, and more). (For another example see Frone et al., 1992; another important justification for a one indicator to factor model is Liang et al., 1990).

11. Model evaluation using chi-square, goodness-of-fit and misfit indices {PP8a, PP9}. The Chi-square/df, NFI, NNFI (Tucker Lewis Index, TLI), CFI, RMSEA, AIC, CAIC. (see Byrne, 1994, pp 53-58; Kline, Ch. 8, pp 189-214).

12. Conventional model: Illustrating the input and output of the Children's Adjustment model (Model B: {PP10}). (cross-sectional model with multiple indicators). New elements: (a) How to model latent variables with several observed indicators for each latent factor, and (b), how to include demographics and other background variables as part of the model. (This model is described in the article by Pierce et al., 1998).

We will also cover here the following additional topics:

(a) how many indicators to model for each latent factor (see Marsh et al., 1998),
(b) the rationale for indices prepared as parcels (groups) of items {PP11a, PP11b},
(c) how to handle scales with different number of scale points {PP11c}.

13. Basic rules of measurement and structural model identification {PP11d, PP11e, PP11f, PP11g, PP11h}. Reading: Kline, Chapter 6, pp. 125-149.
14. Nested (hierarchical) and non-nested (non-hierarchical) models {PP12a, PP12b} and how to test the difference between nested models {PP12c, PP12d}. Reading: Kline, Chapter 8, pp. 214-222.

15. Reviewing the stages in constructing and testing a SEM model {PP13}. Reading: Kline, Chapter 5, pp. 91-95.

16. Longitudinal panel model: Illustrating the input and output of the JOBS II mediation Model (Model D: {PP15a, PP15b, PP15c} New elements: (a) How you model effects of an experiment and its mediation effects {PP14c}, and (b), how to build a model that involves an intervention and longitudinal design of the follow-up assessments. (This model is described in the article by Vinokur and Schul, 1997).

17. Estimating direct, indirect and total effects {PP16a, PP16b}. Reading: Kline, Chapter 7, pp. 164-169; and analyzing mediation effects {PP16b1 to PP16b5}.

18. Modeling direct and mediating effects of an experiment using longitudinal design (Russell et al., 1998 {PP16c, d, e, and e1}).

19. Group comparison model: Illustrating the input and output of the Job-Search Intention Model (Model C; {PP16e2, PP16e3}). New elements: (a) how to impose constraints to test equality of loading, exogenous variances and paths, and (b), how to compare the model across groups (e.g., is a model for males same or different than the model for the females). Imposing between group constraints (testing equality of factor structures, and of paths).

20. How to model interactions (moderation effects)? {Wolchik et al., 1993 {PP16f} and Marsh et al., 2004).

21. Multiple sources model: Illustrating the input and output of the Couples' Stress and Coping Model (Model E: {PP17a, PP17b, PP17c}). New elements: How to build a model with data from different sources (e.g., husbands and wives). Model E is the most complex model with multiple indicators, longitudinal design and data from different sources. (This model is described in the article by Vinokur, Price and Caplan., 1996).

22. Equivalent models and the issue of causal interpretation. {PP18a, PP18b, PP18c, PP18d}. (For a comprehensive article see MacCallum et al, 1993). Reading: Kline, Chapter 9, pp. 224-228.


24. How to model (and control for) common factor variance in cross-sectional design with measures from the same respondent. Based on the article by Vinokur-Kaplan, 1995. {PP21a}, Also see Lindell & Whitney, 2001 and Williams & Anderson, 1994.
25. Multi-trait Multi-method models and the correlated uniqueness model \{PP21b, PP21c, PP21d\} (See Bagozzi, 1993; Kline, Chapter 9, pp 250-252). Also see Tomas & Oliver, 1999 \{PP21e, PP21f\}.

26. Special Topics:

(a) How to model change in longitudinal panel design \{PP22a, PP22b\}.
Also an example from Price, Choi, Vinokur (2002) \{P22c\} also see Kessler and Greenberg (1981, pp 77-82), and Maassen & Bakker, 2001, pp 256 – 264.

(b) Confirmatory analysis: Do we need two factors or one would suffice?
(E.g., Are social support and social undermining opposites of the same underlying latent factor? Is sense of mastery and optimism the same construct? (Marshal & Lang, 1990\{PP3, and PP12a\}). Or, for those who lose a loved one, is grief and depression the same psychological experience? (Vinokur, et al. (under review, 2002) \{PP12cc\}.

(c) Confirmatory analysis: Is a given construct unidimensional?
(see Rubio et al, 2001).

(d) Dealing with and interpreting correlations among errors and disturbances \{PP8a\}.

(e) How to handle badly skewed variables, missing data, outliers, and categorical variables. (Kline, Chapter 3, pp 51-64, and Chapter 7, pp. 176-182).

(f) How to deal with various error messages and nonconvergence. What to do when:
a.... getting a warning message that certain parameters are linearly dependent on others,
b.... when certain parameters were set to lowest or highest bound
c.... you need to improve the fit of the model (dropping or adding parameters, retesting)

(g) Suppressor variables in SEM models (see Maassen & Bakker, 2001); \{PP22g,h, i,j\}.

(h) Power analysis for SEM models \{PP23a, PP23b\}. Also see: Kline, Ch 12, pp. 222-225.

(j) Linear Growth Curve Modeling: \{PP24a, PP24b, PP24c\} – only brief examples

(k) How to fool yourself with SEM? (Kline, Chapter 13, pp. 356-366) and \{PP25a\}
II. Required, Highly Recommended Useful Readings

1. Required reading
2. Highly Recommended readings, guidebooks or textbooks
3. Very useful recommended readings or textbooks
# available on the Ctools course website).

A. Basic Textbooks and Manuals

1. Kline, R. B. (2011). Principles and practice of structural equation modeling. (3rd Edition). New York: The Guilford Press. ISBN for the paperback is: 9781606238769. [This is the main textbook for this course. Every student should have a copy. The local book stores will carry copies or else try Amazon.com].

2. Byrne, B. M. (2006, 2nd Edition). Structural equation modeling with EQS and EQS/Windows: Basic concepts, applications, and programming. Thousand Oaks, CA: Sage Publications. [Second most highly recommended textbook, but optional, for only if you intend to continue using EQS. Ideally, every student should have a copy or at least an access to the book in the library]

Nearly all the content of the two manuals below is also embedded in the HELP section of the EQS software:


B. Other useful textbooks


C. General reviews of SEM


D. Other Available Resources Dedicated to SEM


Websites:
2. www.hawaii.edu/sem/sem.html
4. SEMNET discussion group, see http://www2.gsu.edu/~mkteer/semnet.html
   To subscribe, see instructions on the above webpage
4. To obtain data for your papers: http://www.icpsr.umich.edu See below:
   On a rich archive with thousands of documented datasets available to students and faculty from a consortium of about 400 universities around the world. Datasets can be used to prepare master theses, dissertations and other research publications.

E. How to report SEM work in your research paper


2 Raykov, T., Tomer, A., & Nesselroade, J. R. (1991). Reporting structural equation modeling results in Psychology and Aging: some proposed guidelines. Psychology and Aging, 6(4), 499-503. [Important article that set standards for how and what should be reported in articles that include structural analyses – but somewhat dated, Boomsma (2000) article is more up to-date and comprehensive]

F. Misc. Specific Topics

1. Issues relating to indicators, parcels and factors

On Parceling:


[The practical implications of this article for using one observed indicator (e.g., index) for one latent variable are demonstrated in the article by Frone et al below.]


On Reflective and Formative Factors:


2. Adjustment for reliability


3. Model identification


4. Measures of goodness of fit and misfit


5. Model modification: capitalizing on chance


6. Equivalent models

7. Power analysis in SEM


8. Modeling one or more common method effects


9. Modeling data from different sources


Using categorical variables: Group comparisons


Using continuous variables:

11. Using Meta-analysis with SEM


12. Modeling change


13. On causal inferences using SEM


14. Mediation analyses


Also, more on Sobel test see: http://quantpsy.org/sobel/sobel.htm and for a test based on Bootstrap see: http://quantpsy.org/medmc/medmc.htm

The following websites include abundance of information on MEDIATION and also on several topics of SEM:

David Kenny's website (the first below) is most highly recommended.
http://users.rcn.com/dakenny/kenny.htm
http://www.gsu.edu/~mkteer/semfaq.html
http://users.rcn.com/dakenny/mediate.htm
http://www.public.asu.edu/~davidpm/ripl/mediate.htm

15. Data preparation (transformations, outliers and imputations)


16. Misc. modeling issues (e.g., setting weights, factor loadings)


G. Misc. References of Various Research Studies Using SEM


III. Description of the Required Course Assignments

PART I (structured individual exercises based on class work in the lab)

Part I of the course assignments is based on an SPSS dataset on CTools (see RESOURCES, ASSIGNMENTS), that will be provided to each student. The data in this data set were collected using the questionnaire that is provided on ab_quest in order to apply Aizen’s Attitude-Behavior Model (ab_model) based on the Theory of Planned Behavior (TPB). The model is used here to investigate the predictors of the intensity of job search behavior of recently unemployed job seekers and their reemployment success six months later. Detailed review and information on TPB is available on the website of Professor Icek Aizen: http://www-oit.umass.edu/~aizen

To get your individual dataset, go to the CTools (RESOURCES, ASSIGNMENTS, and save to your computer the file AB_ALL.Zip and AB_4figs.ppt). After unzipping you will get 35 files in the form: ABM##.SAV. Each student in the class will be assigned a student number ### and your individual file for the purpose of working on the assignments is your assigned student number. For example, if you were assigned for this class student number 23, you will pick up and work on the data set in the file ABM_023.SAV. Also be sure to save the file ABM_000.SAV that will be used in the lab and for other special tasks. For completing the assignments you will need to print the very last four figures (Figures A0, A, B and C) from the PowerPoint Presentation file (SEM_PP06.ppt) with the models that need to be estimated with the data set using the EQS or similar software such as AMOS. For the various assignments, you will need to estimate each model with your dataset and list the results on the respective figure of the model. Each assignment also requires you to answer two to four questions. Please turn in the scheduled assignment with the estimated results written on the Figure and the output printout stapled (with the figure as first page). Deadlines for the assignments will be announced in class.

Students are asked to complete the following six structured assignments:

Assignment no. 1 (Figure A0, and Figure A1):
This assignment has four parts, (a) to (d).

(a) Estimate the factor model in Figure A0 (the model with 2 or more indicators per latent factor) as described on the figure and write the results on the figure including, the path
coefficients, R^2, the correlations, df, N, chi-square, NFI, NNFI, CFI and RMSEA. [Do not write the factor loading on the figure – you will do this on the next part of the assignment for model A]

NOTE: For this part (a) of the assignment you will need to prepare a data set with the following variables that must appear in the data set in exactly the same order as follows:

\[ v111 \text{ to } v133, zv134, zv135 \]  (Let us call the file for this dataset: Assign1A0.SAV). zv134 and zv135 are variables that need to be created. The following SPSS command creates in the data set the two new standardized variables Zv134 and Zv135:

DESCRIPTIVES VAR = V134 V135 /SAVE.

For more on “How to create the various indicator variables for Models A, B and C?” See this section in the document which includes the information on how to create the new variables. You can use the command SAVE to save the file as given below:

SAVE OUTFILE='C:\Assign1A0.SAV' /KEEP= v111 to v133  zv134 zv135.

(b). Estimate the factor model in Figure A (this is also a model with 2 or more indicators per latent factor) as described on the figure and write the results on the figure (Figure A) including the factor loadings, the path coefficients, R^2, the correlations, df, N, chi-square, NFI, NNFI, CFI and RMSEA. In addition, compare the results of model A0 to A and describe on a separate page: (1). whether one set of regression path coefficients is consistently larger by more than .05 in model A0 than in model A or vice versa? [Let us use a difference of .05 or larger to decide that a path coefficient is larger than the other] (2) whether the chi-square and the degrees of freedom are larger in one model than the other; and (3) whether the goodness of fit measures of the two models indicate that one of the models has a better fit; if it does, which model has a better fit and (4) why.

(c). Estimate the measurement model of the model in Figure A. In a measurement model you do not have paths among factors, so delete them from the Figure (or write delete above each path). Complete the following: (1). On Figure A include along the arrows to the indicators all the factor loadings. (2). On the bottom of the figure, fill in the df, the N, the Chi-square, NFI, NNFI, CFI and RMSEA. (3). A measurement model includes all the correlations among the factors: so, on a separate page include a table of the correlations among the six factors (= bottom half of the matrix of the correlations among the six factors).

NOTE: For part (b) of the assignment you will need to prepare a data set with the following variables that must appear in the data set in exactly the same order as follows:

\[ v201, v202, v117, v118, v119, v120, v121, v122, v123, v211, v212, v213, zv134, zv135 \]  (Let us call the file for this dataset: Assign1A.SAV). Some of these variables need to be created. The section below “How to create the various indicator variables for Models A, B and C?” includes the information on how to create the new variables.

You can use the command SAVE to save the file as given below:

SAVE OUTFILE='C:\Assign1A.SAV' /KEEP= v201 v202  v117  v118  v119 v120  v121  v122  v123  v211  v212  v213  zv134 zv135.

(d). On a separate page provide a comparison of the goodness-of-fit and misfit indices and conclude which model, the measurement (from part
Assignment no. 2: Estimate the factor model in Figure B (with one indicator per factor) as shown in the figure and provide all the results as in assignment 1 on the figure. In addition, compare the results of model A to B and describe on a separate page: (a) whether one set of path coefficients (in model A versus B) is consistently larger than the other? And, (b) whether the goodness of fit measures of the two models indicates that one of the models has a better fit. If it does, which model has a better fit and why.

For this assignment and (also for assignments no 3) you will need to prepare a data set with the following variables that must appear in the data set in exactly the same order as follows: V51 v52 v53 v54 v55 v56 (Let us call the this dataset: Assign23.SAV). On how to prepare the new variables in this data set see the section below.

Assignment no. 3: Estimate the path model described in Figure C, and provide the results on the figure as you did on assignments 1 and 2. In addition, on a separate page, describe whether: (a) the goodness-of-fit measures of model C appear better or worse than those of Model A (assignment 1), and (b) the size of the path coefficients of model C appear larger or smaller than those of Model A (assignment 1), and if so (c) why.

For this assignment use the same dataset you prepared for assignment no.2 (that is, file for this dataset: Assign23.SAV)

Assignment no. 4: This assignment has two parts, (a) and (b).

(a) Using the factor model in Figure A (with 2 or more indicators per factor) as described on the figure estimate it simultaneously for the group of males and the group of females. Provide all the results for both groups on the figure using the fully constrained model.

(b) Examine the modification indices (ML Lagrange test) of the output and test whether one or more (up to three) of the path coefficients is different for the males and females by a statistically significant degree. On a new Figure write the figures for the chi-square and goodness-of-fit measures and the path coefficients where the males and females are different according to your test. Fill out only the values for the paths where there is a difference and leave all others empty.

For this assignment use the same STUCTURE of the dataset you prepared for Model A, but, you will need two separate data sets: one for the males, a second one for the females. You can use the same set up for creating the variables for assignment 1A but SAVE the data set for males and females separately based on V31 (gender: males = 0 females = 1). (Let us call the files for the males and females datasets: Assign4m.SAV and Assign4f.SAV)

The SPSS syntax is:

temp.
SELECT IF (V31 = 0).
SAVE OUTFILE = 'C:\-\Assign4m.SAV' /KEEP= v201 v202  v117  v118  v119 v120 v121 v122 v123  v211 v212 v213  zv134 zv135.
temp.
SELECT IF (V31 = 1).
SAVE OUTFILE = 'C:\\Assign4f.SAV' /KEEP= v201 v202 v117 v118 v119
 v120 v121 v122 v123 v211 v212 v213 zv134 zv135.

FREQUENCY V31.

Assignment no. 5: This assignment has two parts (a) and (b)

(a). Estimate the factor model in Figure A, but instead of F6 use the dichotomous,
categorical variable, V136 as an observed variable. Write the results on the figure. Note that
here you need to treat V136 as a categorical variable (which is V13 - see figure D) in the model,
by adding to the /SPECIFICATION section the following:
   CAT=V13; ME = ML, ROBUST; ANALYSIS = CORRELATION; MATRIX = RAW;
   In this model you will not have F6, but instead the model and the figure will have V13.

(b). Estimate the factor model in Figure B, again with V136, but, do not treat it as a
categorical variable. That is, simply remove from the /SPECIFICATION the section CAT=V13;
ME = ML, ROBUST; ANALYSIS = CORRELATION; MATRIX = RAW; and run the setup.
Write the results on the model. On a separate page, indicate the difference in the path F5 to V13
in the first and second run.

Here again, in this model you will not have F6, but instead the model and the figure will
have V13.

For this assignment and you will need to prepare a data set with the following variables that must
appear in the data set in exactly the same order as follows:
   v201 v202 v117 v118 v119 v120 v121 v122 v123 v211 v212 v213 v136 (Let us call
this dataset: Assign5.SAV)

Description of the Variables in the ABM##.SAV Data Set.

V21 – Subject ID
Demographics
V31 – Gender (Male = 0; Fem. = 1)
V32 – Age (in years)
V33 – Education (from 1-5)
   1= Part High School; 2= High School; 3= Part College
   4= Baccal. Degree; 5= Post Graduate
V34 – Minority Status (0= white; 1= minority, mostly Af. American)
V35 – Occupation (from 1 -7,)
   1= Professionals; 2= Managers
   3= Clerical/Kindred; 4= Sales Workers
   5= Crafts/Foreman; 6= Operatives; 7= Laborers/Service

The other variables in your data set are:
For self efficacy: v111 v112 v113 v114 v115 v116

For Attitude: v117 v118 v119

For Subjective Norms: v120 v121

For Intention: v122 v123

For Search Behavior: v124 v125 v126 v127 v128 v129 v130 v131 v132 v133:

For Reemployment: V134 v135 v136

For the assignments you will need to create the additional variables of V201 v202 v211 v212 v213 v214 v215 v216 v51 v52 v53 v54 v55 v56 as explained in the next section below.

Note. It is most efficient to create all the variables and then SAVE them in separate datasets for the various assignments. One SAVE for Assignments 1, second SAVE for assignments 2 and 3, and third SAVE for assignment 5. Then, you can also save the two data sets for assignment 4 for the male and female groups based on V31 (Gender).

How to create the various indicator variables for Models A, B and C?

Self Efficacy: Based on questions: v111 v112 v113 v114 v115 v116

For the model in Figure A: compute mean of v111 v113 and v115 \rightarrow V201
And compute mean of v112 v114 and v116 \rightarrow V202

For the models in Figures B and C, compute mean of:
\[
\text{v111 v112 v113 v114 v115 v116} \rightarrow v51
\]

Attitude: For the models in Figures B and C, compute the mean of:
\[
v117 v118 v119 = \rightarrow v52
\]

Subjective Norms: For the models in Figures B and C, mean of v120 v121 = \rightarrow v53

Intention: For the models in Figures B and C, compute mean of v122 v123 = \rightarrow v54

Behavior: based on questions v124 v125 v126 v127 v128 v129 v130 v131 v132 v133

For model in Figure A, compute mean of v124 v127 v130 v133 \rightarrow V211
And compute mean of v125 v128 v131 \rightarrow V212
And compute mean of v126 v129 v132 \rightarrow V213
For the models in Figures B and C, compute the mean of all the 10 questions 124 v125 v126 v127 v128 v129 v130 v131 v132 v133 = \rightarrow v55

Reemployment or Employment: based on questions v134 v135 and v136:

For model in Figure A0 and Figure A, create new variables from V134 and V135 that are the standardized variables ZV134 and ZV135. The following SPSS command creates in the data set the two new standardized variables Zv134 and Zv135:

DESCRIPTIVES VAR = V134 V135 /SAVE.

Use the newly created standardized variables ZV134 and ZV135 as the two indicators V24 and V25 (for the factor of employment in model Figure A0) and v13 and v14 (for employment in Model Figure A).

For the models in Figures B and C, Create a new variable which is: the mean of the standardized variables ZV134 and ZV135, that is, compute mean of ZV134 ZV135 \rightarrow V56

The SPSS command is: COMPUTE V56 = MEAN.2 (ZV134, ZV135)

For all other indices in our model you will use Mean.2 in the command, as they are composed of 2 or three items each.

PART II (A research paper including an empirical test of SEM)

The students are required to submit a final paper as follows:

(1) the paper should be about 18 and up to 32 double space pages including an abstract, references, tables, figures and footnotes; appendices such as program output, are NOT counted as part of the 32 page limit. (2) Only ONE SIDED printed HARD COPY of the paper is acceptable, and (3). The paper should include an appendix with ONE SIDED printed copy of the output(s) of the model(s) described in the paper and a figure with all the variables and factors clearly labeled and numbered. The output should be clearly marked to link it to the reported analyses in the paper. (4) The paper should be in the format of a research article modeled in style and structure after research articles appearing in the official journals published by the American Psychological Association (e.g., Journal of Applied Psychology, Journal of Personality and Social Psychology). It must include the following sections: (a) a title page with student name and ID, (b) an abstract (up to ¾ of a page), (c) introduction with background, rationale for and a description of the model including well specified hypotheses, (d) fully developed and detailed method section, (e) results section, (f) and discussion section, (g) references, (h) footnotes, (i) Tables (one per page) (j) Figures (one per page). The model should include at least four latent constructs. Method or Result section must include a full figure of the SEM model with the results. One of the tables must include the matrix of correlations and means and standard deviation of the variables of the SEM model. Emphasis should be given to appropriate and clear report of structural equation model construction based on the hypotheses, testing and evaluation as reported in the method and result sections of a professional publication (see Raykov et al., 1991; or Boomsma, 2000). The following factors will receive special consideration (weight) in the evaluation of the report: (a) the sophistication of the model in terms of one or more of the following: number of constructs, indicators per construct, number of sources of data, longitudinal vs. cross sectional design, group comparisons, constraints, treatment of alternative models; treatments of mediation; treatment/modeling of moderation (b) adequacy
and accuracy of the report of the model and the results (Raykov et al., 1991), and (c) discussion of weaknesses and limitations. The final grade will be determined based on this final paper.

**Deadline for submission of the report:** To be announced in class.

**Grade Policy for a Formal Letter Grade**

**Part I, Assignments:** Satisfactory completion of all first four assignments is required.

**Part II, Final Paper:** The required elements are specified above.
IV. Articles for the course on Ctools Website

(The articles on Ctools are under Course Resources’ subdirectory “Course Readings”)


--End of Syllabus---------------------------------