COURSE SYLLABUS
CPSE 730 and IP&T 730
Spring Term, 2016

INSTRUCTORS:

Dr. Richard Sudweeks, 150-M MCKB, 801-422-7078
Office Hours:

CLASS MEETING SCHEDULE

T & Th, 12:00p.m. –2:50 p.m.

REQUIRED TEXTBOOK

Snijders, T.A.B. & Bosker, R.J. (2012). *Multilevel analysis: An introduction to basic and advanced multilevel modeling*. Los Angeles: Sage.

Robson, K. & Pevalin, D. (2016). *Multilevel modeling in plain language*. Los Angeles: Sage.

EXPECTED LEARNING OUTCOMES

As a result of successfully completing this course, students should be able to do the following:

1. Explain the similarities and differences between ordinary least squares regression and multilevel regression in terms of (a) the kinds of data structures that can be most appropriately be analyzed by each, (b) the kinds of research questions that can be addressed by each, (c) the main features that distinguish between single-level and multilevel models, and (d) the likely consequences of using each approach when the other would be more appropriate.
2. Understand the basic concepts and notational conventions used in multilevel modeling (e.g., nested units of analysis and within-level dependencies; estimated intercept and slope parameters and residuals; within-group versus between-group variance; intraclass correlation coefficients; conditional versus unconditional models; fixed versus random model components; within-level versus cross-level interactions; cross-sectional versus longitudinal designs; time-varying versus time invariant predictors; growth trajectories; etc).
3. Demonstrate proficiency in using multilevel software to analyze hierarchically structured data including (a) preparing the data files, (b) generating the input commands, (c) executing analyses, and (d) interpreting and evaluating the output.
4. Apply appropriate strategies to analyze hierarchically structured data sets by building and testing alternative models.
5. Write a proposal to conduct an original, multilevel study including a description of (a) the purpose of the study, (b) the primary research questions or hypotheses, (c) procedures for collecting relevant data, and (d) appropriate strategies for building models and analyzing the data.
6. Prepare written reports of completed multilevel research studies in accordance with the reporting guidelines in the published literature on multilevel research and the stylistic prescriptions presented in the *Publication Manual* of the American Psychological Association.
7. Summarize, interpret, and critique written reports of completed multilevel studies completed by other researchers.

SOFTWARE

The use of Multilevel/Hierarchical Modeling techniques is not feasible or practical without modern computers and software. General purpose statistics packages such as *SAS*, *SPSS*, and *Stata* each include specific procedures and routines that can be used to perform multilevel analyses. In addition, more specialized programs such as *HLM*, *Mplus*, and *MLWin* can also be used for this purpose. However, in this class we will focus on learning to use *Stata* to conduct multilevel analyses. Each student is expected to become proficient in using this procedures. The course textbook includes relevant guidelines and examples.

COURSE OUTLINE

The topics included in this course will be taught in the following order:

1. The nature of hierarchical data structures and the meaning of nesting
2. The disadvantages of using Ordinary Least Squares regression models to analyze hierarchical data and the advantages of multilevel modeling
3. Preparing data files for multilevel analysis
4. Basic concepts and notational symbols used in multilevel models with two levels
5. Analyzing two-level models using Stata
6. Checking assumptions and assessing model-data fit
7. Strategies for building and testing alternative models
8. Analyzing models with three levels
9. Issues to consider when designing multilevel studies
10. Using multilevel models to analyze longitudinal data
11. Alternative covariance structures
12. Multilevel structural equation models

GRADING POLICY

Grades will allocated based on students' performance on the homework exercises (20%), the two examinations (40%), and the two projects (40%).

COURSE PROJECTS

Each student is expected to successfully complete two projects:

1. Prepare a written summary-review of a published journal article reporting the results of a research study that used to MLM. The report should include a description of the purpose and context of the study plus your analysis and critique of how well multilevel modeling techniques were used in this study.
2. Analyze a multilevel data set and write a report describing the purpose for which the study was conducted, how the data were collected and analyzed, and the findings and results of the study.

PUBLISHED TUTORIALS, PRIMERS, OVERVIEWS, AND OTHER INTRODUCTORY ARTICLES

The articles and other materials in this list focus on basic concepts, logic, and procedures used in multilevel/hierarchical modeling. They are listed here for your reference.

Atkins, D.C. (2005). Using multilevel models to analyze couple and family treatment data: Basic and advanced issues. *Journal of Family Psychology, 19*, 98-110.

Arnold, C.L. (1992). An introduction to hierarchical linear models. *Measurement and Evaluation in Counseling and Development, 25*, 58-90.

Ferron, J.M., Hogarty, K.Y., Dedrick, R.F., Hess, M.R., Niles, J.D. & Kromrey, J.D. (2008). Reporting results from multilevel analyses. In A.A. O'Connell & D.B. McCoach (Eds.), *Multilevel modeling of educational data* (pp. 391-426). Charlotte, NC: Information Age Publishing.

Garson, G.D. (2013). *Hierarchical linear modeling: Guide and applications*. Thousand Oaks, CA: Sage.

Harlow, L.L. (2014). *The essence of multivariate thinking: Basic themes and methods* (2nd ed.). New York: Routledge. [See chapter 8, "Multilevel modeling," pp. 199-201.]

Hoffman, D.A. (1997). An overview of the logic and rationale of hierarchical linear models. *Journal of Management, 23*, 723-744.

Holt, J.K. (2008). Modeling growth using multilevel and alternative approaches. In A.A. O'Connell & D.B. McCoach (Eds.), *Multilevel modeling of educational data* (pp. 111-159). Charlotte, NC: Information Age Publishing.

Kahn, J.H. (2011). Multilevel modeling: Overview and applications to research in counseling psychology. *Journal of Counseling Psychology, 58*, 257-271.

McCoach, D.B. & Black, A.C. (2008). Evaluation of model fit and adequacy. In A.A. O'Connell & D.B. McCoach (Eds.), *Multilevel modeling of educational data* (pp. 245-272). Charlotte, NC: Information Age Publishing.

McCoach, D.B. & Black, A.C. (2012). Introduction to estimation issues in multilevel modeling. *New Directions for Institutional Research, 154*, 23-39.

Morris, C.N. (1995). Hierarchical models for educational data: An overview. *Journal of Educational and Behavioral Statistics, 20*, 190-200.

Myers, N.D., Brincks, A.M., & Beauchamp, M.R. (2010). A tutorial on centering in cross-sectional two-level models. *Measurement in Physical Education and Exercise Science, 14*, 275-294.

Nezlek, J.B. (2008). An introduction to multilevel modeling for social and personality psychology. *Social and Personality Psychology Compass, 2*, 842-860.

O'Connell, A.A. & McCoach, D.B. (2004). Applications of hierarchical linear models for evaluations of health interventions: Demystifying the methods and interpretations of multilevel models. *Evaluation & the Health Professions, 27*, 119-151.

Osborne, J.W. (2000). Advantages of hierarchical linear modeling. *Practical Assessment, Research & Evaluation, 7*(1), 1-7.

Paccagnella, O. (2006). Centering or not centering in multilevel models: The role of the group mean and the assessment of group effects. *Evaluation Review, 30*, 66-85.

Peugh, J. & Enders, C. (2005). Using the SPSS mixed procedure to fit cross-sectional and longitudinal multilevel models. *Educational and Psychological Measurement, 65*, 717-741.

Raudenbush, S.W. (1988). Educational applications of hierarchical linear model: A review. *Journal of Educational Statistics, 13*, 85-116.

Raudenbush, S.W. & Bryk, A.S. (1986). A hierarchical model for studying school effects. *Sociology of Education, 59*, 1-17.

Reise, S.P. & Duan, N. (1999). Multilevel modeling and its application in counseling psychology research. *Counseling Psychologist, 27*, 528-551.

Roberts, J.K. (2002). The importance of the intraclass correlation in multilevel and hierarchical linear modeling designs. *Multiple Linear Regression Viewpoints, 28*(2), 19-31.

Roberts, J.K. (2004). An introductory primer on multilevel and hierarchical linear modeling. *Learning Disabilities: A Contemporary Journal*, *2*(1), 30-38.

Roberts, J,K. & McLeod, P. (2008). Software options for multilevel models. In A.A. O'Connell & D.B. McCoach (Eds.), *Multilevel modeling of educational data* (pp. 427-467). Charlotte, NC: Information Age Publishing.

Robson, K. & Pevalin, D. (2016). *Multilevel modeling in plain language*. Los Angeles: Sage.

Sullivan, L.M., Dukes, K.A., & Losina, E. (1999). Tutorial in biostatistics: An introduction to hierarchical linear modeling. *Statistics in Medicine, 18*, 855-888.

Tabachnick, B.G. & Fidell, L.S. (2007). *Using multivariate statistics* (5th ed.). Boston: Pearson Allyn & Bacon. [See chapter 15, "Multilevel Linear Modeling," pp. 781-857).]

Woltman, H., Feldstain, A., MacKay, J.C., & Rocchi, M. (2012). An introduction to hierarchical linear modeling. *Tutorials in Quantitative Methods for Psychology, 8*(1), 52-69.

SUPPLEMENTARY RESOURCE MATERIALS

The following books and articles are useful supplementary materials for students who desire to examine published applications of multilevel analysis or desire to gain a more in depth understanding of specific concepts or procedures used in multilevel/hierarchical linear modeling.

Baldwin, S.A. & Fellingham, G.W. (2013). Bayesian methods for the analysis of small sample multilevel data with a complex variance structure. *Psychological Methods, 18*, 151-164.

Baretvas, S.N., Meyers, J.L., & Rodriguea, R.A. (2005). The cross-classified multilevel measurement model: An explanation and demonstration. *Journal of Applied Measurement, 6*, 322-341.

Bickel, R. (2007). *Multilevel analysis for applied research: It's just regression!* New York: New York: Guilford.Boyle, M.H. & Willms, J.D. (2001). Multilevel modeling of hierarchical data in developmental studies. *Journal of Child Psychology and Psychiatry, 42*, 141-162.

Burstein, L. (1980). The analysis of multi-level data in educational research and evaluation. *Review of Research in Education, 8*, 158-223.

Burstein, L. (2002). The analysis of multilevel data in educational research in evaluation. *Review of Research in Education, 8*, 158-233.

Castro, S.L. (2002). Data analytic methods for the analysis of multilevel questions: A comparison of intraclass correlation coefficients, $r_{wg(j)}$, hierarchical linear modeling, within- and between analysis, and random group resampling. *The Leadership Quarterly, 13*, 69-93.

Curran, P.J. (2003). Have multilevel models been structural equation models along? *Multivariate Behavioral Research, 38*, 529-569.

de Leeuw, J. & Kreft, I. (1986), Random coefficients models for multilevel analysis. *Journal of Educational Statistics, 11*, 57-85.

de Leeuw, J. & Kreft, I. (1995), Questioning multilevel models. *Journal of Educational Statistics, 20*, 171-189.

de Leeuw, J. & Kreft, I.G.G. (2001). Software for multilevel analysis. In A.J. Leyland & H. Goldstein (Eds.), *Multilevel modeling of health statistics* (pp. 187-204). Chichester, UK: Wiley.

Draper, D. (1995). Inference and hierarchical modeling in the social sciences. *Journal of Educational and Behavioral Statistics, 20*, 115-147.

Enders, C.K. & Tofighi, D. (2007). Centering predictor variables in cross-sectional multilevel models: A new look at an old issue. *Psychological Methods, 12*, 121-138.

Finch, W.H., Bolin, J.E., & Kelley, K. (2014). *Multilevel modeling using R*. Boca Raton, FL: CRC Press.

Gaudreau, P., Fecteau, M.C., Perreault, S. (2010). Multi-level modeling of dyadic data in sport sciences: conceptual, statistical, and practical issues. *Measurement in Physical Education and Exercise Science, 14*, 29-51.

Gelman, A. & Hill, J. (2007). *Data analysis using regression and multilevel/hierarchical model*s. New York: Cambridge University Press.

Goldstein, H. (1987). *Multilevel models in education and social research*. London: Griffin.

Harrison, D.M. & Raudenbush, S.W. (2006). Linear regression and hierarchical linear models. In J.L. Green, G. Camilli, & P.B. Elmore (Eds.), *Handbook of complementary methods in education research* (pp. 411-426). Washington, DC: American Educational Research Association.

Heck, R.H. & Thomas, S.L. (2015). *An introduction to multilevel modeling techniques* (3rd ed.). New York: Routledge.

Hoffman, D.A. & Gavin, M.B. (1998). Centering decisions in hierarchical linear models: Implications for research in organizations. *Journal of Management, 24,* 623-641.

Hox, J. (2010). *Multilevel analysis: Techniques and applications* (2nd ed.). New York: Routledge.

Hox, J. & Roberts, J.K. (2010). *Handbook of advanced multilevel analysis*. New York: Routledge.

Kenny, D.A. & Hoyt. W.T. (2009). Multiple levels of analysis in psychotherapy research. *Psychotherapy Research, 19,* 462-468.

Kreft, I. & de Leuuw, J. (1998). *Introducing multilevel modeling*. London: Sage.

Kreft, I.G.G., de Leeuw, J., & Kim, K. (1990). The effects of different forms of centering in hierarchical linear models. *Multivariate Behavioral Research, 30,* 1-22.

Lane, C.J. & Zelinski, E.M. (2003). Longitudinal hierarchical linear models of the Memory Functioning Questionnaire. *Psychology and Aging, 18,* 38-53.

Luke, D.A. (2004). *Multilevel modeling*. Thousand Oaks, CA: Sage.

Leyland, A.H. & Goldstein, H. (2001). *Multilevel modeling of health statistics*. Chichester, UK: John Wiley.

Maas, C.J.M. & Hox, J.J. (2005). Sufficient sample sizes for multilevel modeling. *Methodology, 1*, 86-92.

Muthen, B.O. (1994). Multilevel covariance structure analysis. *Sociological Methods & Research, 22,* 376-398.

Nezlek, J.B. (2001). Multilevel random coefficient analyses of event and interval contingent data in social and personality psychology research. *Personality and Social Psychology Bulletin, 27,* 771-785.

Nezlek, J.B. & Zyzniewski, L.E. (1998). Using hierarchical linear modeling to analyze grouped data. *Group Dynamics, 2,* 313-320.

O' Brien, R.M. (2000). Levels of analysis. In E.G. Borghatta & R.R. Montgomery (Eds.), *Encyclopedia of Sociology* (2nd ed., pp. 1591-1596). New York: Macmillan.

O' Connell, A.A. & McCoach, D.B. (Eds.) (2008). *Multilevel modeling of educational data*. Charlotte, NC: Information Age Publishing.

Raudenbush, S.W. (1988). Educational applications of hierarchical linear models: A review. *Journal of Educational Statistics, 13*, 85-116.

Raudenbush, S.W. (1995). Reexamining, reaffirming, and improving application of hierarchical models. *Journal of Educational and Behavioral Statistics, 20*, 210-220.

Raudenbush, S.W. & Bryk, A.S. (2002). *Hierarchical linear models: Applications and data analysis methods* (2nd ed.). Thousand Oaks, CA: Sage.

Rogosa, D. & Saner, H. (1995). Longitudinal data analysis examples with random coefficient models. *Journal of Educational and Behavioral Statistics, 20,* 149-170.

Scott, M.A., Simonoff, J.S., & Marx, B.D. (Eds.) (2013). *The Sage handbook of multilevel modeling*. Los Angeles: Sage.

Seltzer, M.H., Wong, W.H.M., & Bryk, A.S. (1996). Bayesian analysis in applications of hierarchical models: Issues and methods. *Journal of Educational Statistics, 21*, 131-167.

Singer, J.D. (1998). Using SAS PROC MIXED to fit multilevel models, hierarchical models, and individual growth models. *Journal of Educational and Behavioral Statistics, 24*, 323-255.

Singer, J.D. & Willet, J.B. (2003). *Applied longitudinal data analysis: Modeling change and event occurrence*. New York: Oxford University Press.

Skrondal, A. & Rabe-Hesketh, S. (2004). *Generalized latent variable modeling: Multilevel, longitudinal, and structural equation models*. Boca Raton, FL: Chapman & Hall.

Snijders, T.A. (2005). Power and sample size in multilevel linear models. In B.S. Everitt & D.C. Howell (Eds.), *Encyclopedia of statistics in behavioral sciences* (vol. 3, pp. 1570-1573). Chichester, UK: Wiley.