COURSE SYLLABUS
CPSE 730 and IP&T 730
Spring Term, 2019

INSTRUCTORS:

Instructors:

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Class Meeting Schedule:

M &W, 9:00-11:50 341 MCKB

REQUIRED TEXTBOOK

Packet Available at the BYU Store: Sudweeks, R., IP&T/CPSE 730, Hierarchical Linear Modeling, ISBN 978-0-70003-0152-2, $11.25 **You will be lost without this packet**!!!!

RECOMMENDED TEXTBOOKS

The following textbooks are recommended. They vary in approach and scope. You should access at least one of them. I will describe the advantages of each so you can choose which fits your needs.

Finch, W. H & Bolin, J.E. (2017). Multilevel Modeling Using Mplus, CRC Press. ISBN-13: 978-1-4987-4824 (pbk).

Hox, J.J., Moerbeek, M. & van de Schoot (2018). Multilevel Analysis: Techniques and Applications: Quantitative Methodology, Third Edition. Routledge. ISBN: 978-1-138-12136-2 (pbk).

Heck, R.H. , Thomas, S., & Tabata, L. (2014). Multilevel and Longitudinal Modeling with IBM SPSS (2nd ed.). New York, NY: routledge. ISBN: 978-0-415-81711-0

The Finch and Bolin text is reasonably light on theory and does not go into too many weeds. It also provides clear instruction on using Mplus (if that is your favored syntax-based program. The downside, in my opinion, is that the parameter estimates in the Mplus output are hard to track. I had to do a lot of extra work to identify the components of the Mplus output in the book. The chapter on longitudinal HLM uses incorrect subscripting which can be confusing for a first time user. There are more errata that I expected to see, but overall, it is well written.

The Hox et al. text moves quickly through a wide range of material. However, it sometimes goes into details (the weeds) in the beginning of the text that are not particularly helpful to first time users. The Hox text has less errata than the other texts and is written well. It does not rely on a

single program. All examples have accompanying datasets that are formatted for multiple programs (SPSS, HLM, MLwiN, and Mplus). A major advantage for first time users is that the Hox text presents parameter estimates from each example in tables that are easy to follow. (None of the texts add the Greek and Arabic symbols into the tables as I would prefer, but Hox's tables are easy to follow nonetheless.)

The Heck text is written simply without as much technical/theoretical material or breadth of coverage as the other two. There is an accompanying text by Heck. (*An Introduction to Multilevel Modeling Techniques*) that does cover more theory and is logically consistent with the applied text recommended here. The recommended Heck text provides excellent screenshots of the SPSS input process which are very helpful to first time users. The output for each example is reasonably isomorphic with the actual SPSS output which is also very helpful to students. The downside of the Heck text is that the chapter on longitudinal analysis is wrong…or at least the extended example is wrong. It is possible to simply use the example as it is erroneously executed and learn from it, but it is wrong. It is possible to run the analysis correctly and compare the results to the erroneous results, which is instructive but irritating, as it makes most of the explanatory text in the chapter irrelevant.

So if you already prefer to work in Mplus, the Finch text will be a very good choice. If you prefer to work in SPSS, the Heck text(s) is a good choice. If you prefer to work in R, the Hox text might be a good choice because the website will have multiple formats of the data that can probably be used in R.

I will try to illustrate concepts using data and examples from all three texts in both SPSS (in which I am more fluent) and Mplus (in which Rich is more fluent) and hope that my work prepares you to do your two projects using the software of your choice.

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.

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. (Dr. Fischer is a fan of MLwiN because it translates models well, but is it expensive, inaccessible for students and clunky to learn.)

The topics included in this course will be taught:

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 cross-sectional models
6. Checking assumptions and assessing model-data fit
7. Strategies for building and testing alternative models
8. Analyzing models with three level cross-sectional models
9. Issues to consider when designing multilevel studies
10. Using multilevel models to analyze longitudinal data
11. Alternative covariance structures
12. Analyzing generalized hierarchical models

Session	Date	Readings	Topic	Homework
1 W	5/1	Heck 1 & 2 Hox 1 & 2 Finch 1 & 2	Bridge & Introduction	
2 M	5/6	Heck 3 Hox 3 Finch 3 & 4	2-level Cross-sectional Modeling	
3 W	5/8	Heck 3 Hox 3 Finch 3 & 4	2-level Cross-sectional Modeling	
4 M	5/13	Heck 3 Hox 3 Finch 3 & 4	2-Level Cross-sectional Modeling Software Variations	
5 W	5/15	Heck Chapter 4 Finch 5	3-level Cross-sectional Modeling	
6 M	5/20		Practice and Prepare for Midterm Cushion	
7 W	5/22	Midterm Exam	Midterm Exam	
Monday	5/27	Memorial Day	Memorial Day	
8 W	5/29	Heck 5 & 6 Hox 5 Finch 6	Begin Longitudinal Modeling	

9 M	6/3	Heck 5 & 6 Hox 5 Finch 6	Longitudinal Modeling	
10 W	6/5	Heck 5 & 6 Hox 5 Finch 6	Longitudinal Modeling	
11 M	6/10	Heck 5 & 6 Hox 5 Finch 6	Longitudinal Modeling	
12 W	6/12	Hox 6 & 7 Finch 7 & 8	Generalized Hierarchical Modeling	
13 M	6/17		Practice and Prepare for Final Exam	
W Final Exam	6/19 9:00-11:00	Final Exam	Final Exam	

GRADING POLICY

Grades will allocated based on students' performance on the the two examinations (50%), and the two projects (50%).

COURSE PROJECTS

Each student is expected to successfully complete two projects:

1. Analyze a cross-sectional multilevel data set and write a report describing the findings and results of the analysis.
2. Analyze a longitudinal multilevel data set and write a report describing the findings and results of the analysis.
3.

BYU POLICIES

Academic Honesty

The first injunction of the BYU Honor Code is the call to be honest. Students come to the university not only to improve their minds, gain knowledge, and develop skills that will assist them in their life's work, but also to build character. President David O. McKay taught that "character is the highest aim of education" (The Aims of a BYU Education, p. 6). It is the purpose of the BYU Academic Honesty Policy to assist in fulfilling that aim. BYU students should seek to be totally honest in their dealings with others. They should complete their own work and be evaluated based upon that work. They should avoid academic dishonesty and misconduct in all its forms, including but not limited to plagiarism, fabrication or falsification, cheating, and other academic misconduct.

BYU Honor Code

In keeping with the principles of the BYU Honor Code, students are expected to be honest in all of their academic work. Academic honesty means, most fundamentally, that any work you present as your own must in fact be your own work and not that of another. Violations of this principle may result in a failing grade in the course and additional disciplinary action by the university. Students are also expected to adhere to the Dress and Grooming Standards. Adherence demonstrates respect for yourself and others and ensures an effective learning and working environment. It is the university's expectation, and my own expectation in class, that each student will abide by all Honor Code standards. Please call the Honor Code Office at 422-2847 if you have questions about those standards.

Preventing Sexual Harassment

Title IX of the Education Amendments of 1972 prohibits sex discrimination against any participant in an educational program or activity that receives federal funds. The act is intended to eliminate sex discrimination in education. Title IX covers discrimination in programs, admissions, activities, and student-to-student sexual harassment. BYU's policy against sexual harassment extends not only to employees of the university, but to students as well. If you encounter unlawful sexual harassment or gender-based discrimination, please talk to your professor; contact the Equal Employment Office at 422-5895 or 367-5689 (24-hours); or contact the Honor Code Office at 422-2847.

Students with Disabilities

Brigham Young University is committed to providing a working and learning atmosphere that reasonably accommodates qualified persons with disabilities. If you have any disability which may impair your ability to complete this course successfully, please contact the Services for Students with Disabilities Office (422-2767). Reasonable academic accommodations are reviewed for all students who have qualified, documented disabilities. Services are coordinated with the student and instructor by the SSD Office. If you need assistance or if you feel you have been unlawfully discriminated against on the basis of disability, you may seek resolution through established grievance policy and procedures by contacting the Equal Employment Office at 422-5895, D-285 ASB.

PUBLISHED TUTORIALS, PRIMERS, OVERVIEWS, AND OTHER INTRODUCTORY ARTICLES

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.]

Heck, R.H. (2001). Multilevel modeling with SEM. In G.A. Marcoulides & R.E. Schumacher (Eds.), *New developments and techniques in structural equation modeling* (pp. 89-127). Mahwah, NJ: Erlbaum.

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.

Mehta, P.D. & Neale, M.C. (2005). People are variables too: Multilevel structural equations modling. *Psychological Methods, 10*, 259-284.

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.

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