COURSE SYLLABUS
CPSE 730 and IP&T 730: Multilevel Modeling
Spring Term, 2021

INSTRUCTORS

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& 1:00 p.m.-2:00 p.m., M & W

CLASS MEETING SCHEDULE,

The class will meet online via Zoom from 12:00-2:50 p.m. every Tuesday and Thursday.

REQUIRED TEXTBOOK and COURSE PACKET

Heck, R.H., & Thomas, S.L. (2020). *An introduction to multilevel modeling techniques: MLM and SEM approaches* (4th ed.). Routledge.

Course Packet for CPSE/IP&T 730 available at the BYU Store

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 successfully investigated 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 have been more appropriate.
2. Understand the basic concepts used in multilevel modeling including, but not limited to the following:
    - 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 effects
    - maximum likelihood versus restricted maximum likelihood estimation
    - within-level versus cross-level interactions
    - structured versus unstructured covariance matrices
    - cross-sectional versus longitudinal designs
    - time-varying versus time-invariant predictors
3. Build and evaluate alternative models to analyze hierarchically structured data.
4. Write the set of equations for a model of interest including the correct equations at each level and the combined equation.
5. Read and interpret the equations for two- and three-level models with confidence.
6. Demonstrate proficiency in using multilevel software to analyze hierarchically structured data sets including (a) preparing the data files, (b) writing the input command files, (c) executing command files, (d) debugging syntax errors, and (e) interpreting and evaluating output files.
7. Summarize, interpret, and critique written reports of completed multilevel studies completed by other researchers.

SOFTWARE

The use of Multilevel/Hierarchical Modeling techniques would not be feasible or practical without modern computer hardware 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 *Mplus*, *HLM*, and *MLWin* can also be used for this purpose. In this class we will focus on using *Mplus*. Each student is expected to become proficient in (a) preparing data files to be read into *Mplus*, (b) writing Mplus syntax to prepare input files, (c) debugging input files that fail to run properly, and (d) reading and interpreting *Mplus* output files with understanding.

GRADING POLICY

Grades will be 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 of the three projects described below. All students are expected to complete Project 1. Students may choose to complete either Project 2 or Project 3.

1. Prepare a written summary and critique of a published journal article reporting the results of a research study that used multilevel modeling. 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 and to what extent the researchers' conclusions are supported by the data.

2. Analyze a multilevel data set and write a summary report which describes—
   - the purpose of the study,
   - the research questions on which the study focused,
   - how the data were obtained and analyzed,
   - the models compared, and
   - the findings and conclusions of your study.

3. Prepare a written proposal to conduct a conduct a research study using multilevel modeling techniques. The written document should include—
   - the purpose for conducting the study,
   - the research questions that you plan to investigate,
   - a brief review of relevant previous research and a rationale for why the proposed needs to be conducted,
   - the kinds of data to be analyzed and how and from what source this data will be obtained,
   - the kinds of models that you expect to build and how you expect to evaluate them.

COURSE OUTLINE

The topics to be taught in this course include:

1. The nature of hierarchical data structures and the meaning of *nesting*
2. The limitations associated with using ordinary least squares regression models to analyze hierarchical data and the advantages of multilevel models
3. Basic concepts and notational symbols used in multilevel models with two and three levels
4. How to use *Mplus* software to analyze multilevel data
5. Analyzing two-level models
6. Developing a general strategy for analyzing multilevel data
7. Checking assumptions and assessing model-data fit
8. Strategies for building and testing alternative models
9. Analyzing models with three levels
10. Issues to consider when designing multilevel studies
11. Conducting multilevel analyses using generalized linear models
12. Using multilevel models to analyze longitudinal data
13. Alternative covariance structures

SCHEDULE

Session	Date	Readings	Topic	Homework
1 T	Apr 27	H&T chapt. 1	Intro & Bridge to Multiple Regression	Huang (2018)
2 Th	Apr 29	H&T chapt. 2	2-level cross-sectional models	
3 T	May 4	H&T chapt. 3	2-level cross-sectional models	
4 Th	May 6	H&T chapt. 3	2-level cross-sectional models	
5 T	May 11	H&T chapt. 4	3-level cross-sectional models	
6 Th	May 13	H&T chapt. 4	3-level cross-sectional models	
7 T	May 18			Midterm Exam
8 Th	May 20		Review & consolidate	
9 T	May 25	H&T chapt. 5	Introduction to Longitudinal Models	
10 Th	May 27	H&T chapt. 5	Longitudinal Models	First Project
11 T	June 1	H&T chapt. 5	Longitudinal Models	
12 Th	June 3	H&T chapt. 5	Longitudinal Models	
13 T	June 8	H&T chpat. 5	Longitudinal Models	Distribute Final
14 Th	June 10		Cushion	Second Project
15 T	June 15		Review	
16 Th	June 17			Final Exam

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 D-285 ASB.

PUBLISHED TUTORIALS, PRIMERS, OVERVIEWS, AND OTHER INTRODUCTORY ARTICLES

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

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.

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

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

Hayes, A.F. (2006). A primer on multilevel modeling. *Human Communication Research, 32*, 385-410.

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). 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). Information Age Publishing.

Huang, F.L. (2018). Multilevel modeling and ordinary least squares regression: How comparable are they? *Journal of Experimental Education, 86*(2), 265-281.

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

Keith, T.Z. (2015). *Multiple regression and beyond* (2nd ed.). Routledge. [See "Multiple Modeling," pp. 228-240.]

Kim, J. & Choi, K. (2008). Closing the gap: Modeling within-school variance heterogeneity in school effect studies. *Asia Pacific Education Review, 9*, 206-220.

Mehta, P.D. & Neale, M.C. (2005). People are variables too: Multilevel structural equation modeling. *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.

Muthen, B.O. & Khoo, S.-T. (1998). Longitudinal studies of achievement growth using latent variable modeling. Learning and Individual Differences, 10(2), 73-1010.

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. (2008). A brief introduction to hierarchical linear modeling. In J.W. Osborne (Ed.), *Best practices in quantitative methods* (pp. 445-450). Sage.

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

Peralta, H., Moreno, M., Harwell, M., Guzey, S.S., Moore, T.J. (2018). Going beyond the mean: Using variance to enhance understanding of the impact of educational models. *Education Research Quarterly, 41*(3), 39-71.

Peugh, J.L. (2010). A practical guide to multilevel modeling. *Journal of School Psychology. 48*, 85-112.

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.

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

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

Robson, K. & Pevalin, D. (2016). *Multilevel modeling in plain language*. 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).]

Tan, F.E.S. (2008). Best practices in analysis of longitudinal data. In J.W. Osborne (Ed.), *Best practices in quantitative methods* (pp. 451-470). Sage.

Van Dusen, B. & Nissen, J. (2019). Modernizing use of regression models in physics education research: A review of hierarchical linear modeling. *Physical Review Physics Education Research, 15(*2), 1-13.

Woltman, H., Feldstain, J., MacKay, 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.

Bickel, R. (2007). *Multilevel analysis for applied research: It's just regression!* Guilford.

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

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.

Feingold, A. (2015). Confidence interval estimation for standardized effect sizes in multilevel and latent growth modeling. *Journal of Consulting and Clinical Psychology, 83*(1), 157-168.

Finch, H. (2017). Multilevel modeling in the presence of outliers: A comparison of robust estimation methods. *Psicologica: International Journal of Methodology and Experimental Psychology, 38*(1), 57-92.

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

Goldstein, H. (2011). *Multilevel statistical models* (4th ed.). Wiley.

Grund, S., Ludtke, O., & Robitzsch, A. (2018). Multiple imputation of missing data at level 2: A comparison of fully conditional and joint modeling in multilevel designs. *Journal of Educational and Behavioral Statistics, 43*(3), 316-353.

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). American Educational Research Association.

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

Hoffman, L. (2015). *Longitudinal analysis: Modeling within-person fluctuation and change*. Routledge.

Hox, J., Moerbeek, M., & van de Schoot, R. (2018). *Multilevel analysis: Techniques and applications* (3rd ed.). Routledge.

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

Huang, F.L. (2016). Alternatives to multilevel modeling for the analysis of clustered data. *Journal of Experimental Education, 84*(1), 175-196.

Huang, F.L. (2018). Multilevel modeling myths. *School Psychology Quarterly, 33*(3), 492-499.

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.

Lai, M.H.C. & Kwok, O. (2015). Examining the rule of thumb of not using multilevel modeling: The 'Design effect smaller than two' rule. *The Journal of Experimental Education, 83*(3), 423-438.

Luke, D.A. (2019). *Multilevel modeling* (2nd ed.). Sage.

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). 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.

McCulloch, C.E. & Neuhaus, J.M. (2013). Generalized linear mixed models: Estimation and inference. In M.A. Scott, J.S. Simonoff, & B.D. Marx (Eds.), *The Sage handbook of multilevel modeling* (pp. 271-286). Sage.

McNeish, D. (2017). Small sample methods for multilevel modeling: A colloquial elucidation of REML and the Kenward-Roger correction. *Multivariate Behavioral Research, 52*, 661-670.

McNeish, D. & Kelley, K. (2019). Fixed effects models versus mixed effects models for clustered data: Reviewing the approaches, disentangling the differences, and making recommendations. *Psychological Methods, 24*(1), 20-35.

McNeish, D. & Stapleton, L.M. (2016). Modeling clustered data with very few clusters. *Multivariate Behavioral Research, 5*1, 495-518.

Nezlek, J.B. (2011). *Multilevel modeling for social and personality psychology*. Sage.

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

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.

Preacher, K.J., Curran, P.J., & Bauer, D.J. (2006). Computational tools for probing interactions in multiple linear regression, multilevel modeling, and latent curve analysis. *Journal of Educational and Behavioral Statistics, 31*, 437-448.

Raudenbush, S.W. (1988). Educational applications of hierarchical linear models: 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.

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

Rights, J.D., Preacher, K.J., & Cole, D.A. (2019). The danger of conflating level-specific effects of control variables when primary interest lies in level-2 effects. *British Journal of Mathematical and Statistical Psychology, 73*, 194-211.

Rights, J.D. & Sterba, S.K. (2016). A framework of R-squared measures for single-level and multilevel regression mixture models. *Psychological Methods, 23*(3), 434-457.

Rights, J.D. & Sterba, S.K. (2019). Quantifying explained variance in multilevel models: An integrative framework for defining R-squared measures. *Psychological Methods, 24*(3), 309-338.

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.

Schweig, J. (2013). *Measurement error in multilevel models of school and classroom environments: Implications of reliability, precision, and prediction*. (CRESST Report 828). National Center for Research on Evaluation, Standards, and Student Testing, University of California at Los Angeles.

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

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*. Chapman & Hall.

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

Van Leeuwen, D.M. (1997). A note on the covariance structure in a linear model. *American Statistician, 51*(2), 140-144.

Walls, T.A., & Schafer, J.L (Eds.) (2006). *Models for intensive longitudinal data*. Oxford University Pres.

Wampold, B.E. & Serlin, R.C. (2000). The consequence of ignoring a nested factor on measures of effect size in analysis of variance. *Psychological Methods, 5*(4), 425-433.

Software Issues Related to Applications of Multilevel Models

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

Galecki, A.T. & West, B.T. (2013). Software for fitting multilevel models. In M.A. Scott, J. S. Simoff, & D.B. Marx (Eds.), *The Sage handbook of multilevel modeling* (pp. 465-483). Sage.

McCoach, D.B., Rifenbach, G.C., Newton, S.D., Li, X., Kooken, J., Yomtov, E., Gambino, A.J., & Bellara, A.. (2018). Does the package matter: A comparison of five common multilevel modeling software packages. *Journal of Educational and Behavioral Statistics, 43*(5), 594-627.

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). Information Age Publishing.

Examples of Published Studies Using Multilevel Models

Albano, A.D., Christ, T.J., & Cai, L. (2018). Evaluating equating in progress monitoring measures using multilevel modeling. *Measurement*, 16(3), 168-180.

Bergee, M.J. & Weingarten, K.M. (2021). Multilevel models of the relationship between music achievement and reading and math achievement. *Journal of Research in Music Education, 68*(4), 398-418.

Blochliger, O.R. & Bauer, G.F. (2018). Correlates of burnout symptoms among child care teachers: A multilevel modeling approach. European Early Childhood Education Research Journal, 26(1), 7-25.

Bowers, A.J. & Urick, A. (2011). Does high school facility quality affect student achievement" A two-level hierarchical linear model. Journal of Education Finance, 37(1), 72-94.

Chester, D.S. (2019). Beyond the aggregate score: Using multilevel modeling to examine trajectories of laboratory-measured aggression. *Aggressive Behavior, 45*(5), 498-506.

Codding, R.S., Volpe, R.J., Martin, R.J., Krebs, G., & Ardoin, S. (2019). Enhancing mathematics fluency: Comparing the spacing of practice sessions with the number of opportunities to respond. *School Psychology Review, 48*(1), 89-97.

Cornelius, A.D., Brewer, B.W., & van Ralte, J.L. (2007). Applications of multilevel modeling in sport injury rehabilitation research. *International Journal of Sport & Exercise Psychology, 5*(4), 387-405.

Gentry, W.A., & Martineau, J.W. (2010)., Hierarchical linear modeling as an example for measuring change over time in a leadership development evaluation context. *Leadership Quarterly, 21*(4), 645-656.

Hartley, S.L., Papp, L.M., & Bolt, D. (2018). Spillover of marital interactions and parenting stress in families of children with autism spectrum disorder. *Journal of Clinical Child & Adolescent Psychology, 47* (Supplement), S88-S99.

Konishi, C., Miazaki, Y., Hymel, S., & Waterhouse, T. (2017). Investigating associations between school climate and bullying in secondary schools: Multilevel contextual effects modeling. *School Psychology International, 38*(3), 240-263.

Laska, K.M., Smith, T.L., Wislocki, A.P., Minami, T., & Wampold, B.E. (2013). Uniformity of evidence-based treatments in practice: Therapist effects in the delivery of cognitive processing therapy for PTSD. *Journal of Counseling Psychology, 60*(1), 31-41.

Leroux, A.J. (2019). Student mobility in multilevel growth modeling: A multiple membership piecewise growth model. *Journal of Experimental Education, 87*(3), 430-448.

McCoach, D.B., O'Connell, A.A., Reis, S.M., & Levitt, H.A. (2006). Growing readers: A hierarchical linear model of children's reading growth during the first 2 years of school. *Journal of Educational Psychology, 98*(1), 14-28.

Mohammadpour, E., Kalantarrashidi, S., & Shekarchizadeh, A. (2015). Multilevel modeling of science achievement in the TIMMS participating countries. *Journal of Educational Research, 108*, 449-464.

Rose, R.A. (2018). Multilevel modeling in family violence research. *Journal of Family Violence, 33*(2), 109-122.

Schreiber, J.B. (2002). Institutional and student factors and their influence on advanced mathematics achievement. *Journal of Educational Research, 95*(5), 247-266.

Singh, J. (2016). Effect of school and home factors on learning outcomes at elementary school level: A hierarchical linear model. *International Journal of Primary, Elementary and Early Years Education, 44*(2), 116-139.

Sullivan, A.L., Van Norman, E.R., & Klingbell, D.A. (2014). Exclusionary discipline of students with disabilities: Student and school characteristics predicting suspension. *Remedial & Special Education, 35*(4), 199-210.

Summers, R. & Abd-El-Khalick, R. (2019). An exploration of Illinois students' attitudes toward science using multivariate multilevel modeling with a cross-sectional sample of responses from grades 5 through 10. *Journal of Research in Science Teaching, 56*(8), 1106-1134.

Swierzy, R., Wicker, P., & Breuer, C. (2019). Usefulness of multilevel modeling in sport management research: The case of voluntary roles in nonprofit sports clubs. *Measurement in Physical Education and Exercise Science, 23*(4), 325-336.

Xiao, Y., Han, J., & Koenin, K. (2018). Multilevel Rasch modeling of two-tier multiple choice test: A case study using Lawson's Classroom Test of Scientific Reasoning. *Physical Review Physics Education Research, 14*(2), 1-18.

Yamada, H., Bohannon, A.X., Grunow, A., & Thorn, C.A. (2018). Assessing the effectiveness of Quantway®: A multilevel model with propensity score matching. *Community College Review, 46*(3), 257-287.