RMS 4915 – HIERARCHICAL LINEAR MODELING

SPRING 2018

**Course Description**

Data in education, psychology and other social science fields are often found to be clustered with hierarchical structure. For example researchers may work with students nested in classrooms in schools, or participants measured repeated over time. They cannot be handled adequately by standard statistical procedures due to violations of model assumptions. HLM is an extension of linear regression that can simultaneously account for the different levels of a hierarchical (nested) structure.

This course is designed to help students learn the basic principles and application of Hierarchical Linear Modeling (HLM) in behavioral sciences. It will provide an introduction of HLM models, discuss the basics of the HLM approach, in particular as it relates to analyzing nested data structures and repeated measures data. Emphasis will be placed on learning via applications in education and other social sciences. Students will learn the basic conceptual HLM framework and its empirical applications.

**Course Objective**

This course is for advanced doctoral students in social science who have strong interest and background in quantitative research methods. They will learn theory and applications of the HLM models to tackle appropriate research questions in behavioral and social sciences. By the end of this course the student is expected to

* Understand basic theory and principles of HLM
* Be effective consumers of research articles using HLM
* Be able to run HLM models with appropriate datasets and interpret the results

**Instructor Information**

Duan Zhang, Ph.D., Associate Professor in Research Methods and Statistics

Office: KRH 232 Tel: 303-871-3373 Email: [duan.zhang@du.edu](mailto:duan.zhang@du.edu)

Office Hours: M 9-11:30 & W 3: - 4:30 or by appointment

**Class Meetings: Th 1 – 2:50pm in KRH 306**

GTA: Peiyan Liu (Peiyan.liu@du.edu)

GTA Office hours: M 2-4 & T 10-12 in RMS Cubes (KRH 2nd floor near LIS offices)

**Prerequisite**: Graduate Standing, RMS 4911 – Correlation and Regression

* *Minimum Technical Skills Expected*: using email with attachments, using Microsoft WORD and POWERPOINT programs, familiar with SPSS and basic EXCEL functions.

**Text:** Raudenbush, S. W., & Bryk, A. S. (2002). *Hierarchical Linear Models: Application and Data Analysis Methods, 2nd Ed.* Sage Publications.

* Additional readings will be distributed in class and/or placed on Canvas.

**Course Format**

This is a **hybrid** course in which the class meeting time will be evenly distributed online and face-to-face (roughly 90 minutes each way). You are required to engage with course content and complete in-class and after-class assignments through the canvas course. You must participate fully in the face-to-face AND online portion of this course in order to fulfill the learning objectives and receive a passing grade.

**Software**

There are several statistical software packages available to conduct HLM analyses including HLM, PROC MIXED in SAS, Mixed procedure in SPSS, and MLwiN. Some multilevel models, particularly those focusing on longitudinal change, can be done in SEM packages such as LISREL and MPlus.

The analyses presented in this class will be done using the free student version of HLM7 (<http://www.ssicentral.com/hlm/student.html>), although you are free to use other multilevel programs for your individual exercises and projects if you wish.

**Assignment Guidelines**

All the assignments must be typed up and submitted electronically on canvas by the due date. Everyone has ***one*** opportunity for late work. After that ***five*** points will be deducted from the credit for assignments submitted late for each day after the due date. Each assignment will be graded on a 100-point scale.

* **Online Discussion Participation**
  + Each week every student is expected to make at least one substantive post based on the chapter content and respond to at least one of your peers' posts.
  + Your substantive post must be related to the topic being discussed that week and can be a question or comment from your learning. Yet it can't be something such as "xxx is so useful" or “I agree with xxx" etc.
  + The substantive post must be made by the end of each Wed and the response post must be finished by each Sunday. You are more than welcome to make or reply to more than one post
* **Case Study Exercises**
  + Two case study exercises will be posted separately on canvas, in which the data and research questions will be given for the students to investigate.
  + The students will use the information to run the appropriate HLM models, and submit the annotated output with precise answers to the research questions in short paragraphs.
* **Final Project Proposal**
  + *You may work in groups of no more than 3 for the proposal and report.*
  + 5 double-spaced typed pages maximum in total
  + 1-2 paragraphs describing your research topic and research question
  + Your hypotheses (3 maximum) and associated predictions
  + Description of Methods (à la APA style)
  + Proposed Data Analytic Approach (include example HLM model equations)
* **Final Project Report**

It should have all the major components of a typical APA style research paper (title page, abstract, introduction, methods, results, discussion, and references). No more than 15 double-spaced pages excluding appendices.

* The introduction section (1 page) should clearly delineate the topic of your study and your specific research questions.
* The methods section (2-3 pages) should be brief on participants and variables.
* Devote most of your section to describing the data and models that will be employed to test your specific research questions.
* Do NOT run every possible model for a given dataset. Choose one outcome variable and small sets of level-1 and level-2 predictors and build to a final model using the steps described in class (e.g., building a level-1 model and then a level-2 model).
* The results section (3-5 pages) should provide answers to your research questions. Include appropriate tables/graphs as necessary. However, do NOT attach large amounts of HLM program output as an appendix. Choose the most useful and informative
* The discussion section (2 pages) should present a thoughtful critique (NOT a simple restatement) of the results including any deficiencies in the study/questions/analyses, etc.

Both the proposal and final report should be formatted according to APA Publication Manual guidelines. I will be especially sensitive to APA styles on

* Reporting of test statistics in the paper text
* General formatting and numbering of tables and figures
* Section headings (introduction, results, etc.)
* Form of references and proper use of references
* Economy and logical flow of expression in the text including appropriate verb tenses within each section
* Bias in language used

The final reports will be evaluated primarily on correctness, completeness, and conciseness. All members in a group will get the same grade for its proposal and report.

**Course Grading Policy**

Class Attendance and Participation 20%

Case studies 15% X 2

Final Project proposal 20%

Final Project Report 30%

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| A | 93-100% | A- | 90-92 | B+ | 87-89 | B | 83-86 | B+ | 80-82 |
| C+ | 77-79 | C | 73-76 | C- | 70-72 | D+ | 67-69 | D | 63-66 |
| D- | 60-62 | F | <60 |  |  |  |  |  |  |

**Class Communication Policies**

Everyone is expected to attend all classes. Notify the instructor in advance when extenuating circumstances prevent you from coming to class. Be sure to get notes from your classmates and download any materials from Canvas if you must miss a class.

* All readings and assignments are due when assigned, regardless of whether a student is able to attend the regular class period. It is *strongly recommended* that students devote regular study time to keep up with readings and assignments. This is a four (4) credit hour class so please plan accordingly.
* If extraordinary circumstances warrant special arrangements for making up work or working in advance of an anticipated absence, it is the ***student’s responsibility*** to make these arrangements with the instructor **IN ADVANCE**.

**Incompletes**:

Incompletes are discouraged. Prolonged illness may warrant assigning an incomplete where no other grade will do justice to the student's academic performance and commitment to the course. Incompletes must be arranged with me prior to the end of the quarter. Incompletes will revert to a grade of F if not cleared within appropriate time frame (see <http://www.du.edu/registrar/calendar/incompletedeadline.html> for dates)

**Canvas:**

This course is offered via the university's learning management system, Canvas.  If you have technical issues with the Canvas software, you can click on the Help button at the top right corner of the page, or contact Canvas technical support at 855-712-9770.

* Canvas Student Tutorial is available at <https://du.instructure.com/courses/190>

**Tentative Course Schedule**

*Subject to change*

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| --- | --- | --- |
| Week | Topic | Readings / Assignment |
| 1 | Stats Review and Overview of HLM | Correlation and regression notes |
|  | *Lab - Review of SPSS* | Chapter 1, Osborne (2000) |
| 2 | Logic of HLM | Chapter 2 |
|  | Lab - *Intro to HLM programs* |  |
| 3 | Estimation and Hypothesis Testing | Chapter 3 |
| 4\* | HLM Analysis: An Illustration  ***Research Proposal Due*** | Chapter 4 |
| 5 | Applications in Organizational Research | Chapter 5 |
| 6\* | Applications in Growth Models  ***Case Study 1 Due*** | Chapter 6 |
| 7 | Three-Level Models | Chapter 8 |
| 8\* | HLM Model Evaluation | Chapter 9 (p154-158) |
|  | ***Case Study 2 Due*** |  |
| 9 | Handling Missing Data in HLM | Chapter 11 (p336 – 351) |
| 10 | Advanced Models & Course Review | Chapter 11 (p351 – 370) |
| \*3/14/2017 | ***Final Project Paper Due*** | |

**UNIVERSITY OF DENVER PROFESSIONAL EXPECTATIONS**

**Honor Code**

All students are expected to abide by the University of Denver [Honor Code](http://www.du.edu/studentlife/studentconduct/honor_code_2012-2013.pdf). These expectations include the application of academic integrity and honesty in your class participation and assignments. Violations of these policies include, but are not limited to:

*Academic Misconduct*

* Plagiarism, including any representation of another’s work or ideas as one’s own in academic and educational submissions.
* Cheating, including any actual or attempted use of resources not authorized by the instructor(s) for academic submissions.
* Fabrication, including any falsification or creation of data, research or resources to support academic submissions.

**Students with Disabilities**

Any participant who feels s/he may need an accommodation based on the impact of a disability should contact us privately to discuss his or her specific needs.  Additionally, please contact the Disability Services Program located on the 4th floor of Ruffatto Hall; 1999 E. Evans Ave. to coordinate reasonable accommodations for students with documented disabilities. (Tel: 303.871.2278/7432/2455).

Information is also available online at: <http://www.du.edu/disability/dsp>

**FERPA and Privacy**

The University of Denver is committed to the safeguarding and accurate maintenance of student records. The Family Educational Rights and Privacy Act (FERPA) of 1974 provides students with a number of rights regarding their educational records. Occasionally students will need to release part or all of their student record(s) to third parties such as parents, attorneys, or employers. The University of Denver will not release student records without the written consent of the student.

For more information, please see the Notification to Students of Educational Records and Student Information Rights and Policies or contact the Office of the Registrar at 303.871.4300 or registrar@du.edu.

**HLM References** (primarily books)

Aerts, M, Geys, H, Moldenberghs, G., & Ryan, L.M. (2002). Topics in Modelling of Clustered Data. NY: Chapman & Hall/CRC.

De Leeuw, J., & Meijer, E.. (2008). Handbook of Multilevel Analysis. Springer.

Gelman, A., & Hill, J. (2007). Data Analysis Using Regression and Multilevel/Hierarchical Models. NY: Cambridge.

Goldstein, H. (2003). [Multilevel statistical methods](http://www.amazon.com/exec/obidos/redirect?link_code=ur2&tag=hlmonline-20&camp=1789&creative=9325&path=http%3A%2F%2Fwww.amazon.com%2Fgp%2Fproduct%2F0340806559%2Fqid%3D1136992745%2Fsr%3D1-1%2Fref%3Dsr_1_1%3Fs%3Dbooks%2526v%3Dglance%2526n%3D283155)ir?t=hlmonline-20&l=ur2&o=1 (3rd ed). London: Edward Arnold.

Hox, J.J. (2002). Multilevel Analysis: Techniques and Applications. Mahwah: N.J.: Earlbaum.

\*\*Kreft, I., de Leeuw, J., & Aiken, L.S. (1995). The effect of different forms of centering in hierarchical linear models. Multivariate Behavioral Research, 30, 1-12.

Kreft, I. & de Leeuw, J (1998). Introducing multilevel modeling. Thousand Oaks: Sage.

Little, T.D., Schnabel, K.U, & Baumeter, J. (2000). Modeling longitudinal and multilevel data. Mahwah, NJ: Lawrence Erlbaum Associates.

Pinheiro, J. C. & Bates, D. M. (2000). [Mixed-effects models in S and S-PLUS](http://www.amazon.com/exec/obidos/redirect?link_code=ur2&tag=hlmonline-20&camp=1789&creative=9325&path=http%3A%2F%2Fwww.amazon.com%2Fgp%2Fproduct%2F0387989579%2Fqid%3D1136993177%2Fsr%3D2-1%2Fref%3Dpd_bbs_b_2_1%3Fs%3Dbooks%2526v%3Dglance%2526n%3D283155)ir?t=hlmonline-20&l=ur2&o=1. New York: Springer.

Rabe-Hesketh, S. and Skrondal, A. (2005). [Multilevel and Longitudinal Modeling using Stata](http://www.stata-press.com/books/mlmus.html). College Station, TX: Stata Press.

\*\*Singer, J.D. (1998). Using SAS PROC MIXED to fit multilevel models, hierarchical models, and individual growth models. Journal of Educational and Behavioral Statistics, 23, 323-355.

Singer, J.D. & Willett, J.B. (2003). Applied Longitudinal Data Analysis: Modeling Change and Event Occurrence. NY: Oxford University Press.

Snijders, T. & Bosker, R. (1999). Multilevel analysis: An introduction to basic and advanced multilevel modeling. Thousand Oaks, CA: Sage.

Verbeke, G, & Moldenberghs, G. (2000). Linear mixed models for longitudinal data. NY: Springer-Verlag.

*\*\* Available on canvas.*

*There are many more references and web-sites devoted to multilevel models, HLM, etc.*