

**SYLLABUS**

**Multilevel Analysis of Survey Data**  
 Survey Research Techniques Summer Program 2011

University of Michigan: Education 890 or Psychology/Sociology 988.202  
 University of Maryland: SURV699K

*Note: This is a video course taught simultaneously at the University of Michigan and the University of Maryland. Although the syllabus is the same for each location, registration, on-site faculty, staff, and facilities are different. Check the syllabus and the individual institutions for details.*

**Logistical Information**

*Where and When*

**Class Time:** June 6 – July 1, 2011, 10:30-12:30 p.m. (includes lectures and labs). Orientation at the University of Michigan takes place on Monday, June 6, starting at 9:00 a.m., in the meeting rooms on the 6<sup>th</sup> floor of the Institute for Social Research (ISR) building. This is primarily for students who are not already part of the University of Michigan community. Orientation at the University of Maryland takes place on Monday, June 6, 10:30 -12:30, Room 2208 Lefrak Hall. The first class will be held on Tuesday, June 7, at the regular time.

**Location:** The location for lectures at the University of Michigan is room 300 in the Perry Building, whereas the location for the lectures at the University of Maryland is room 2208 in Lefrak Hall. These are video-conference rooms that we will use for all lectures. The labs at the Michigan site will be held in East Hall, Room B-250. The labs at the Maryland site will be Lab 4 (0231 LeFrak Hall) on June 8, 10, 14, 17, 24, and 28, and in Lab 3 (0229 LeFrak Hall) on June 21.

<i>Staff</i>	<i>University of Michigan</i>	<i>University of Maryland</i>
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<b>Office Hours:</b>	Tues 2-4, 4220-A SEB	Tues 1-3 pm, Benjamin 2110

*Staff (continued)*

	<i>University of Michigan</i>	<i>University of Maryland</i>
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Office Hours:	Wed 2-4 pm and Thurs 2-4 pm, always in SOE room 3010 (computer lab)	Thurs 1-3 pm, in the Benjamin Bldg in room 2110

*Registration*

The course is offered through the University of Michigan's Survey Research Techniques Summer Institute at the Institute for Social Research and the Joint Program in Survey Methodology at the University of Maryland. (Please note that the course is not part of ICPSR, the other series of summer research methods courses at ISR.) Dr. Steven Heeringa directs the Summer Institute at the University of Michigan; Jill Esau is education programs administrator ([jesau@isr.umich.edu](mailto:jesau@isr.umich.edu)). The Institute's office is in room 4050 in the ISR building at the University of Michigan (734-647-4620). Roger Tourangeau directs JPSM; Rupa Jethwa Eapen is the assistant to the director ([rjeapen@survey.umd.edu](mailto:rjeapen@survey.umd.edu)). The JPSM office is in room 1218 in Lefrak Hall (301-314-7911)

The course enrolls both degree and non-degree students. Degree students may take the course either for credit or as an audit; non-degree students are all auditors ("summer scholars" at UM). Although tuition is required of students in any of these categories, course-credit tuition is higher at the University of Michigan and the University of Maryland. Michigan students may register and pay tuition in one of two categories: Summer Institute or School of Education. Summer Institute students, either degree or non-degree students, register in the usual way and pay fees through the Institute. Students who qualify for School of Education course credit also register with the Summer Institute, but they will need to register for ED-890 also in the Fall 2011 term, with tuition paid for a 3-credit course in that semester. Students planning to take advantage of the School of Education option must take the course for credit. Maryland students register for the course as part of the University's summer schedule. For Maryland students who have tuition reimbursement in the fall but not the summer, it may be possible to defer tuition payment until the beginning of the next academic year. These arrangements must be made with the instructor and JPSM prior to the first day of the course. At both universities, it is very difficult to change status after the course is over, so be sure you're registered in the right category.

***Course Overview***

*Purpose and Aims*

A problem. Although the hierarchical linear modeling technique is applicable to many disciplines in social science and the professions, our course provides examples of its utility in a particular discipline: education. A major phenomenon of interest in educational research is the learning of

individual students. Two educational realities -- (1) that learning implies change in individuals over time but (2) learning occurs in organizational settings (classrooms, schools) -- cause persistent and troublesome methodological problems in quantitative research. One problem is how to measure change. Another involves how to accommodate the grouped nature of the phenomenon (often referred to as "the unit of analysis problem"), as education almost always occurs in groups (classrooms, schools) while its effects are expected to accrue to individuals. These methodological problems have distinct, long-standing, and non-overlapping literatures. In a sense, the problems share a common cause: traditional statistical techniques are not adequate to model the hierarchical nature of either phenomenon.

Applicability. Education illustrates a clear dilemma in this regard, and much educational research is flawed because of it. However, the problem is not limited to that field. Both measuring change and estimating effects on individuals when the "treatment" takes place in groups are common phenomena in social science evaluation research. Therefore, although the instructors in this course all specialize in the field of education, and the data we use in the course for illustrative purposes are educational, the usefulness of the techniques learned in the course have broad applications. In past years, students have come from many social science and professional fields.

Focus. The course is meant to introduce students to the multilevel methodology and to help them become skilled in its use. We begin by discussing the need for multilevel methods in survey research, as well as the circumstances under which these methods are appropriate and necessary. We ask students to read articles in which the method is employed, both to become familiar with the standard terminology and notation and to review the substance of a variety of work where these methods are applicable. When the course ends, we hope that students will have both good understanding and considerable skill in using HLM in survey research with nested data.

Target audience and prerequisites. Although the course focus is on quantitative methodology, our orientation is more toward applications than statistical derivations. We expect that students have a working knowledge of general linear models and are familiar with non-experimental multivariate methods; preparation in mathematical statistics is not required. We do expect, however, that students have considerable experience with statistical computing in a social science setting. Generally, this means that students have completed at least two semesters of graduate training in quantitative research methods and statistics and are capable of formulating, conducting, and interpreting results for and analysis of variance (ANOVA) and OLS regression with several variables. We also expect that students are reasonably skilled in and comfortable with using common statistical software (e.g., SPSS, SAS, STATA) for data manipulation.

Although the database offered for class use comes from the field of education, we expect that class members come from a variety of social science disciplines. At any point in the course, students with access to other data with a multilevel structure, adequate within-and between-group sample sizes, and appropriate variables are encouraged to make use of them. However, because the course moves at a fast pace (a semester's work in four weeks with weekly written assignments and HLM analyses), it is unwise to use new data if preparing them would occupy a substantial amount of students' time and effort. In previous years, the intensity of the class has meant that most students have worked with the class data files.

Objectives. Hopefully, students in this class will learn:

1. To formulate multilevel research problems in terms of a hierarchical linear model (HLM).

2. To pose and test hypotheses about various parameters of multilevel models and to write clearly about both the statistical and substantive meaning of these results.
3. To examine critically the application of HLM to particular problems in light of its statistical assumptions.
4. To conduct a meaningful two-level hierarchical linear model analysis, write up the results, and draw substantive conclusions from the analysis.
5. To gain a reading knowledge of applications of hierarchical linear models beyond the standard two-level organizational model.

### *Organization*

Format. We have offered this course as part of the ISR Summer Institute since 1994. The course has been offered jointly at the University of Maryland, through the Joint Program in Survey Methodology, using video-conferencing technology since 1997.

We teach the course in a workshop format, which alternates between lectures and labs. Both lectures and labs are required, as this is a "hands-on" course. Lectures and labs are informal, meant to provide opportunities for questions and discussions. A culminating activity in the course is the final project (both a paper and an oral presentation). The purpose of presenting students' "work in progress" is to provoke discussion around the HLM methodology employed in a variety of contexts (data, research questions) rather than as a "test" of the quality of work. The scope of final project presentations depends on class sizes at both locations. In past years, several final projects have been developed into conference presentations and gateway research activities.

Hopefully, the class structure and format accommodate some variety in the backgrounds and expectations students bring to the class. Lectures provide the theory and purpose of HLM, discussion of analyses using it, as well as a vehicle for understanding what is being done, why it might be done, what conclusions may be drawn, and examples of studies using HLM. The labs offer "how-to" experiences, where students receive instruction from the Teaching Assistants in how to use the statistical software, HLM (Hierarchical Linear Models). Although out-of-class work involves both readings and weekly write-ups of computing projects, the majority of out-of-class time is spent at a computer, learning to work with HLM and to prepare data and variables to use in HLM analyses. There is no exam. All students, whether they are taking the course for credit or not, receive a letter grade. Assignments of class members not receiving course credit will be evaluated on the same scale.

Although comparable HLM software is available in both mainframe and PC versions, class instruction uses HLM for Windows. We will be working with HLM 7.00. This version has been provided to us for instructional purposes and will "expire" August 1<sup>st</sup>. Anyone desiring to purchase a copy of HLM software may do so from Scientific Software International (SSI) in Chicago, IL.

Requirements. Minimum requirements include attending all lectures and labs, completing assigned readings, writing up three short and one longer data analysis, and making an oral presentation. As the course is designed around learning to **use** HLM, all students (including auditors) are expected to complete the assignments, in order to learn the methodology, how to apply it to data, and to receive feedback on their work. The assignments are meant to be progressive. Thus, it is impossible to do the later assignments without mastering the skills

involved in the early ones. If for some reason students need to miss a class, they are still expected to complete the assignments. Missing classes is strongly discouraged.

The course finale is the presentation of final projects, each focusing on a topic of personal and substantive interest. This will include both a written paper of 10-20 pages and a short presentation to the class (10-15 minutes). Students may work individually or in pairs on all assignments. Assignments 1-3 are each worth 20% of the final grade, and the final project is worth 40% of the grade (15% oral presentation; 25% paper).

Data. Many of the examples discussed in class, and the course-supplied data file, come from a multilevel longitudinal educational dataset. We make use of the first two waves of the Early Childhood Longitudinal Study, Kindergarten Cohort (ECLS-K). As stated, class members are welcome to use their own data (if the data have an appropriate multilevel structure) for assignments beyond the introductory ones. If you plan to do this, you should discuss it early with Professors Lee or Croninger to make sure your data are appropriate for use with HLM.

The ECLS-K data are available from the National Center for Education Statistics (NCES) in the U.S. Department of Education. Many NCES datasets exist in two forms: public-use and restricted. ECLS-K is available in both forms, but we will make use of the public-use version. You should feel free to obtain a copy of these data from NCES on your own (go to: <http://nces.ed.gov/ecls/>). For the class, we will supply students with SPSS systems files (children and schools) made from ECLS-K, where we have sampled down the numbers of children, schools, and variables. The dataset contains the first two waves of ECLS-K data, the Fall 1998 wave and Spring 1999 wave when children were kindergarteners. Because the sampling frame for ECLS-K involved a two-stage process (first schools were sampled, then a random sample of kindergarten children in those schools was drawn), the data structure is quite appropriate for school-effects studies using multilevel statistical methods.

Computer usage. We'll use the latest version of HLM for Windows in class. Students will have access to the software at on-site labs and through temporary copies of the program that can be downloaded onto their personal computers. Statistical software (e.g., SPSS and SAS) is available at many University of Michigan and University of Maryland computing sites. We use SPSS for labs and class handouts.

If you wish to purchase your own copy of the HLM software, the cost is about \$495, with modest additional charges for future upgrades. It is also possible to do a "trial-run" and rent HLM for specific periods of time. The HLM software is sold by Scientific Software Incorporated (SSI), 7383 N. Lincoln Avenue, Suite 100, Chicago, IL 60646. Telephone: (847) 657-2140. Fax: (847) 675-0720. Website: [www.ssicentral.com](http://www.ssicentral.com). Of course, it is strictly illegal to copy the software.

### ***Materials***

#### *A. Books:*

Raudenbush, S. W., & Bryk, A. S. (2002). Hierarchical Linear Models: Applications and Data Analysis Methods, 2<sup>nd</sup> Edition. Newbury Park, CA: Sage Publications. [Note: Most of the issues that we will cover are included in the first edition. While we recommend that you purchase the 2<sup>nd</sup> edition, you will probably be able to follow along if you already own the 1<sup>st</sup> edition.]

Raudenbush, S.W., Bryk, A., Cheong, Y.F., Congdon, R.T., & du Tort, M. (2011). HLM 7:

Hierarchical Linear and Nonlinear Modeling. Chicago, IL: Scientific Software International. [This is the handbook or users guide for the software we will use in class. It is only available online as a pdf file; it can be downloaded at the class website. It takes a little time to open so be patient.]

(Optional) O’Connell, A.A. and McCoach, D.B. (Eds.) (2008). Multilevel Modeling of Educational Data. Charlotte, N.C.: Information Age Publishing. (We will include two required chapters from this book in the course pack, but students may appreciate the readability of this edited volume and the additional topics that it covers.)

### *B. Course pack:*

The course pack is in two sections. Course pack A (required) includes all readings assigned in the course, whereas Course pack B (optional) includes additional readings on HLM that you may wish to refer to on your own during or after the course.

The readings listed below for each class should be read before the class meets. The readings that are not in the books listed above are available for students in Michigan (in Course pack A) from the Copy Center in the basement of ISR. A copy of both course packs is on reserve at the Helen Newberry House at the University of Michigan. If students at the University Maryland site are interested in getting a copy of either Course pack A or B, please contact Professor Croninger.

Policy on Readings. All required readings listed for the course are either in the books, Course Pack A, or on the C-Tools site at UM. Reading assignments in the HLM 7 manual are not listed in this syllabus. Students should become familiar with the manual very early in the course and to have read the relevant sections before each lab. You may also find it useful to keep an electronic copy of the manual on your laptop for lab sessions.

The class dataset is in two SPSS systems files (for children and schools). Students who wish to use SAS or STATA will need to convert these files. Depending on the statistical software students choose to use, we expect that they have access to the appropriate User's Guide or manual. Our labs include very little direct instruction in SPSS (and none in SAS or STATA). We assume that students gained good skills in statistical computing and general linear model techniques in previous courses and/or project work.

### *C. Websites*

There are numerous websites in Europe and the United States with lectures and training materials on multilevel models. We do not specifically recommend any of these sites, but you may want to explore some of them to see what is useful and available to you. We list a few here: the Scientific Software International website, a site at the University of Bristol (UK), another at the University of California Los Angeles, a site at the University of Michigan for Optimal Design, and a final site that accompanies the paper on probing interactions in multilevel models that is part of the required readings for the course.

[www.ssicentral.com](http://www.ssicentral.com). [There are FAQs and a number of “how-to” postings.]

<http://www.cmm.bristol.ac.uk/learning-training/> [Some video lectures and examples, mostly associated with MLwiN; follow some of the links to find lists of publications, recommended textbooks, and how to join a multilevel discussion group.]

<http://www.ats.ucla.edu/stat/> [No videos about HLM but examples and datasets from some of the major textbooks. Some good videos of lectures about other techniques and SPSS, too.]

<http://sitemaker.umich.edu/group-based/optimal%20design%20software> [Optimal design, web-based resources for doing power analyses using multilevel models.]

<http://people.ku.edu/%7Epreacher/interact/index.html> [This site accompanies the paper by Preacher, Curran and Bauer about probing interaction effects in multilevel models.]

### *Schedule*

The pace of the course is fast. Each week includes an assignment that involves posing a multilevel research question, data manipulation, computing, interpreting, and writing. We expect all students (credit or no-credit) to complete three assignments and a final project, due at the end of each of the four weeks. The assignments build on one another, becoming progressively more complex. Because of the fast pace, we discourage requests for extensions on assignments. It is important that students practice the skills covered in lab and master them promptly, as knowledge is cumulative. The major time spent on the course is at the computer, particularly in the first two weeks. The usual schedule has lectures on Monday, Wednesday, and Thursday, labs on Tuesday and Friday, 10:30 – 12:30. Because the first full class falls on Tuesday (June 7, 2011), the first week's labs are on Wednesday and Friday, with the first assignment due on Friday.

The topics and reading assignments listed for each class are approximate, based on the pace we think we will follow and reflecting the order of topics covered class by class. Although the progression will be the same as listed in the syllabus, the days on which each topic is covered depends, to some extent, on how the course progresses. Assignment deadlines will not change, however.

The final project and its presentation represent the culminating experience of the course. Format for the project should resemble articles from scholarly journals in the course pack -- discussion of the problem and some theory, discussion of method, presentation of results, and discussion of the substantive meaning of the findings. You need not conduct a literature review on your chosen topic; but if you have knowledge of relevant literature, feel free to cite it.

We expect that students read the assigned readings for each class before the class meets. Some of the readings for the course are quite technical, and you may find them difficult to fully understand. Some students have found it useful to revisit the more complex readings after the lecture, concentrating on the particular issues covered in the class.

We encourage students to work in pairs, although it is possible to work alone. In past years, many students have told us that the collegiality of working with a partner greatly enhanced their experience in this class. Because research out of class settings is almost always collegial, we have found that two minds focused on something new often produce more than the sum of the parts.

## PART I: WHY DO WE NEED MULTILEVEL MODELS?

Monday, June 6: **Summer Program Orientation** at the University of Michigan starts at 9:00 am. Non-UM students should go to the 6<sup>th</sup> floor of ISR. University of Maryland students should go to Room 2208 in Lefrak Hall at the normal meeting time (10:30 am).

Tuesday, June 7: **Introduction to the multilevel approach.** The first two readings are excellent examples of early arguments about the unit of analysis problem and the way it shapes our theories and results.

Burstein, L. and Miller, M.D. (1981). Regression-based analyses of multilevel educational data. In R.F. Borusch, P.M. Wortman, D.S. Corday, and Associates. Reanalyzing Program Evaluations. San Francisco: Jossey-Bass.

Haney, W. (1980). Units and levels of analysis in large-scale evaluation. In New Directions for Methodology of Social and Behavioral Science, 6, 1-15.

Read also pages in Course pack A that describe the Early Childhood Longitudinal Study - Kindergarten Cohort. These are from the Electronic Codebook on the ECLS-K CD.

You may also find it useful to go to the NCES website ([www.nces.ed.gov](http://www.nces.ed.gov)), click on "Reports," and ask for NCES 2000-070. This is a report entitled, "America's Kindergarteners," and it provides considerable information about the full sample from the ECLS-K. This may be downloaded free from the Internet.

Wednesday, June 8: **Lab.** Introduction to computing facilities at each location and distribution of class data files and HLM for Windows software. Accessing raw and systems data with HLM. Missing data. Investigating a two-level data structure for a dependent variable. Specifying the fully unconditional model and calculating the intraclass correlation. *[Please review the assignment for Friday, June 10, so that you can be working toward its completion.]*

Thursday, June 9: **School effects, units of analysis, and an overview of Hierarchical Linear Models.** The Bidwell and Kasarda article is one of the few articles to argue that our methods determine (in this case, limit) our theories about educational phenomena; it also demonstrates the empirical consequences of privileging one unit of analysis over another.

Bidwell, C.E. and Kasarda, J.D. (1980). Conceptualizing and measuring the effects of school and schooling. American Journal of Education, 88, 401-430.

Read Chapters 1 & 2 Raudenbush and Bryk (2002). Hierarchical Linear Models: Applications and Data Analysis Methods, 2<sup>nd</sup> Edition. This book will hereafter be referred as R & B.

Friday June 10: **Lab.** Continuation of Wednesday's lab. **Assignment #1 due:** Select a simple multilevel research question that can be addressed with the ECLS-K data. Select a single dependent variable, a few child-level and a few school-level variables that will be helpful in exploring this question. Construct a multivariate data matrix (MDM) that uses these variables, making sure that you specify an appropriate weight. Compute the intraclass correlation (ICC) for your outcome. In a brief write-up, specify an appropriate research question, a description of variables, and a rationale for your choices. State and interpret

the meaning of the ICC. Include a cover page that has a substantive title, your name, course, and date. Attach a copy of the statistics file for the MDM and the output for the fully unspecified model. Hand the assignment in at the end of lab

Student hoping to use their own data for this class will be required to complete Assignment 1 with both the class ECLS-K data and their own data (i.e., two Assignment 1's). We suggest that the ECLS-K assignment be completed first and turned in on Friday; personal data second (and turned in by Monday, June 13)

## **PART II: THE WITHIN-GROUP HLM MODEL**

Monday, June 13: **Logic of hierarchical linear models.** The Paterson and Arnold readings are meant to provide a general overview of the logic of multilevel models. You will find some inconsistencies in these readings due to their relatively early understanding of multilevel models; nonetheless, these readings are relatively straightforward and useful explanations of multilevel models.

Paterson, L. (1991). An introduction to multilevel modeling. In S. W. Raudenbush and J. D. Willms (Eds.), Schools, classrooms, and pupils. San Diego: Academic Press.

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

Review Chapter 2 of R & B.

Tuesday, June 14: **Lab.** Creating within-group models in HLM. Random v. fixed effects. Centering options. Interpretation of HLM output.

Wednesday, June 15: **Overview of statistical estimation.** These readings continue to provide an overview of multilevel modeling, including its use to estimate school effects. The last reading addresses centering level-1 predictors specifically, an issue that has generated much misunderstanding and confusion.

Read Chapters 3 and 4 of R & B.

Cohen, P., Cohen, J., West, S. G., Aiken, L. S. (2002). Random coefficient regression and multilevel models. In Applied Multiple Regression/Correlational Analysis for the Behavioral Sciences (Chapter 14, pp. 536-567). Mahwah, NJ: Lawrence Erlbaum.

Raudenbush, S. W. & Willms, J. D. (1995). The estimation of school effects. Journal of Educational and Behavioral Statistics, 20 (4), 307-337.

Enders, C. K., & Tofigi, D. (2007). Centering predictor variables in cross-sectional multilevel models: A new look at an old issue. Psychological Methods, 12 (2), 121-138.

### PART III: THE BETWEEN-GROUP HLM MODEL

Thursday, June 16: **Application of HLM to research on organizational effects.** The Lee and Bryk article was written as an early primer for those interested in using multilevel modeling to estimate schools effects; the Rowan and colleagues articles is an interesting exploration of using aggregate measures to model different organizational designs.

Read Chapter 5 of R & B.

Lee, V.E. and Bryk, A.S. (1989). A multilevel model of the social distribution of high school achievement. Sociology of Education, 62(2), 172-192.

Rowan, B., Raudenbush, S.W., and Kang, S.J. (1991). Organizational design in high schools: A multivariate analysis. American Journal of Education, 99(2), 238-266.

Friday, June 17: **Lab.** Continuation of Tuesday's lab. **Assignment #2 due:** Within-group HLM data analysis and write-up. Include at least 3 independent variables in the within-group model. Between-group model should be unconditional. You should write up what you have done, along with the substantive meaning and interpretation of results. Be sure to discuss possible second-stage outcomes (what does the output tell you about possible outcomes at level 2?). Again, please put a cover page on this assignment, with a title, your name, and the date. We prefer that you make and number tables (or read the HLM output into your text), and refer to tables or output in your write-up. If you choose to include HLM output instead of making tables, then you should edit it down to include only the meaningful output. Please turn in Assignment #2 to your TA in the Friday lab. *[You should be thinking about your final project and what data you will use. Please review the assignment and prospectus due at the end of next week.]*

Monday, June 20: **Example of HLM application using ECLS-K data.** The Lee and colleagues reading provides an example of a multilevel model using the same dataset (though more complete) that you are using for the class. The Preacher and colleagues reading discusses how to examine interactions. Check the website that goes with this article, <http://people.ku.edu/%7Epreacher/interact/index.html>.

Lee, V. E., Burkam, Ready, D. D., Honigman, J.J., & Meisels, S. J. (2006). Full-day vs. half-day kindergarten: In which program do children learn more? American Journal of Education. 112(1), 163-208. A more extensive set of appendices & technical information is available on the journal's website.

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 (3), 437-448.

Tuesday, June 21: **Lab.** Constructing the two-level HLM model. Modeling intercepts and slopes. More on fixed and random effects. Interpretation of HLM output. Graphing HLM results.

Wednesday, June 22: **More applications of organizational effects models; Model specification: Centering; random and fixed effects.** We will review another school effects articles, and then focus on a review of what we have learned so far in the class. Review as many of the additional readings as possible; they cover a range of related

topics, such as how to estimate model fit, power analysis, and a review of the uses and misuses of multilevel modeling in education research.

Read Chapter 9 R & B.

Rice, J. K., Croninger, R. G., & Roellke, C. (2002) The effect of block scheduling high school mathematics courses on student achievement and teacher's use of time: Implications for educational productivity. Economics of Education Review, 21, 599-607.

McCoach, D.B. and Black, A.C. (2008). Evaluation of model fit and adequacy. In A.A. O'Connell and A.C. Black (Eds.) Multilevel Modeling of Educational Data (Chapter 7). Charlotte, NC: Information Age Press.

Spybrook, J. (2008). Power, sample size, and design. In A.A. O'Connell and A.C. Black (Eds.) Multilevel Modeling of Educational Data (Chapter 8). Charlotte, NC: Information Age Press.

Dedrick, R. F. et al. (2009) Multilevel modeling: A review of methodological issues and applications. Review of Educational Research, 79 (1), 69-102.

#### **PART IV: OTHER APPLICATIONS OF MULTILEVEL MODELS**

Thursday, June 23: **Introduction to the study of change.** We now look at nesting within individuals and growth curve modeling. Although not required for this class, one of the best texts on modeling change and event occurrence over time is: Singer, J. D., & Willett, J. B. (2003). Applied longitudinal analysis: Modeling change and event occurrence. New York: Oxford University Press. If growth curve modeling interests you, this is the text to purchase.

Read Chapter 6 of R & B.

Willett, J.B. (1994). Measuring change more efficiently by modeling individual growth over time. In T. Husen & T.N. Postlethwaite (Eds.) The International Encyclopedia of Education, 2<sup>nd</sup> Edition. Oxford, UK: Pergamon Press.

Friday, June 24: **Lab.** Refining the 2-level HLM models. More on centering, level-1 and level-2 specification, and interpretation of HLM output.

**Assignment #3 due:** Prepare and write up an HLM that includes no more than 3 significant group-level predictors. You should model the intercept, and if possible (and you can find a slope that varies between schools) try modeling one slope as an outcome. Be sure you understand the meaning of the effects of group predictors on slopes, and describe this in your write-up. You may work individually or in pairs. It is a good idea to think of this assignment as a test run for your final project idea. Form of write-up should follow description for Assignment #2. Please turn both in to your TA in the Friday lab.

**Also Due:** One-page prospectus of plan for final project. Include research question, data, and some description of HLM usage. Projects may be done in pairs or individually. Try to discuss this idea with faculty or one of the TAs beforehand, to make sure idea is appropriate for HLM and feasible within the timeframe and your expertise. Using your

own data is encouraged, if you have some and it is appropriate for HLM analysis. Please turn in the final project prospectus with Assignment #3.

Monday, June 27: **Application of HLM to studying change or growth.** These are two early demonstrations of growth curve modeling and the logic of modeling change.

Bryk, A.S. & Raudenbush, S.W. (1987). Application of hierarchical linear models to assessing change. Psychological Bulletin, 101(1), 147-158.

Huttenlocher et al. (1991). Early vocabulary growth: Relation to language input and gender. Developmental Psychology, 27(2), 236-248.

Tuesday, June 28: **Lab.** Growth curve modeling with HLM. Organizing data for modeling growth in HLM. Linear and non-linear terms. Interpretation of HLM output.

Wednesday, June 29: **Advanced applications of multilevel models: Dichotomous outcomes.**

So far we've looked at only continuous, dependent variables using HLM. But what if you want to investigate a binary or dichotomous outcome? We will discuss some special circumstances associated with multilevel modeling of a binary outcome and hierarchical generalized linear models (HGLM) as a solution. Read chapter 8 in R & B and the Lee and Burkham article (an example used in the lecture). The other articles are optional but will provide additional background on using HGLM with limited continuous measures. They are on the website.

Read Chapter 8 of R & B.

Lee, V. E., & Burkam, D. T. (2003). Dropping out of high school: The role of school organization and structure. American Educational Research Journal, 40(2), 353-393, (In Course pack A).

Optional: Osgood, D.W., Wilson, J.K., O'Malley, P.M., Bachman, J.G., & Johnston, L.D. (1996). Routine activities and individual deviant behaviors. American Sociological Review, 61, 635-655. This article investigates several dichotomous outcomes, but also includes the study of change.

Rumberger, R.W. (1995). Dropping out of middle school: A multi-level analysis of students and schools. American Educational Research Journal, 32(2), 583-625. (In Course pack B)

## **PART V: STUDENT PRESENTATIONS**

Note: The days required for presenting final projects depend on the course enrollment and how many students choose to work jointly. We have scheduled two days, based on previous years' enrollment. We expect that all students are present on both the day they present and the day they are in the audience. Presentations will occur at each location without the video link. Students should provide abstracts of their projects to the TAs 24 hours in advance to be made available at the other location.

Thursday, June 30: **Presentation of final projects for Group I.**

**Assignment #4 due:** Final paper due for Group I. This is a final write-up of your work for the class, which may be an expansion of your work for Assignment 3. If you use citations to support the theory on which your work rests, please use APA or ASA format, and include all citations. Cite course readings as appropriate. Presentation and paper should include tables and graphs as appropriate.

Friday, July 1: **Presentation of final projects for Group II.** Final paper due for Group II. See description above. The optional readings compare different software packages and may be of interest to you. They are on the website.

Optional readings: De Leeuw, J., & Kreff I. G. G. (no date). Software for multilevel analysis.

Roberts, J. K., & McLeod, P. (2008). Software options for multilevel models. In A.A. O'Connell and A.C. Black (Eds.) Multilevel Modeling of Educational Data (Chapter 12). Charlotte, NC: Information Age Press.

Zhou, X-H., Perkins, A.J., & Hui, S. L. (1999). Comparison of software programs for general linear multilevel models. The American Statistician, 53 (3), 282-290.

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