UNIVERSITY OF VICTORIA
DEPARTMENT OF PSYCHOLOGY

PSYC 537 (A01)
Multilevel Modeling

Spring 2022 (Jan 10 – April 7, 2022)

Time: Mondays 13:00-15:50
Room: Online via Zoom (Meeting ID: 859 4377 6540; Password: 064231)
In Person (Clearihue A108)

Instructor: Stuart MacDonald, PhD
Office Hours: Following class,
or by appointment
Office: Cornett A261
Phone: (250) 472-5297
E-mail: smacd@uvic.ca

TERRITORY ACKNOWLEDGEMENT

We acknowledge and respect the lək̓ʷəŋən peoples on whose traditional territory the university stands and the Songhees, Esquimalt, and WSÁNEĆ peoples whose historical relationships with the land continue to this day.

COURSE DESCRIPTION

This graduate course is designed to introduce you to the concepts and practical application of multilevel models for nested data structures, including both cross-sectional and longitudinal data. Hierarchical or nested data structures are very common in numerous fields. Examples of data hierarchies where lower (micro) levels of analysis are nested within higher (macro) levels include students nested within schools, as well as repeated measurements nested within persons. Regardless of the type of nesting, multilevel modeling software facilitates the simultaneous analysis of associations within (and across) each hierarchical level. Core topics to be covered will include (a) an introduction to multilevel equations as well as the central importance of multilevel models and when they should be employed, (b) a focus on examples of nested data structures including definitions and methods for measuring change, and (c) the application of multilevel models (aka hierarchical linear models or HLMs) for assessing associations at both the micro and macro levels, as well as cross-level interactions between variables measured at different levels of the nested data hierarchy. A central feature of the course will be to provide you with a conceptual and practical understanding of multilevel models and the HLM 7 and R software packages (as well as Mplus or SPSS to a lesser extent) so that you can compute analyses and interpret results from your own data. To maximize learning, as we proceed through the course topics, you should consider how each theme applies to your own data and research interests. Methodological advances have made multilevel models essential statistical tools for research in Psychology and many related fields – I regularly employ such models in my research (e.g., patients within care contexts or provinces, repeated assessments within individuals) and anticipate many rewarding discussions with each of you in the coming term.

COURSE PREREQUISITES

The official prerequisite for this course is PSYC 532 (GLM: Univariate). Students from other Departments (e.g., Educational Psychology and Leadership Studies, Sociology, Exercise Science, etc) regularly take this course. If you have limited experience with topics covered in PSYC 532, please contact me to discuss your
background. I would be happy to provide suggestions for supplementary reading material that will prepare you for concepts and topics that we will discuss in class. The focus of PSYC 537 concerns the conceptual understanding and application of analyses for nested data structures (rather than detailed comprehension of the underlying mathematics). Class participation and successful completion of the course assignments presupposes fundamental knowledge of multiple regression.

### COURSE FORMAT AND LEARNING GOALS

This advanced graduate course on multilevel modeling is specifically designed to promote learning through lecture, practical application, dialogue, and sharing of ideas. Our regular meetings will integrate conceptual learning with practical application. We will hold in-depth discussion of issues (e.g., definitions, methodological approaches and problems, how to prepare data and use software, etc), with each day’s theme building successively on content from previous days/lectures. Although this is a course on novel statistical procedures that requires some lecturing, the success of the course is predicated upon our lively exchanges. I invite each of you to participate in virtual group discussions to your fullest extent and to ask questions about specific procedures based on examples from your research area or personal data sets -- your perspective is important to the collective learning experience! As detailed in the evaluation section of the syllabus, opportunities will be provided to further enhance both your written and spoken skills.

In my capacity as a guide to your learning, I am committed to you achieving the following learning outcomes:

1. Obtain a basic understanding of why multilevel models are essential for analyzing nested data

2. Introduce key concepts and equations for multilevel models to facilitate a fundamental understanding of:
   a. level 1 or micro HLM models (e.g., the description of individual trajectories of change)
   b. level 2 or macro HLM models (e.g., how between-person differences moderate within-person change)

3. Apply practical knowledge in management and analysis of nested data using HLM and R software packages (and Mplus or SPSS to a lesser extent). *If possible, this objective will be fulfilled using your own nested (cross-sectional or longitudinal) data.*

4. Enhance your communication skills (e.g., share ideas, hone presentation skills, respond to questions) and confidence when speaking among your peers

5. Refine your scientific writing by creating (a) a *Methods* section that summarizes your population, measures, and the statistical method employed, and (b) a *Results* section that summarizes findings from your multilevel analyses. In completing these manuscript sections, please adhere to APA style (according to the 7th edition of the APA publication manual).

### ACADEMIC EXPECTATIONS

Your contributions to class discussions and completion of laboratory assignments are required to achieve the learning outcomes. Thus, I expect you to attend class. Should circumstances prevent your attendance, please inform me (in advance if possible). If you are unable to submit the final written assignment on the specified date, you should apply to the Dean of Graduate Studies for permission to receive a grade of INC (Incomplete).

You are expected to abide by the University’s policy on plagiarism and cheating (*see last 2 pages*).
COURSE REGISTRATION

You are personally responsible for checking your registration status before the end of the course-add period (Wednesday, January 26, 2022). Please verify and confirm your registration status as, according to University policy, I am unable to facilitate a course addition after this date even if you have been attending class. Also note that Monday, February 28, 2022 is the last day for officially withdrawing without academic penalty. University policy states that failing to attend lectures does not constitute official withdrawal.

EVALUATION

Evaluation of your progress toward the course objectives will be based upon several graded requirements including: (a) class participation (regular contributions to discussions, practical application of methods), (b) presentation of research findings, (c) two assignments based on level 1 (e.g., within-person change) and level 2 (e.g., between-person differences in within-person change) models, and (d) a written Method and Results section summarizing your findings. The expectations and rationale for each are briefly outlined below (see corresponding letters).

(a) Virtual Class Participation
An in-depth understanding of assigned readings prior to class is essential. Your personal observations, comments, and questions on the weekly readings will facilitate learning for the entire group. Regular class attendance is also essential as conceptual discussions and practical application of the methods using HLM (and other software) will be done concurrently. In evaluating your class participation, I will take into account your attendance (virtual or in person) and level of participation in class (e.g., poses and answers questions, regularly attempts and completes exercises, builds on others’ views).

(b) Class Presentation of Research Findings
Near the end of term, you will be asked to give a presentation that summarizes key findings from your data based on analyses conducted in class and/or for the assignments. During the second week of class, each individual will have an opportunity to finalize her/his presentation date. Each student is expected to make a 20-minute presentation that outlines research area, associated hypotheses, study population, measures, statistical models, key findings, and implications of the results. The goal is to apply and explain techniques learned in class, while at the same time simulating a research talk at a conference. The ensuing discussion should take another 5 minutes. View this as an opportunity to get invaluable feedback on your research questions and findings, how you might tweak your statistical models, etc. Feel free to (a) use questions raised by peers as well as your own critical questions to facilitate group discussion, (b) to employ strategies that ensure lively group discussion, and (c) to guide and moderate the discussion as required. This assignment is intended to promote your spoken communication skills. Evaluation of individual presentations will be based on the ability to identify and present key findings from your analyses, as well as your comprehension and ability to explain the techniques employed.

(c) Practical Assignments
Multilevel models employ data at two hierarchical levels of analysis: (1) level 1 or micro level data (e.g., performance scores for individuals within contexts, individual change over time in performance), and (2) level 2 or macro level data (e.g., information pertaining to the context rather than the individual, or variables that are constant across time such as sex). To facilitate pedagogical demonstration of multilevel modeling, lectures will initially focus on level 1 models (representing within-person or individual level effects), followed in subsequent lectures by level 2 models (representing between-person or context-level effects). A brief written assignment
(4-5 pages) will be associated with each type of model. Both assignments require the creation of an outline/brief summary that includes your research questions/hypotheses and associated HLM equation(s), the computation of statistical analyses using HLM (or other software), an abridged version of your output file from these analyses, your brief interpretation of the output, and an example table or figure that concisely summarizes your findings.

The purpose of these assignments is twofold: (a) to have you gain experience in using HLM and in identifying key findings, and (b) to facilitate early progress on your final written assignment due on THURSDAY, APRIL 14, 2022 thereby reducing demands on your time during the busy end-of-term period. The outlines/brief summaries are intended to emulate the planning and reflection required to produce effective scientific writing. Performance will be evaluated on (a) the appropriate use of the statistical models (relative to your research questions), (b) identification and explanation of key findings, and (c) implications of your results.

Ideally, these two assignments as well as the final assignment will be completed using your own multilevel data (cross-sectional or longitudinal) such as those collected for your master’s or dissertation project, or from a collaboration with your supervisor. Doing so will be advantageous for your retention of the material (i.e., applying multilevel models to data you already understand), and will promote scientific efficiency (you could complete a method and results section and get published!). For longitudinal data sets, 3 or more measurement occasions are preferable (note that missing data are fine). Please let me know during the first few classes whether it is possible for you to bring your own multilevel data. If not, I will seek suitable data for you.

The level-1 assignment is due on MONDAY, FEBRUARY 28, 2022, with the level-2 assignment due on MONDAY, MARCH 21, 2022. Pending progress in lectures, these due dates may be moved back.

(d) Final Written Assignment: Method and Results Section
For your major writing assignment, I would like you to create a manuscript-length Method and Results section based on your own personal data, research questions, and analyses throughout the course. Please note that the short outline assignments (see section c) can be easily adapted into a polished results section, with your remaining task to create a method section summarizing your sample, measures, and the statistical method (with a number of these details already compiled for your oral presentation!). The focus is on the Method and Results, as this course concerns learning and applying multilevel modeling techniques for hierarchical data. However, contextually speaking, it would be useful for me if you also included: (a) a brief introduction that summarizes the research area (in 1-2 paragraphs) and your hypotheses (in a 3rd paragraph), as well as (b) a brief discussion that highlights the key findings and their associated implications (in no more than 3 paragraphs).

The method and results sections should provide a detailed summary typical of articles published in APA journals (e.g., Psychology & Aging, Developmental Psychology). Detailed method subsections that I would like to see include: (a) participants, (b) measures, (c) and procedures such as data preparation and statistical analysis (including a description of multilevel models and inclusion of specific multilevel (MLM) equations from your study). Please consult the APA manual for formatting details (e.g., levels of headings, etc.). The results section should summarize all key findings relevant to your research questions (feel free to create and refer to relevant tables and figures). The review must be typed with citations referenced using APA style. The combined length of the method and results sections should be no more than 15 double-spaced pages, excluding references, figures, and tables. Please do not attempt to write the most comprehensive Method and Results sections known to humankind! Evaluation will not be based on number of words, but rather on your: (a) ability to summarize the most pertinent information in the Method (e.g., sample, measures, statistical method/summary of multilevel modeling) and Results (e.g., overview of key findings specific to your research questions,
significance of level-1 vs. level-2 predictors, etc.) sections, (b) capacity for critical thinking and novelty, and (c) writing, attention to detail, and adherence to APA style.

Finally, as each of you will have very different research questions and will thus employ different models, I have refrained from recommending any single example in the published literature for you to consult regarding content and formatting for this assignment. As the term unfolds and I familiarize myself with your data/questions, feel free to consult me for specific examples of published articles that are closely tailored to your own project. These articles can serve as templates as you work on your final assignment.

**Your final written assignment is due on THURSDAY, APRIL 14, 2022.**

**Grading**
I have purposely employed several forms of evaluation in recognition that each of you has individual learning styles. Your grade for the course will be based on both written and spoken contributions, providing you the best opportunity to demonstrate your many abilities. Further, to minimize anxiety associated with individual projects that count toward a large percentage of your grade, I have specifically chosen to parse evaluation into smaller components. Your workload should not increase, but rather be more evenly dispersed across the term.

1. Class participation/discussion = 10%
2. Presentation of research findings = 30%
3. Written assignment 1 = 10%
4. Written assignment 2 = 10%
5. Final written assignment using APA style = 40%

Graded course requirements will be weighted and aggregated to yield a percentage score. The final letter grade in the course will be based on total percent score rounded up at values of .5 or greater (e.g., 89.5 will be rounded up to 90, but 89.4 will not). Final grades will be assigned according to the following scale: 90-100% = A+; 85-89 = A; 80-84 = A-; 77-79 = B+; 73-76 = B; 70-72 = B-; 65-69 = C+; 60-64 = C; 50-59 = D; 0-49 = F.

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<tr>
<th>WEEKLY TOPICS AND ASSIGNED READINGS</th>
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There is no required textbook for this class. In lieu, I carefully selected chapters and articles that outline a given week’s theme (e.g., basic concepts of hierarchical linear modeling, definitions of change, etc.) and that set the stage for group discussions, practical demonstrations, assignments, and presentations. For select topics, I have included representative data/articles from my own research that will inform some of the practical lab exercises. Please note that this is a tentative reading list that will likely evolve pending your individual data sets and research interests. Each article identified below represents a core reading for a given topic/theme that I may supplement with additional suggested readings.

**Readings**
The required readings will consist of selected chapters and articles. These articles are available online through the UVic library website.
JANUARY 10
First Meeting

Why a course on multilevel modeling?
Getting to know you
Brief overview of syllabus and course objectives, and discussion of individual data sets

JANUARY 17
Detailed Introduction to the Course

In-depth discussion of syllabus and assignments
Graphical depiction of multilevel models: introducing the basic equation
Basic questions of developmental science: on the issue of change


JANUARY 24
History of Change Analyses

Difference scores, residual change scores, repeated-measures analysis of variance (RMANOVA), and slopes-as-outcomes models


JANUARY 31
From RMANOVA to Multilevel Models

The impact of clustered data/correlated observations across time or context
Key features of the investigation of change
What are the relative advantages of multilevel models and when should I use them?
Screening, preprocessing, and structuring your data
**Basic equations and terminology (fixed and random effects, etc.)**


**FEBRUARY 7**

**Multilevel Modeling: Level 1 Models**

*Basic equations and terminology continued (fixed and random effects, etc.)*

*Model assumptions*

*Maximum likelihood, missing data, and borrowing strength*

*Fully unconditioned models and intraclass correlation coefficient*

*Using HLM: Illustration and practice with sample data*


**FEBRUARY 14**

**Multilevel Modeling: Level 1 Models (continued)**

*Centering level 1 predictors*

*Alternative metrics for time (e.g., time in study vs. time as age vs. time as process)*

*Comparing nested and non-nested models for evaluating model fit*

*Class time to work on assignment 1 (due Monday, Feb 28th)*


**FEBRUARY 21**
No Class (Family Day/Reading Break)

**FEBRUARY 28**
Multilevel Modeling: Level 2 Models

*Adding between-subject or context-level predictors to the level 1 models*

*Evaluating model fit (deviance statistic, Wald statistic)*

*Using HLM: Running and interpreting models with level 1 and level 2 predictors*


**Please note that assignment 1 (level 1 model) is due today, Monday, Feb 28 (10%).**

**MARCH 7**
Multilevel Modeling: Level 2 Models (continued)

*Centering level 2 predictors*

*Computing the percentage of between- and within-person variance accounted for*

*Discussion of an example from the literature*

*Class time to work on assignment 2 (due Wednesday, March 21st)*


**MARCH 14**

Multilevel Modeling Using Other Software Programs

*Running multilevel models in SPSS or Mplus*

*Class time to work on assignment 2*

*Individual consultations*

**Please note that assignment 2 (level 2 model) is due Monday, March 21st (10%)**

**MARCH 21**

Class Presentations (30%)

*Up to 5 student-based presentations and associated discussion will be held on this day.*

*Individual consultations and class time to work on final assignment (due Thursday, April 14th).*

Some Additional Topics in Multilevel Modeling (*time permitting*)

*Statistical power and sample size for multilevel models*

*Multilevel Structural Equation Modeling (MSEM)*

*Piecewise and change point models*

*Advanced topics in multilevel modeling (generalized linear models for categorical outcomes, latent growth curve modeling)*


**Please note that assignment 2 (level 2 model) is due today, Monday, Mar 21 (10%).**

### MARCH 28

**Class Presentations (30%)**

Up to 5 student-based presentations and associated discussion will be held on this day. Individual consultations and class time to work on final assignment *(due Thursday, April 14th).*

### APRIL 4

**Class Presentations (30%)**

Up to 5 student-based presentations and associated discussion will be held on this day. Individual consultations and class time to work on final assignment *(due Thursday, April 14th).*

**Please note that this is our final class (Thursday, April 7th is the last day of classes for the Spring 2022 term).**

### THURSDAY, APRIL 14

**Please note that your final assignment *(Method and Results sections)* is due today (40%). Please feel free to send your assignment to me via email *(smaed@uvic.ca)* as an attachment *(ideally in MS Word).*

**The above schedule, course policies, and assignments are subject to change**
UNIVERSITY OF VICTORIA
Department of Psychology

Important Course Policy Information
Spring 2022

Commitment to Inclusivity and Diversity

The University of Victoria is committed to promoting, providing and protecting a positive and supportive and safe learning and working environment for all its members.

Policy on Academic Integrity including Plagiarism and Cheating

The Department of Psychology fully endorses and intends to enforce rigorously the Senate Policy on Academic integrity https://www.uvic.ca/calendar/future/undergrad/#/policy/Sk_0xsM_V7bc=true&bcCurrent=08%20-%20Policy%20on%20Academic%20Integrity&bcGroup=Undergraduate%20Academic%20Regulations&bcItemType=policies. It is of utmost importance that students who do their work honestly be protected from those who do not. Because this policy is in place to ensure that students carry out and benefit from the learning activities assigned in each course, it is expected that students will cooperate in its implementation.

The offences defined by the policy can be summarized briefly as follows:

1. **Plagiarism.** You must make sure that the work you submit is your work and not someone else’s. There are proper procedures for citing the works of others. The student is responsible for being aware of and using these procedures.

2. **Unauthorized Use of an Editor.** The use of an editor is prohibited unless the instructor grants explicit written authorization.

3. **Multiple Submission.** Only under exceptional circumstances may a work submitted to fulfill an academic requirement be used to satisfy another similar requirement. The student is responsible for clarifying this with the instructor(s) involved.

4. **Falsifying Materials Subject to Academic Evaluation.** This includes falsification of data, use of commercially prepared essays, using information from the Internet without proper citation, citing sources from which material is not actually obtained, etc.

5. **Cheating on Assignments, Tests, and Examinations.** You may not copy the work of others in or out of class; you may not give your work to others for the purpose of copying; you may not use unauthorized material or equipment during examinations or tests; and you may not impersonate or allow yourself to be impersonated by another at an examination. The Department of Psychology has a policy of not making old examinations available for study purposes. Therefore, use of old exams without the express written permission of the instructor constitutes cheating by the user, and abetting of cheating by the person who provided the exam.

6. **Aiding Others to Cheat.** It is a violation to help others or attempt to help others to engage in any of the conduct described above.
Instructors are expected to make every effort to prevent cheating and plagiarism. This may include the assignment of seating for examinations, asking students to move during examinations, requests to see student identification cards, and other measures as appropriate. Instructors also have available to them a variety of tools and procedures to check for Internet and electronic media-based cheating. In instances of suspected or actual plagiarism or cheating, instructors, following prescribed procedures, are authorized to take steps consistent with the degree of the offence. These measures will range from a zero on the test or assignment or a failing grade for the course, probation within a program to temporary or even permanent suspension from the University.

Rights of Appeal are described in the Policy on Academic Integrity in the University calendar January 2021.

**The definitive source** for information on Academic Integrity is the University Calendar

**Other useful resources on Plagiarism and Cheating include:**

1. The Ombudsperson’s office: [https://uvicombudsperson.ca/tips/plagiarism/](https://uvicombudsperson.ca/tips/plagiarism/)
   - The **Office of the Ombudsperson** is an independent and impartial resource to assist with the fair resolution of student issues. A confidential consultation can help you understand your rights and responsibilities. The Ombudsperson can also clarify information, help navigate procedures, assist with problem-solving, facilitate communication, provide feedback on an appeal, investigate and make recommendations. Phone: 250-721-8357; Email: ombuddy@uvic.ca; Web: uvicombudsperson.ca.


**Wellness Statement**

**BE WELL**

A note to remind you to take care of yourself. Do your best to maintain a healthy lifestyle this semester by eating well, exercising, getting enough sleep and taking some time to relax. This will help you achieve your goals and cope with stress. All of us benefit from support during times of struggle. You are not alone.

**Discovering Victoria, UVic and your Community:**
Grad school can involve a lot of time studying and researching on your own – but it does not have to be an isolating experience. There are a lot of other grad students out there like you who are looking to connect outside of academics.

[www.uvic.ca/mentalhealth/graduate/connect/index.php](http://www.uvic.ca/mentalhealth/graduate/connect/index.php)

**Counselling Services:**
Counselling Services can help you make the most of your university experience. They offer free professional, confidential, inclusive support to currently registered UVic students.

[www.uvic.ca/services/counselling/](http://www.uvic.ca/services/counselling/)

**Health Services:**
University Health Services (UHS) provides a full service primary health clinic for students, and coordinates healthy student and campus initiatives. [www.uvic.ca/services/health/](http://www.uvic.ca/services/health/)

**Centre for Accessible Learning:**
The CAL staff are available by appointment to assess specific needs, provide referrals and arrange appropriate accommodations [www.uvic.ca/services/cal/](http://www.uvic.ca/services/cal/). The sooner you let us know your needs, the quicker we can assist you in achieving your learning goals in this course.

**Elders' Voices:**
The Office of Indigenous Academic and Community Engagement (IACE) has the privilege of assembling a group of Elders from local communities to guide students, staff, faculty and administration in Indigenous ways of knowing and being.

[www.uvic.ca/services/indigenous/students/programming/elders/](http://www.uvic.ca/services/indigenous/students/programming/elders/)

**Mental Health Supports and Services:**
Mental health supports and services are available to students from all areas of the UVic community:

[www.uvic.ca/mentalhealth/graduate/](http://www.uvic.ca/mentalhealth/graduate/)