Indiana University Bloomington

General Education Curriculum

Mathematical Modeling Course Proposal

Instructions

For each proposed course, please fill out this form, append a course syllabus, save the file, and send to the appropriate school academic officer (i.e., school/college official) by email as a PDF. The proposal file must be named according to the following convention:

Subject code <hyphen> letter prefix and course number <hyphen> GenEd category abbreviation.pdf

For example: MATH-M118-MM.pdf

Please be sure to complete **all five (5) pages** of the course proposal form.

The method for appending a file to a PDF varies depending your version of Adobe Acrobat or Adobe Reader. Please consult the instructions or help menu for your software. Do not attempt to use non-Adobe software to fill out this proposal form.

Note: Course proposals may not be submitted directly to the GenEd Committee by individuals or departments. All course proposals must be approved by the appropriate school, who will then forward the proposals to the GenEd Committee.

PART I: Course Information

Subject area (e.g., MATH-M): EDUC-N **Catalog number (e.g., 118):** 106 **Credit hours:** 3

Course title: The Mathematics of Learning: Modeling Data in Education and Our World

Generic/variable-title course: ☐ Yes ◉ No (If proposing a single topic of a generic course, please include topic title below.)

Topic title: _____

Bulletin description:

Introduces concepts and techniques to solve problems using mathematical modeling. Provides practice using data and computational environments to formulate and explore problems, develop models, draw inferences, and communicate results. Critically examines the role of models in education and areas of widespread interest such as health, climate science and popular media.

Proposal submitted by

Department or Program: Mathematics Education Program, Dept. of Curriculum & Instruction

School / College: School of Education **Date:** Nov. 1, 2022

PART II: GenEd Learning Outcomes

Mathematical Modeling courses provide rigorous instruction in fundamental mathematical concepts and skills presented in the context of real-world applications. The modeling skills provide analytical methods for approaching problems students encounter in their future endeavors.

Learning Outcomes

Students proficient in Mathematical Modeling should demonstrate the ability to

1. create mathematical models of empirical or theoretical phenomena in domains such as the physical, natural, or social sciences;
2. create variables and other abstractions to solve college-level mathematical problems in conjunction with previously-learned fundamental mathematical skills such as algebra;
3. draw inferences from models using college-level mathematical techniques including problem solving, quantitative reasoning, and exploration using multiple representations such as equations, tables, and graphs.

PART III: Learning Outcomes for the Proposed Course

Please list below the student learning outcomes for the proposed course as they appear in the course syllabus. Alignment with GenEd MM learning outcomes should be evident. (NB. Syllabi for GenEd-approved courses must include a clear statement of the learning outcomes for the course.)

Students who successfully complete this course will demonstrate the ability to:

1. create mathematical models (including graphical, algebraic, and statistical models) of empirical data drawn from education and areas of widespread interest such as health, climate science and popular media.
2. create variables and other abstractions to solve college-level mathematical problems building from previously learned fundamental mathematical skills such as algebra.
3. draw inferences from models using college-level mathematical techniques including problem solving, quantitative reasoning, and exploration using multiple representations such as equations, tables, and graphs.
4. communicate problem formulations and problem solutions with mathematical rigor and in ways that make sense to a wide audience.

PART IV: Alignment of Course Learning Outcomes with GenEd Learning Outcomes

IU Bloomington GenEd Student Learning Outcomes for This Course

Below, please explain how each of the GenEd MM learning outcomes is addressed in the proposed course (e.g., readings, assignments, etc.). To be approved as a GenEd Foundations course (EC or MM), a course must meet all of the corresponding GenEd learning outcomes.

1. Students proficient in Mathematical Modeling should demonstrate the ability to create mathematical models of empirical or theoretical phenomena in domains such as the physical, natural, or social sciences.

Students who successfully complete the Mathematics of Learning: Modeling Data course will have repeatedly demonstrated on problem sets and on exams the ability to begin with a problem and a data set from education or other areas of widespread interest such as health, climate science and popular media; formulate the problem; execute an appropriate problem-solving process that involves creating a graphical, algebraic, or statistical model; interpret the model to arrive at a solution to the problem; and communicate the solution in a way that would make sense to a wide audience. By doing this, students will demonstrate their ability to "create mathematical models of empirical or theoretical phenomena in domains such as the physical, natural, or social sciences."

2. Students proficient in Mathematical Modeling should demonstrate the ability to create variables and other abstractions to solve college-level mathematical problems in conjunction with previously-learned fundamental mathematical skills such as algebra.

Students who successfully complete the Mathematics of Learning: Modeling Data course will need to create variables, functions, and abstract relationships such as probabilities, correlations, and relative rates of change in order to solve the problems assigned on problem sets and on exams. The creation of graphical, algebraic, and statistical models from a data set builds on previously learned fundamental mathematical skills such as algebra. For example, the routine task in many problems of constructing an interpretable table of observed conditional probabilities from a matrix of count data requires algebraic reasoning.

3. Students proficient in Mathematical Modeling should demonstrate the ability to draw inferences from models using college-level mathematical techniques including problem solving, quantitative reasoning, and exploration using multiple representations such as equations, tables, and graphs.

Students who successfully complete the Mathematics of Learning: Modelling Data course will need to interpret and draw accurate inferences from graphical, algebraic, and statistical models of empirical data to draw conclusions about the relationships between variables. The problem-solving process routinely required for this course will often engage students in an initial exploration of the data using multiple graphical and tabular representations of the data and data statistics (e.g., counts, means, standard deviations). Once students have discovered and created a useful mathematical model for solving the problem, they will need to use quantitative reasoning to interpret the model. For example, in the first unit, students will create a faceted scatter plot to explore how a correlation between two variables is influenced by a categorical variable. Interpreting such a plot requires a nuanced quantitative argument. In the second unit, students will use quantitative reasoning to interpret linear regression models, for example, reasoning about the coefficient for a variable as the rate of change in outcome relative to the rate of change in the predictor. In the last unit, for example, students will reason about the relationship between models of observed data and analogous models of simulated data to argue whether the data indicates a relationship between variables that is unlikely to occur by chance. As these cases illustrate, students will repeatedly demonstrate "the ability to draw inferences from models using college-level mathematical techniques."

PART V: Course Characteristics

Mathematical Modeling Course Characteristics

Mathematical Modeling courses provide rigorous instruction in fundamental mathematical concepts and skills presented in the context of real-world applications. The modeling skills provide analytical methods for approaching problems students encounter in their future endeavors.

Course Characteristics

1. Mathematical modeling courses

- are mathematics courses that either are required for students in the natural and mathematical sciences or address problems through mathematical models;
- emphasize mathematical rigor and abstraction, fundamental mathematical skills, and college-level mathematical concepts and techniques; teach how to develop mathematical models and draw inferences from them;
- include a full semester or equivalent of frequent and regular assignments that provide practice in mathematical modeling and mathematical techniques. Problems providing modeling practice
    - are phrased with limited use of mathematical notation and symbols;
    - require a formulation step on the part of the student;
    - require college-level mathematical techniques leading from the formulation to the conclusion;
    - have a conclusion that involves discovery or interpretation.

2. Courses approved for the Mathematical Modeling requirement must demonstrate and provide a system for consistency in instruction and in assessment of student achievement.

3. Courses approved for the mathematical modeling requirement should engage students with mathematical concepts and techniques that prepare them for a variety of possible future courses and degrees.

4. A course used to satisfy the Mathematical Modeling Foundations requirement may not double-count toward the Breadth of Inquiry Natural and Mathematical Sciences requirement.

Please explain how the proposed course exhibits the MM course characteristics. If proposing a generic (i.e., variable title) course for blanket approval, please explain how all topics/variable titles of this course exhibit MM course characteristics.

1. The Mathematics of Learning: Modeling Data course address data-based problems through mathematical models.

The problem solutions require students to use mathematical abstractions such as variables and functions to create mathematically rigorous arguments about the meaning of data. Students are taught to create appropriate graphical, algebraic, and statistical models for data sets including a variety of combinations of numerical and categorical variables. The creation, application, and interpretation of these models relies on fundamental mathematical skills from algebra and college level mathematical concepts drawn from probability and statistics.

The Mathematics of Learning course includes frequent and regular modeling assignments. Biweekly tutorials are focused on teaching concepts and skills to solve problems in a computational environment, and biweekly problem sets allow students to demonstrate their mastery of concepts and skills. Both tutorials (which are designed to be low-stakes and educative) and problem sets (which are more high-stakes and evaluative) consistently provide practice using mathematical modeling to solve problems. The problems are all phrased with limited mathematical notation, require formulation on the part of the student, require college-level mathematical techniques and concepts to progress from formulation to the solution, and the solution requires discovery and interpretation. Typical problems for each unit are provided in an attachment.

2. The Mathematics of Learning: Modeling Data course will provide consistency in instruction and assessment of student learning through common lecture materials, readings, assignments, and by using rubric-based grading with instructor training and ongoing faculty supervision. All sections of the course will use the same lecture materials (slides, activities) and the same readings. Weekly reading checks implemented on Canvas with the Quick Check in-line question tool will use questions drawn from a common bank across sections. All assignments will be the same across sections, with equivalent versions of exams prepared each semester. Common rubrics will be used to grade problem solutions (cf., the rubrics used for open response questions on AP Calculus or AP Computer Science exams). Instructors will be trained on all rubrics together with an ongoing collection of cases that provide an example of student work, the official score, and the rationale for the score to support consistency in how the rubric is applied. A faculty member will supervise the course and meet with instructors regularly to adjudicate any borderline cases in grading and maintain consistency across all sections.

3. The Mathematics of Learning: Modeling Data course responds to the increasing availability and use of data in everyday life and across almost all professions by equipping students with skills to use data to make mathematically rigorous arguments and to evaluate and verify data-based arguments that others make. The mathematical concepts and techniques students will learn in the course will be broadly useful in any workplace that collects or uses data. Similarly, data is increasingly used in a wide number of degrees including but extending well beyond the courses or degrees in science, information technology, or mathematics with which it is historically associated. The skills and concepts taught in this course will be equally relevant and useful to students majoring in Community Health, Elementary Education, Epidemiology, Nursing, Psychology, or Social Work as it is to students pursuing degrees in Astronomy, Biotechnology, Cognitive Science, or Data Science.

4. The Mathematics of Learning: Modeling Data course does not count towards the Breadth of Inquiry Natural and Mathematical Sciences requirement.

PART VI: Course Syllabus

A course syllabus must be appended to this proposal. The syllabus should indicate a clear and consistent connection between the elements of the course—i.e., course description, learning objectives, course readings, assignments, and assessments—and the GenEd MM learning outcomes and course characteristics.

You may also provide annotations, sample assignments, or additional explanation further highlighting the alignment of the course with the GenEd learning outcomes and course characteristics.

If proposing a variable title course for blanket approval, please append syllabi for at least three topics.

Typical EDUC-N106 Problems

The problems used in N106 are all phrased with limited mathematical notation, require formulation on the part of the student, require college-level mathematical techniques and concepts to progress from formulation to the solution, and the solution requires discovery and/or interpretation.

Example Problem from Unit 1

> *In August 2021 Israeli public health data revealed that 60% of those hospitalized during the Delta COVID-19 surge were fully vaccinated. Some media reports argued this showed the vaccines were ineffective—or at least less than 90% effective as advertised. Do you agree? Use the Israeli data to explain.*

To solve this problem appropriately, students must articulate and support with a mathematical argument why the naïve interpretation seems reasonable when only considering vaccination status and hospitalization but ultimately is inaccurate and misleading once age is considered: older people were more likely to be vaccinated and more likely to be hospitalized. The formulation step requires students to discover age as an initially overlooked but essential variable. The modeling to support the solution could be graphical and rely on quantitative reasoning, or algebraic/statistical using observed probabilities. Students must use fundamental mathematical skills to move from the data to either of these models. This problem and its solution illustrate the college level statistical concept of Simpson's paradox: a relationship disappears or even reverses when you control for other factors.

Example Problem from Unit 2

> *Model the college admission data and determine whether high school GPA or SAT scores are better predictors of first year college GPA. Explain your conclusion and rationale using everyday language.*

To solve this problem appropriately, students must create and compare two linear regression models using, for example, the college level statistical concepts of R^2 or root mean squared error (RMSE). The formulation step involves deciding how to compare the predictive value of two linear models. To achieve full credit, they must be able to move beyond numerical comparison (e.g., R^2 for one model is greater than the other, so it is better) to articulate a widely accessible explanation (e.g., the higher R^2 value means that variation in the predictor it uses accounts for more of the observed variation in first year college GPA than the predictor used in the other model, so the first model is likely to make better predictions where first year GPA is unknown).

Example Problem from Unit 3

> *The glacier data set includes the cumulative mass balance of four U.S. reference glaciers relative to the base year of 1965. Climate scientists have claimed that glacier retreat is accelerating. Compare how fast glaciers changed before 2009 with how fast they have changed in the last decade of available data (2009 – 2019). Explain in everyday language whether it is plausible that glacier retreat is accelerating based on these data.*

The formulation step for this problem involves realizing that glacier retreat can be modeled as a rate of change in cumulative mass balance and determining an appropriate strategy for comparing glacier retreat before and after 2009. One appropriate solution for this problem is to use a multiple regression model that predicts cumulative mass balance from time, a binary indicator for data points in the last decade, and the interaction (product) of time and the last decade indicator. In a complete solution, students must articulate why the interaction term enables the comparison of the modeled linear rate before and after 2009, interpret the coefficient as the difference in rate before and after 2009, and interpret the p-value for this coefficient by providing a mathematically rigorous argument in widely accessible language about the likelihood the rate is constant across all observed data (i.e., H_0: $B_{<2009} = B_{\geq 2009}$). The concepts and techniques required to solve this problem are drawn from college level statistics and probability.

N106: The Mathematics of Learning: Modeling Data in Education and Our World

Syllabus

Spring Semester 2023

Instructor

Dr. Jacobson
School of Education, Room 3058
812-856-8149
Email: erdajaco@indiana.edu

Class Location and Times

MW 8:00 AM–9:15 AM
ED 3125

Office Hours:

ED 3058, Tuesdays 11am-1pm and by appointment

Canvas

Assignments, class notes, and other course materials will be posted on Canvas. Please submit all written assignments electronically using Canvas.

Required Texts

(1) **[MD]** ***Statistical Inference via Data Science: A ModernDive into R and the Tidyverse*****! (https://moderndive.com/index.html)** This online book is free to use and licensed under a Creative Commons Attribution-NonCommercial-ShareAlike 4.0 International License.

(2) **[IMS] Introduction to Modern Statistics (https://openintro-ims.netlify.app/index.html)** This online book is free and available under a Creative Commons Attribution-ShareAlike 3.0 Unported United States License.

Required Materials

(3) Download and install **R (http://ftp.ussg.iu.edu/CRAN/)** and **RStudio Desktop (https://www.rstudio.com/products/rstudio/)** You can also access RStudio without installation through IUAnywhere or on Datacamp > Workspace or by visiting an IU computer lab.

Supplemental Text

(4) **[R4DS] R for Data Science (https://r4ds.had.co.nz/)** This book is free to use, and is licensed under the Creative Commons Attribution-NonCommercial-NoDerivs 3.0 License.

Note: Additional readings and materials will be posted on Canvas.

Course Description

Examines how to solve problems through mathematical modeling by using advanced concepts and techniques to develop models, draw inferences, and communicate results. Provides training and practice using data and computational environments to formulate and explore problems. Critically examines the role of models in media, education, and public health.

Learning Outcomes

In this course, we will examine how to solve problems through mathematical modeling by using advanced concepts and techniques to develop models and draw inferences from them. We will explore problems using data sets from a variety of domains including education, climate science, and public heath with a focus on clear communication, constructing accurate arguments, and engaging with others' reasoning.

Many of the techniques we will explore involve learning to code in the statistical programming language *R (https://www.r-project.org/)*, but rest assured this course assumes no background knowledge of programming or statistics. This course will introduce all the mathematical concepts and skills you will need for the problems we discuss.

In this course, problems will be phrased with limited use of mathematical notation and symbols and describe real-world situations. You will learn approaches and strategies in *problem formulation*, the first step of problem solving where you determine what is required to solve the problem and what counts as a solution. The problems will require you to apply college-level mathematical techniques to advance from this formulation stage to a solution. Problem solutions will require you to draw inferences from the models you have created, and to use college-level mathematical techniques including data exploration with representations such as equations, tables, and graphs, problem solving, and quantitative reasoning. We will also discuss the assumptions and potential sources of bias that influence the interpretation of problem solutions as well as various ethical considerations when communicating results to an audience.

By the end of the course, students will be able to

1. create mathematical models (including graphical, algebraic, and statistical models) of empirical data drawn from education and areas of widespread interest such as health, climate science and popular media.
2. create variables and other abstractions to solve college-level mathematical problems building from previously learned fundamental mathematical skills such as algebra.
3. draw inferences from models using college-level mathematical techniques including problem solving, quantitative reasoning, and exploration using multiple representations such as equations, tables, and graphs.
4. communicate problem formulations and problem solutions with mathematical rigor and in ways that make sense to a wide audience.

Overview of Course Assignments

Several grade categories make up your final grade, weighted as described below. Each of the course assignments is allotted a certain number of points, and each point in a grading category is weighted the same amount toward your final grade. However, points in different categories might be worth different amounts towards your final grade if the categories are weighted differently or if they have a different number of total points. Rubrics will be made available for each assignment.

On all written work, I expect you to demonstrate correct use of the English language with regard to grammar, punctuation, and spelling—I *do* grade on technical writing skills as well as content. Please proofread your work before submitting it. Except otherwise stated, all assignments are to be submitted electronically through Canvas.

1. *20% - Engagement with Assigned Readings & Tutorials*
    - *Reading Checks:* In class discussions of readings will be more engaging and fruitful if you have completed the assigned reading before class and spent some time reflecting on your own. Weekly reading checks will be due on Canvas at 11:59pm on Tuesdays and graded for accuracy – 5 points.
    - *Tutorials:* Learning to code requires practice, and you will be required to complete guided programming tutorials assigned on Canvas. Tutorials will be due every other week at 11:59pm on Sundays and graded for completion – 10 points.
2. *30% - Problem Sets.* Problem sets will be due every other week at 11:59pm on Sundays. Each problem set is worth 20 points. Late problem sets will not be accepted. When I grade your problem sets I will:
    - Evaluate all problems for accuracy and completeness – 10 points
    - Assess the quality of your argument and the rigor of your mathematical communication on selected problems – 10 points
3. *50% - Midterms and Final Exam*. The midterms and the final exam will include an in-class section and a take-home application section using RStudio to model and interpret data to solve problems.

More on Problem Sets

You should expect to do a fair amount of writing on your problem sets. In general, after you have written an explanation of your mathematical thinking, reread it as if it were someone else's thinking. Is what you wrote just a sequence of "steps"? If so, then you haven't really *explained*; you've described, or reported, what you did. In writing explanations, the main idea is to push beyond an account or description by including *reasons* for what you did. Focus on the decisions you made in solving a problem *and the motives or reasons* for those decisions. Making your rationale and the consequences for your process explicit gives you—and your reader—additional information about where you've been and where you might go next. In the end, make sure to use the mathematical facts you discovered to support your conclusion explicitly.

Topical Outline

Each unit will be about 5 weeks in length and include 3 tutorials and 2 problem sets. A recurrent focus will be on the mathematical modeling cycle in which you will create a mathematical model for a real-world quantitative relationship, apply the model to data (measurements of the phenomena of interest), interpret the model by describing what the results of the analysis mean about the model and the world, and consider how to modify or extend the model (or data!) to further improve your understanding.

Unit 1 – Data Science and Descriptive Models
> Using RStudio for data visualization
> Using RStudio for data handling and transformation
> Interpretation and communication, sources of bias, and ethics of reporting

Unit 2 – Statistical Models for Data
> Using RStudio for statistical modeling
> Linear regression
> Multivariate regression

Unit 3 – Simulation-based Statistical Inference
> Probability, functions, and sampling
> Confidence intervals and hypothesis testing
> General linear models and statistical inference

Important Dates

All reading checks are due 11:59pm on Tuesdays
Homework assignments (Tutorials & Problem Sets) are due 11:59pm on Sundays.

Midterm Exam 1
- In class, Wednesday, February 15
- Take-home due 11:59pm on Thursday, February 16

Midterm Exam 2
- In class, Wednesday, March 22
- Take-home due 11:59pm on Thursday, March 23

Final Exam
- In class, Wednesday, May 3
- Take-home, due 11:59pm on Thursday, May 4.

Calculation of Final Grades

The chart shows the percentage required to achieve specific final course grades, based on a typical 90%-80%-70%-60% scale

Grade	Lowest %	Grade	Lowest %	Grade	Lowest %
A+	97	B-	80	D+	67
A	93	C+	77	D	63
A-	90	C	73	D-	60
B+	87	C-	70	F	Below 60
B	83				

Class Policies

***Attendance*:** Attendance is required for all class sessions. That said, we are still in an unusual situation, with the pandemic still a factor in our lives. We need to each take our personal health and the safety of the campus seriously. So, if you have a positive COVID-19 test, have COVID-like symptoms, or have been instructed to quarantine, you should not attend class. Attendance will be taken in class but will be prorated if you are absent due to compliance with campus isolation expectations. Alternative assignments or make-ups may be offered on a case-by-case basis. Please contact the instructor if you plan to be or have been absent for any reason.

Policy on Resubmitting Assignments: If you receive less than 75% of the allocated points on a problem set, you may resubmit the assignment within one week of the time the original is returned to you. (Please submit the original along with your revised version.) When grading a resubmitted assignment, I look to see that you have revised the assignment based on the comments made on the original. *The maximum grade on a resubmitted assignment is 75% of the allocated points*. Resubmitting exams is not allowed.

Policy on Late Assignments: Submit all assignments to Canvas by 11:59pm on the announced due date. Late assignments will not be accepted.

Attendance: Attendance is required for each class. Being late to class or failure to attend will affect your participation grade; it is detrimental for you and disruptive for others. Please inform the instructor if you need to miss class for any reason; there is a limit of 3 excused absences in the semester.

Conduct: Please turn off cell phones during class. You are welcome to take notes electronically but do not surf the web, check email, or send text messages.

Religious Observance: The policy at Indiana University is that instructors must reasonably accommodate students who want to observe their religious holidays at times when academic requirements conflict with those observances. Students missing class for a religious observance can find the officially approved accommodation form by going to the Vice Provost for Faculty and Academic Affairs webpage for religious accommodations. **The form must be submitted at least 2 weeks prior to the anticipated absence.**

Policy on Disability Services for Students: Every attempt will be made to accommodate qualified students with disabilities (e.g., mental health, learning, chronic health, physical, hearing, vision neurological, etc.) You must have established your eligibility for support services through the appropriate office that services students with disabilities. Note that services are confidential, may take time to put into place and are not retroactive; captions and alternate media for print materials

may take three or more weeks to get produced. Please contact Disability Services for Students as soon as possible if accommodations are needed.

Policy on Sexual Misconduct: As your instructor, one of my responsibilities is to create a positive learning environment for all students. IU Policy prohibits sexual misconduct in any form, including sexual harassment, sexual assault, stalking, sexual exploitation, and dating and domestic violence. If you have experienced sexual misconduct, or know someone who has, the University can help. If you are seeking help and would like to speak to someone confidentially, you can make an appointment with the Sexual Assault Crisis Services (SACS) at (812) 855-5711, or contact a Confidential Victim Advocate at (812) 856-2469 or cva@indiana.edu.

It is also important that you know that University policy requires me to share any information brought to my attention about potential sexual misconduct, with the campus Deputy Sexual Misconduct & Title IX Coordinator or the University Sexual Misconduct & Title IX Coordinator. In that event, those individuals will work to ensure that appropriate measures are taken and resources are made available. Protecting student privacy is of utmost concern, and information will only be shared with those that need to know to ensure the University can respond and assist. To learn more, I encourage you to visit Stop Sexual Violence to learn more.

Policy on Bias-Based Incident Reporting: Bias-based incident reports can be made by students, faculty and staff. Any act of discrimination or harassment based on race, ethnicity, religious affiliation, gender, gender identity, sexual orientation or disability can be reported through any of the options: 1) email biasincident@indiana.edu or incident@indiana.edu; 2) call the Dean of Students Office at (812) 855-8188; or 3) use the IU mobile App (m.iu.edu). Reports can be made anonymously if desired.

***Cell phones*:** Please focus on the class during class and do not text. If you are repeatedly texting in class, you will accrue an absence at the discretion of the instructor.

Computers: When we work on computers in the course, ***please refrain from surfing the web, checking email, etc***. I know it's very tempting to engage in these activities, especially if you finish a problem or discussion early. However, we have a short time together, and we need all of it for working on the problems at hand and discussing the many issues that arise.

***Academic Misconduct*:** I hope there will be no need to worry about academic misconduct (cheating, plagiarism, etc.). All university policies concerning academic misconduct will be strictly followed and can be found at Student Code. In particular, it is my obligation to **report any academic misconduct at the university level**. Good information about plagiarism can be found at Information About Plagiarism. **It is your responsibility to be familiar with these policies.** Be forewarned that submitting other people's work as your own work is academic misconduct, unless the assignment allows collaborative work.

Mental Health and Well-being Services:

- The Counseling and Psychological Services (CAPS) website offers a wide array of services to support students.
- The Student Advocates Office (SAO) can help students work through personal and academic problems as well as financial difficulties and concerns. SAO also assists students working through grade appeals and withdrawals from all classes. SAO also has emergency funds for IU students experiencing emergency financial crisis.

INDIANA UNIVERSITY

Doc Nbr:	91295676	Status:	ENROUTE
Initiator:	erdajaco	Created:	Oct 12, 2022

New Course BL EDUC-N 106

Course Request Key Fields

1.	Requesting Campus	BL-IU Bloomington
2.	Matching Course	No
3.	School	EDUC - School of Education
4.	Subject	EDUC - Education
5a.	Course Number	N-106
b.	Has course number been reserved with, ussscrct@indiana.edu, University Student Services and Systems?	Yes
6.	Credit Type	Undergraduate
7.	Is this a Purdue Course?	No
8a.	Course Title	The Mathematics of Learning: Modeling Data in Education and Our World
b.	Recommended Abbreviation	Mathematics of Learning

Course Catalog Attributes

9.	Academic Career	UGRD - Undergraduate
10.	Effective Term (anticipated)	Fall 2023
11.	Credit Hours	Fixed 3.0
12.	Contact Hours	
13.	Is S-F grading approval being requested?	No
14.	Is variable title approval being requested?	No
15.	Prerequisites/Corequisites (to be enforced during registration)	Mastery of two years of high school algebra as indicated by an ALEKS score of 35 or higher, or successful completion of MATH-M 014, MATH-M 018, or MATH-J 111.
16.	Course Description	Examines how to solve problems through mathematical modeling by using advanced concepts and techniques to develop models, draw inferences, and communicate results. Provides training and practice using data and computational environments to formulate and explore problems. Critically examines the role of models in media, education, and public health.

Course Attributes for Scheduling

17.	Equivalent Courses	
18a.	Repeatable for Credit?	No
19a.	Type of Instructional Experience (Select primary component)	Lecture
b.	Additional component(s) that apply	
20.	Instruction Mode (select all that apply)	Face-To-Face
21.	Instructor Name	
22.	Estimated Enrollment	
23.	Estimated Enrollment Percent Expected to be Graduate Students	

24.	Frequency of Schedule	Fall/Spring
25.	Course Typically Offered	Fall and Spring Terms
26.	Will this course be required for majors?	No

Additional Course Information

27.	Justification for New Course	This course will provide a new opportunity for students to understand the broad utility of mathematical models and become empowered to use modeling to learn from data whether in daily life or as part of a future career.
28a.	Does this course overlap with existing courses?	No
29.	Are the necessary reading materials currently available in the appropriate library?	
30.	Do you anticipate this course will require a special fee? (Information Only)	

Essential Syllabus Information

ESI 1.	Course Content	In this course, students will examine how to solve problems through mathematical modeling by using advanced concepts and techniques to develop models and draw inferences from them. Students will explore problems from a variety of domains including education, climate science, and public heath with a focus on clear communication, constructing accurate arguments, and engaging with others' reasoning. Many of the techniques students will explore involve learning to code in the statistical programming language R (https://www.r-project.org/), but this course assumes no background knowledge of programming or statistics. This course will introduce all the mathematical concepts and skills students will need for the problems that are discussed. In this course, problems will be phrased with limited use of mathematical notation and symbols and describe real-world situations. Students will learn approaches and strategies in problem formulation, the first step of problem solving where one determines what is required to solve the problem and what counts as a solution. The problems will require students to apply college-level mathematical techniques to advance from this formulation stage to a solution. Students will also discuss the assumptions and potential sources of bias that influence the interpretation of problem solutions as well as various ethical considerations when communicating results to an audience. By learning how to use mathematical models to learn from data, students will be prepared for a variety of possible future courses and degrees.
ESI 2.	Representative Bibliography or Resources	(1) Statistical Inference via Data Science: A ModernDive into R and the Tidyverse! (https://moderndive.com/index.html) This online book is free to use and licensed under a Creative Commons Attribution-NonCommercial-ShareAlike 4.0 International License. (2) Introduction to Modern Statistics (https://openintro-ims.netlify.app/index.html) This online book is free and available under a Creative Commons Attribution-ShareAlike 3.0 Unported United States License. (3)R for Data Science (https://r4ds.had.co.nz/) This book is free to use, and is licensed under the Creative Commons Attribution-NonCommercial-NoDerivs 3.0 License.

ESI 3.	**Teaching and Learning Methods**	**Each unit will be about 5 weeks in length and include 3 tutorials and 2 problem sets. A recurrent focus will be on learning from the mathematical modeling cycle in which students will create a mathematical model for a real-world quantitative relationship, apply the model to data (measurements of the phenomena of interest), interpret the model by describing what the results of the analysis mean about the model and the world, and consider how to modify or extend the model (or data!) to further improve their understanding.**
ESI 4.	**Learning Outcome/Objectives**	**Students will demonstrate the ability to: (1) create mathematical models of empirical or theoretical phenomena in domains such as education, climate science, and public health; (2) create variables and other abstractions to solve college-level mathematical problems in conjunction with previously-learned fundamental mathematical skills such as algebra; (3) draw inferences from models using college-level mathematical techniques including problem solving, quantitative reasoning, and exploration using multiple representations such as equations, tables, and graphs.**
ESI 5.	**Learning Assessment**	**1.20% - Engagement with Assigned Readings & Tutorials. Reading Checks: In class discussions of readings will be more engaging and fruitful if students have completed the assigned reading and spent some time reflecting before class. Weekly reading checks will be graded for accuracy - 5 points each. Tutorials: Learning to code requires practice, and students will be required to complete guided programming tutorials assigned on Canvas. Tutorials will be graded for completion - 10 points each. 2.30% - Problem Sets. Problem sets will be due every other week. Each problem set is worth 20 points. Problem set grades include: accuracy on all problems and overall completeness - 10 points; and the quality of argument and the rigor of mathematical communication on selected problems - 10 points. 3.50% - Midterms and Final Exam. Both the midterms and the final exam will include an application and skills section using computational software to model and interpret a data set to solve relevant problems and a knowledge and understanding section assessing model representations and inferences, and key concepts from the course.**

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USSS 1.	**Course ID**	
USSS 2.	**Remonstrance List**	