IP1

Mathematical Modeling with Elementary School-Aged Students

Modeling, a cyclic process by which mathematicians develop and use mathematical tools to represent, understand, and solve real-world problems, provides important learning opportunities for school students. Modeling opportunities in secondary schools are apparent, but what about in the younger grades? Two questions are critical in mathematical modeling in K-5 settings. (1) How should opportunities for modeling in K-5 settings be constructed and carried out? (2) What are the tasks of teaching when engaging elementary students in mathematical modeling? In this talk I will present a framework for teaching mathematical modeling in elementary classrooms and provide illustrations of its use by elementary grades teachers.

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IP2

Graduate Student Education in Computational Mathematics and Scientific Computing

Abstract not available at time of publication.

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IP3

Mathematical Modeling: Changing the Landscape of the Mathematics Classroom

As math modeling gains more attention in the K-12 curriculum, we consider the questions: How do we introduce students and teachers to modeling? What can students gain from engaging in modeling experiences? How do we teach modeling? In this session, I will share some of my mathematical modeling experiences working with students and teachers and solicit ideas on how we can work together to support the teaching and learning of mathematical modeling.

Maria Hernandez
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IP4

Lean Out: Connecting Outside the Ivory Tower

It is important that mathematics and statistics educators are well attuned to the research and employment opportunities that exist outside academia for people trained properly in the mathematical sciences. In particular, to increase the number of well-prepared students going into mathematical sciences careers, there is a need to better connect the work that is done in business, industry, and government with what is taught at universities, and to give students and faculty active exposure to the sort of interesting mathematical problems that are encountered. In this talk, the speaker will discuss some of the research and educational partnerships that she has been involved in that actively connect faculty, students, and teachers directly with industry and that has allowed them to engage in research on industrial problems. She will give examples of some industrial research problems that student teams have tackled, discuss some of the skills that are needed to be successful working with and in industry, discuss the challenges that one may face when working with corporate partners, and present a summary of some of the lessons that have been learned over the years in these collaborations.

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IP5

Title Not Available at Time of Publication

Abstract not available at time of publication.

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CP1

Regime Switching Models and the Mental Accounting Framework

We extend Markowitz's mean-variance portfolio theory (1952) and the Mental Accounting framework developed by Das et al. (2010) from their stationary setting to a dynamic one. To generate time-varying scenarios for asset returns, we employ dynamic programming with Regime Switching Models (more specifically Hidden Markov Models and Gaussian Mixture Models). We combine these concepts into a unified framework, evaluate its feasibility and performance, and perform an analysis of the most common pitfalls and practical considerations.

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CP1

Modelling Uncertainty Without An Assumed Distribution: Turbulent Cloud Microphysics

We model uncertainty, without any assumed probability distribution function, by using physical features of the phenomena to reshape state-space fluctuations into fluctuations in a stochastic process. Statistics on these stochastic processes become system parameters which have physical meanings that can be acquired from data. In the application to bulk models of cloud droplet collision and coalescence, the systematic decomposition of density functions (mixing ratio and number), into a mean and a set of pointwise fluctuations, provides a novel way to represent higher moments of the kinetic collection equation and thus close this system of bulk equations. Additionally, conservation of mass and consistency of number result intrinsically from the derivations rather than being applied externally. The independent derivation of the four autoconversion terms provides for (to the best of the author's knowledge) an unprecedented constraining of the autoconversion parameter and subsequent fine control of the evolution of the droplet size spectrum. We compare results from this (stochastic differential equation) 'SDE-based' stochastic model to a deterministic bulk model and use detailed results as benchmarks. Simulations are driven by hydrodynamic and turbulent kernels.

David Collins

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CP1

Educational Magic Tricks Based on Error-Detecting Codes

Magic tricks based on discrete mathematics and computing concepts help grab student attention and can motivate them to delve more deeply. Error detection ideas long used by computer scientists provide a rich basis for working magic; probably the most well known trick of this type is one included in the CS Unplugged activities. This paper shows that much more powerful variations of the trick can be performed, some in an unplugged environment and some with computer assistance. Some of the tricks also show off additional applied mathematics concepts in the areas of information theory and cryptography.

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CP1

Cumulative Prospect Theory with Skewed Return Distribution

We investigate a one-period portfolio optimization problem of a cumulative prospect theory (CPT) investor with multiple risky assets and one risk-free asset. The returns of multiple risky assets follow multivariate generalized hyperbolic (GH) skewed t distribu-tion. We obtain a three-fund separation result of two risky portfolios and risk-free asset. Furthermore, we reduce the high dimensional optimization problem to two 1-dimensional optimization problems and derive the optimal portfolio. We show that the optimal port-folio composition changes as some of investor-specific parameters change. It is observed that the consideration of skewness of stock return distribution has considerable impact on the distribution of CPT investors wealth deviation, and leads to less total risky in-vestment.

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CP1

Online Games in the Calculus Classroom

Online games can be a useful tool that, when coupled with traditional lecture, allows the student to become immersed in the subject, creating a kinetic and energetic environment that will not only help learning, but spark interest in the subject as a whole. However, there are two problems that will be considered in this talk: 1. What are the most effective games and its assessment methods that could be incorporated into the Calculus classroom? 2. How to develop an online interactive game designed to teach the tenets of calculus?

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CP1

Extreme Risk, Value-at-Risk Modeling

We apply an approach for estimating Value-at-Risk (VaR) describing the tail of the conditional distribution of a heteroscedastic financial return series. The method combines quasi-maximum-likelihood fitting of AR(1)-TGARCH(1,1) model to estimate the current mean as well as volatility, and Extreme Value Theory to estimate the tail of the adjusted standardized return series. We employ the approach to investigate the existence and significance of the calendar anomalies: seasonal effect and day-of-the-week effect in Americas Indexes VaR. We also examine the statistical properties and made a comprehensive set of diagnostic checks on the one decade of considered Americas Indexes returns. Our results suggest that the lowest VaR of considered Americas Indexes negative log returns occurs on the fourth season among all seasons. Moreover, comparatively low Wednesday VaR is captured among all weekdays during the test period.

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CP2

Graduate Student Mentorship for Diverse Teams of Undergraduate Researchers in an REU Site

Some summer research programs for undergraduates involve graduate students as well as faculty in research mentorship. As a graduate student, the opportunity for growth and development before transitioning to a faculty career is especially valuable. Graduate students can relate to the undergraduates and to provide guidance for the near future, as they guide the undergraduates with the research project. I will discuss my experiences and what I have learned as a graduate student working with diverse teams of undergraduates over the past three years in the UMBC REU site: Interdisciplinary Program in High Performance Computing. More information on this REU site can be found here: http://hpcreu.umbc.edu/.

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CP2

Education for Simulation and HPC at JSC

Fostering a sound education for students and young researchers at bachelor, master and PhD level in simulation and high-performance computing (HPC) is an essential task of the Jülich Supercomputing Centre (JSC). Applied mathematics education plays a crucial part in these activities. This talk will give an overview of the joint degree programmes with nearby universities and informs on guest student programmes and the Joint Laboratory for Extreme Scale Computing (JLESC) tailored for master and PhD students with interest in HPC.

Johannes Grotendorst
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CP2

Undergraduate Research and Curriculum Development in EXTREEMS-QED at NJIT

The NJIT EXTREEMS-QED program is designed to immerse undergraduates in courses and group research projects in the computational analysis of data and the modeling and simulation of complex systems in multidisciplinary contexts. In this talk, we will describe the research activities of our undergraduates and the curricular enhancements in computational and data enabled science and engineering that have already been made. This project is supported by the NSF.

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CP2

Curriculum in Undergraduate Applied Mathematics: a Single Case

Universities are under increasing pressure to be accountable for student learning gains during the undergraduate years. As our Applied Mathematics program sets undergraduate learning objectives, a number of questions arise: What do our students currently learn? What should they know? What is a contemporary curriculum? How successful are we in serving students drawn from the full range of demographic groups present at our university? We will share our attempts to answer these questions and more.

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CP2

Big Math Network: Best Practices for Undergraduate and Graduate Internships in the Mathematical Sciences

This session will introduce SIAM's BIG Math Network, designed to increase connections between the Mathematical Sciences and BIG (Business, Industry and Government). Building on an NSF-IPAM Industry Internship workshop, the network will provide (1) materials communicating the value of mathematics internships to students, faculty and BIG executives (2) successful practices for internship mentoring, timing, financial support, intellectual property and other logistics (3) information about necessary hard and soft skills. To join, email bigmathnetwork@siam.org.

Rachel Levy
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CP2

SIMIODE - A Community for Teaching Modeling First Differential Equations

SIMIODE - Systemic Initiative for Modeling Investigations and Opportunities with Differential Equations (www.simiode.org) is a community of teachers and learners who believe that modeling can motivate and engage students in learning differential equations. We present the SIMIODE community, offer rich examples of this approach using data, videos, and realistic scenarios, and discuss how faculty can contribute their own materials for a peer-reviewed online publication. Examples will come from engineering, physics, chemistry, and life sciences.

Brian Winkel
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CP3

Mathematical Modeling with Monte Carlo Methods - A Bates College Elective

My goal for this talk is to share my experiences teaching an undergraduate modeling class based on Monte Carlo methods. The class is aimed at students with at least prerequisites in Linear Algebra and multivariable Calculus. The talk will cover the topics covered and the MATLAB codes developed to enhance the pedagogy.

Henry A. Boateng
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CP3

Bifurcation Study of Parametric Diagramm of Predator-Prey Models with Saturation and Competition Affects

We study models given by a three dimensional systems of ordinary differential equations, depending on eight parameters, which describe the dynamics of quantity three populations interacting by a principal a predator-prey with the additional count of affects competition and saturation.We investigate the bifurcations of equilibrium points and limit cycles of a system and constract the parametric diagram on a plane of two parameters, when the other parameters are fixed. Then, by qualitative - numerical methods we study the bifurcations of constracted two dimensional parametric diagram of system, when the values of the other parameters change, thereby we get a full parametric diagramm deepnding on all parameters of a system in the form of two dimensional cross-sections. The investigations has been carried out based on the qualitative and Bifurcation Theory of odinary differential equations, as well as by means a computer experiments.

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CP3
Simulation in Scratch

Computer-based simulation provides a powerful tool for engaging K-12 students actively in mathematics, computer science, and modeling. In this talk, I will outline a series of projects used to engage high school students in computing-based explorations of probability, statistics, discrete mathematics, and calculus. In addition to developing basic and advanced concepts in these subjects, these projects help students develop the modeling and computing skills necessary to conceive of, design, and study their own unique simulations. The projects are all implemented in Scratch, a free, web-based programming environment that is seeing expanded use in K-12 learning. Scratch's block programming approach and its drag-and-drop environment make programming immediately accessible to students, and its sprite-based environment makes a variety of complex interaction-based simulations easy to implement. In this talk, I will discuss the structure and pedagogy of the basic projects, and share innovative and inspiring student work.

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CP3
Aesthetics as a Means to Teaching Mathematics Through Problem Solving

Incorporating applied mathematics in the form of real world problems has attracted much attention among mathematics education researchers and practitioners at the elementary and secondary school levels. This movement raises the question of whether school mathematics has consequently maintained equally, if not sufficiently, rigorous considerations of abstract mathematics. In this presentation, we examine specifically the extent to which abstract mathematics in the form of an appreciation for mathematical aesthetics has been attended in mathematics classrooms.

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MS1
Data-Driven Models of Plankton Ecosystems: Making a Case for Noise

Many idealized ecological systems can be modeled using systems of ODEs and this approach is commonly used in undergraduate courses in mathematical ecology. However, real ecological systems are often subject to numerous environmental fluctuations as well as locally destabilizing internal dynamics. As a result, real ecological data often displays more than enough noise to confound an instructor's attempts to convincingly relate the data to standard ODE models. In this talk I will discuss methods, drawn from current research modeling freshwater plankton ecosystems, that use "noisy" timeseries data to quantify the degree to which an individual species interacts with other species as well as with environmental covariates. These estimates constitute a statistical model of the ecosystem that is accessible to undergraduates with a basic understanding of linear algebra. Additionally, I will discuss some interesting open questions in ecology that can be approached by students using these statistical models.

Craig Jackson
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MS1
Data-Driven Applications Inspiring Linear Algebra

In this talk, I will share a student-centered learning module that collaborators and I have used in a first course in Linear Algebra. The module begin with a Radiography/Tomography application and leads the student to a solution while all the time inspiring "new" mathematical concepts, those that are learned in Linear Algebra. I will discuss how this module inspires ideas such as vector space, span, linear dependence, matrix representations, and more. I will share the successes and work that we are doing to create these products for wider use.

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MS1
Stem Real World Applications of Mathematics

Abstract not available

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MS1
Fascinating Biological Images + Open-Inquiry + Student Collected Image Analysis Data = A Fun Way to Learn (and Teach!) Mathematics and Statistics

Abstract not available

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MS2
Edge@UB—Aspects and Motivation Behind NSF's EDT Program at the University at Buffalo

As reported by the American Mathematical Society, mathematician was the #1 rated career in CareerCast's Job Rated 2014 report. Individual who have demonstrated a high level of mathematical acumen by obtaining a PhD in mathematics are highly prized in both the academic and private sector job markets. However, mathematical faculty at times have struggled to understand the different career paths that might be open to their doctoral students. The EDGE@UB is directed towards enlarging the career imagination of our student; enhancing our facultys ability to mentor students for multiple career options; enlarging our facultys understanding of applications of their research areas; and, to give our research partners, both in industry and other academic units, new connections to the mathematical community.

William Menasco

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MS2

UTD's EDT Program: Team Training Mathematical Scientists Through Industrial Collaborations

This EDT program supplements students' PhD training with a research project posed by an external partner. Teams of students, faculty and the external partner participate in the entire life cycle of applied research. Students precisely formulate a problem, develop mathematical/statistical methods to solve it, and gain confidence and communication skills required to attack applied research. Projects include uncertainty estimation in oil and gas recovery, infectious disease forecasting, computerized tomography, and multisensor tracking of moving targets.

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MS2

Framework: Front Range Applied Mathematics Exchanges and Workshops

We will present an overview of the NSF-supported Front Range Applied Mathematics Exchanges and WORKshops (FRAMEWORK) program jointly hosted within the Department of Mathematics at the University of Wyoming and the Department of Applied Mathematics and Statistics at the Colorado School of Mines. This doctoral training program possesses four key elements: (1) Summer internship opportunities at national laboratories and industrial partners that will introduce PhD students to applications outside of their coursework, improve their technical communication skills, and develop strong scientific connections that will allow them to pursue future careers outside of the academic landscape; (2) Annual end-of-summer workshops designed to train incoming PhD students in technical writing and project management while showcasing the previous cohort's internship experiences, thereby priming the pump for the next cohort; (3) A course exchange program enabling shared delivery of foundational graduate courses and an increased ability to offer new advanced topics courses that will benefit both the breadth and depth of the PhD curriculum at both institutions; and (4) The targeted recruitment of baccalaureate students at non-doctoral institutions along the Front Range designed to enhance the diversity of the PhD pipeline. In general, we will detail the current structure of FRAMEWORK and discuss future goals.

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MS2

The IMA Math-to-Industry Boot Camp

This presentation will be about the concept of the IMA Math-to-Industry Boot Camp and our first experience running it. The Math-to-Industry Boot Camp has been designed to enhance the training of Mathematics Doctorates by providing the students with skills and experiences that are valuable for seeking positions in industry and business, and for recognizing the relevance of mathematics in industrial or government settings. The program will expose students to careers outside academia and position them to make informed career choices. The camp starts with the basics of programming, data analysis, and mathematical modeling. There will be two team projects. Both projects will be goal oriented but open-ended, with the second being posed by industry practitioners. Soft-skills training, such as project management, running meetings, making "elevator pitches," effective presentations, and report writing for non-scientific audiences will be provided. Students will be mentored throughout the six-week period and will have ample opportunity to interact with industry participants. Students successfully completing the program will gain an appreciation of the usefulness of mathematics for solving real-world problems and will be empowered to make an informed career decision.

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MS3

Calculus and 3D-Printing

3D printing can be a powerful tool to help everyone visualize mathematical models. In this talk I will describe how it can be used in the classroom in Calculus II and Multivariable Calculus. There are a variety of different ways to do this; from using models to illustrate ideas, to having the students design, print and share their own models. I will also describe some of the successes and pitfalls of using the technology.

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MS3

Course and Question Structures as Platform for Open-Ended Inquiry by Students

Being asked to do open-ended work (like conjecturing, making arguments and examples, posing good questions, or making definitions) can be intellectually paralyzing for students unused to the freedom of creative mathematics. Inquiry-based learning structures are usually thought of as helping students engaging in the basics of sense-making and rigorous argument, but they also can teach us something about how to mentor students through a more open, student-centered approach to learning and using mathematics.

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MS3

3D Printing Experiments in Mathematics

We have used a creative 3D printing component in service calculus courses at Harvard order to enrich math education. The topic helped and succeeded in motivating calculus, linear algebra and geometry. While gaining experience in printing from standard computer algebra systems we had to learn how to overcome some limitations of current technology.

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MS3

Developing Geometric Imagination With the Aid of 3D Printed Models

Geometric imagination plays a crucial role in the ability of scientists, engineers and mathematicians to comprehend new concepts and discover novel solutions, both in the classroom and in research. Small group, active learning projects that employ 3D printed models of curves and surfaces are being used to develop geometric imagination skills in multivariable calculus students. These projects seek to make associations between algebraic and geometric modes of thinking, and suggest modifications to the traditional curriculum.

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MS4

Overview of the PIC Math Program

PIC Math is a new program to prepare undergraduate students in the mathematics and statistics to succeed in careers in business, industry, and government. Funded by a $2 million NSF grant, this program strives to (a) increase awareness among faculty and students about non-academic career options, (b) provide undergraduate research experience using problems from industry, and (c) prepare students for industrial careers. The program includes a 3-day faculty summer training workshop, a spring semester course in which students learn skills and work on research problems from industry, and an end-of-program research conference at which the students present. For the semester course, we have developed a set of educational and informative videos and prepared materials for the course such as sample syllabi, set of sample research problems from industry, sample student solutions to industrial research problems, and sample videos of student presenting their research. During the first two years, 754 undergraduate students (45% female and 20% underrepresented minorities) and 67 faculty members from 60 universities/colleges have participated in PIC Math.

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MS4

From Comfort Zone to Adventure Zone: Making Connections in BIG and Offering a PIC Math Course

The PIC Math program offers a unique opportunity for mathematics educators to initiate connections within the BIG community and to offer a new type of course motivated by open-ended, real-world problems. I will describe my experience as a participant in the first three years of the PIC Math program, with an emphasis on the perspective of not having prior industrial experience. I will describe implementations of the course, lessons learned, and recommendations for future participants.

Elin Farnell
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MS4

Police Beats, Neighborhood Stability, and Cost/Benefit Analysis: PIC Math at Youngstown State

As part of the PIC Math program, students at Youngstown State have completed projects with local sponsors including designing new police beats for the city, analyzing neighborhood stabilization efforts of a local non-profit, and examining the return on investment for some of YSU's student support services. In this presentation, we will discuss these projects and the students' results.

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MS4

The PIC Math Industrial Case Studies Solving Real World Problems Videos

As part of the NSF-funded PIC Math program, we produced 4 two-video sequences highlighting some research problems that mathematicians and statisticians encounter outside of academia. The first video in each sequence features a professional mathematical scientist talking about their career and some of their research. The second video in the sequence features a faculty member presenting some technical background and an approach that one may use to make progress on the industrial research problem. See http://www.maa.org/programs/faculty-and-departments/pic-math/solving-real-world-problems In this talk, we will discuss the content of the videos, the video production process, and we will give some ideas of how the videos can be used with students.

Suzanne L. Weekes
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MS5

Modeling the Environment with Statistics

Environmental issues can be investigated through standard regression models. However, with the emergence of Big Data, issues related to the environment can also be studied through less conventional modeling techniques such as interactive choropleth maps. This talk will illustrate how conventional and nonconventional methods can be used to answer pressing environmental statistical questions as well as show how to analyze environmental data sets in ways that promote rich student discussion.

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MS5

Modeling the Environment: From Modules to Classes

Incorporating current news articles and hands on activities helps students see the applicability of mathematics and develop appreciation for the material discussed in the classroom. We will discuss articles and activities that we have incorporated within Differential Equations, Calculus and Mathematical Modeling classes, pertaining to issues ranging from agriculture run-off to climate change. We will also discuss activities used in an Environmental Modeling course to motivate, develop, and understand the governing laws of groundwater flow.

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MS5

Hunger Games - Modeling Global Food Production and Population Growth

As the human population is rapidly approaching our planet's carrying capacity, the headlines in the New York Times, the Washington Post, National Public Radio, and American Public Media all ask: How we will feed 9 billion people by 2050? This talk will demonstrate how this pressing issue can be used to launch a modeling problem that can be tailored to address a variety of skills including mathematical techniques, problem solving, researching and citation, team work, and communication. We present a set of introductory modeling exercises that have students explore human population growth, the availability of fertile farm land, and the amount of food that can be produced per acre. We then discuss how students can be encouraged to combine their own models to calculate doomsday (the date when the total population exceeds the population who can be fed) and compare their answer with the expert result quoted in the media. We close with how these activities can be modified to target different learning objectives at various levels.

Jessica M. Libertini
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MS5

Triggering Mechanisms for Deglaciations

For the last million years or so, the Earth's climate has undergone dramatic swings, alternating between deep glaciations with vast ice sheets covering much of North America and relatively warm, but relatively brief, periods with small ice caps. These swings are characterized by long, slow descents into large ice sheets followed by rapid deglaciations. The glacial retreats are thought to be triggered by changes in the Earth's orbital parameters, known as Milankovitch cycles. We discuss some of the conceptual mathematical models that are used to describe possible triggering mechanisms.

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MS6

3D Printing Projects for Multivariate Calculus and College Geometry

Multivariate Calculus and College Geometry are two courses which have natural ways to introduce undergraduates to 3D printing. In this talk, we will describe projects that can be assigned in these courses, where students will design and print 3D objects. The objects are designed in Mathematica and make use of planar and other multivariate functions, trigonometry, polyhedra, and more. Among these objects is the Associahedron discussed in Eugenia Chengs new book.

Edward Aboufadel
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MS6

Assessing Educational Interventions: Moving from "Does It Work?" to "What Do They Know?"

In teaching mathematics complex interventions almost never work exactly as intended. As a result, the question "does it work" often fails to capture the complexity of student activity and learning. In this talk I will present multiple examples of assessment of learning outcomes, at different levels of specificity–from the course-level to the almost minute-by-minute. For each, I will also describe how different types of questions lead to different ways of thinking about student's work.

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MS6

Raising Calculus to the Surface

Abstract not available

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MS7

Mathematical Modeling Competitions, from Regional to International

For the past decade, the math majors completing the capstone course in mathematics at VMI have competed in COMAP's MCM/ICM competition. They also create a poster and present their solution at the MAA sectional meeting. Leveraging the positive feedback from this experience, we are growing our involvement with math modeling competitions, including encouraging more teams of various ages and diverse backgrounds to enter and compete. In order to build excitement and help prepare students, we hold an annual 24-hour modeling competition for students from nearby universities. We will discuss all of our efforts in supporting and encouraging participation in modeling competitions, as well as information about how others might implement them at their institutions.

Karen Bliss
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MS7

Modeling Opportunities for Mathematics Majors, Inside and Beyond the Curriculum

In our increasingly complex world, it is important for college graduates, including mathematics majors, to understand how to apply their skills to a variety of real world problems. Therefore, beyond the exposure they receive in the STEM curriculum, we offer multiple opportunities for our applied mathematics majors to solve real problems. In this talk, we will discuss our required mathematical modeling course, in which students directly engage with the entire modeling process. We will also discuss the AIM summer program, an optional paid research opportunity in which students use their mathematical skills to address problems for local businesses and organizations.

John David
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MS7

Why Teach Mathematical Modeling to Non-Stem Majors - The Development of a New Course

Our previous suite of courses for non-STEM majors were not always well-received by students, and faculty in those departments expressed some dissatisfaction in what students gained (or failed to gain) from the courses. As described in the GAIMME report, we are in the process of re-envisioning those courses with modeling as a centerpiece, helping make connections across disciplines so students can see that modeling can be a useful tool for answering important and difficult questions. In this talk, we will present our approach to developing the course and its materials, including collaborations with faculty in a wide range of disciplines as well as paid problem-developer internships for students who are interested in learning about teaching mathematics.

Greg Hartman
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MS7

Calculus and Differential Equations - Mathematical Modeling for Stem Service Courses

As we prepare our engineers and scientists, we realize that we are preparing them to solve real world problems that often do not look like mathematics problems. While it is important to teach a core set of mathematical skills and develop a common vocabulary, it is equally important to help students develop the skills needed to translate back and forth between a physical scenario and a mathematical framework. In this talk, we will present how STEM majors in calculus and differential equations are exposed to real world problems, introducing them to elements of the modeling process as presented in the GAIMME report.

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MS8

A Framework for Modeling to Encourage Interdisciplinary Conversations

Here we present a framework for thinking about what models and modeling are, particularly to other disciplines. We encourage that differing disciplinary approaches are seen as part of a larger picture of this framework, thinking about model representations in the rule of five, and modeling as the act of moving between representations. We provide examples to illustrate and acknowledge language can interfere with helping students make connections between disciplines, even between statistics and mathematical modeling. Although in targeted to teaching modeling skills to biologists, the lessons can be extrapolated to a variety of other interdisciplinary conversations.

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MS8

A BioGraphy of Life: How Graph Theory Makes Mathematics Recognizable, Relevant, and Research-Rich in Biology Education

Biologists use graphs extensively in ecology, evolution, genetics, developmental biology, and biochemistry: phylogenetic trees, food webs, pedigrees, genetic networks, metabolic pathways, kidney exchange networks, RNA secondary structures. However, they frequently do not know that these representations of their data are mathematical abstractions, generalizations, and visualizations that are amenable to deeper analysis through the use of formal graph theoretic tools: interval graphs, planar graphs, polytopes, trees, Hamiltonian paths, graph grammars will be illustrated with appropriate undergraduate problems.

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MS8

A Framework for Teaching Modeling to Biologists

What are the modeling skills and metacognitive strategies of importance for the life sciences? In this talk, we describe a teaching and learning framework around modeling that (1) highlights the sometimes hidden role of models and modeling in the sciences, and (2) points to a possible path forward on how to move from using models as illustrative tools to using modeling as a process of discovery.

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MS8

Training In-Service Teachers to Think Deeply

About Modeling in the Common Core Movement

Over the years, I have conducted in-service teacher training sessions and workshops organized by the Capstone Institute at Howard University. My role has been to enhance teacher content knowledge in mathematics to increase student learning outcomes and engagement through the talent development philosophy. In this talk, examples of how to develop in-service teachers understanding and knowledge of modeling in the Common Core will be shared. Examples will include the training of in-service teachers from elementary schools and middles schools in Washington, DC.

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MS9

From Student to Mentor: Applying Undergraduate Research Experiences to Mentorship

I will share about two different experiences I had as an undergraduate participating in research with faculty mentors, including the logistics of how each came about as well as why I look back on these experiences as formative and as invaluable opportunities for learning important skills that are hard to teach in a classroom. I will also share about my experience as a graduate mentor for CSUMS, a program for undergraduate research at RPI.

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MS9

How Student Interests Have Motivated and Driven Undergraduate Research

As a faculty member at a primarily undergraduate institution, research with undergraduate students is a very important part of my job. In this talk we will discuss how students interests has driven research projects in applied mathematics. I will talk about the good and bad experiences advising senior projects and the benefit of having students pick the topic and then figuring out the modeling approach as opposed to assigning projects to students.

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MS9

Variations in Mentorship at Dissimilar Institutions

Many factors contribute to the unique experiences that student have participating in undergraduate research projects. Similarly, faculty experiences mentoring students on such projects can vary widely. I will discuss my experiences mentoring students in undergraduate research as a graduate student at a research institute and compare this with my experience a faculty mentor at a small liberal arts college.

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MS9

Merging Interests: Mentoring Undergraduate Research Outside of Your Research Area

This talk covers strategies for conducting undergraduate research when a student has topical interests that lie outside of your area of expertise. I will discuss 1) How to decide on a mutually rewarding topic; and 2) How to let the student lead the portions of the project that align with their interests. Examples will be discussed along with the accomplishments and challenges that come with choosing a project outside of my research comfort zone.

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MS10

Application Fridays Or: How Applied Students Learned to Stop Worrying and Love the Theory

Much like oil and water, abstract theory and tangible applications can be mutually exclusive to many mathematics students. Often, one extreme is as desired as the other is not. In spite of this incompatibility, instructors recognize that one especially effective, but challenging, way to teach mathematics is to blend the two together. In my experience, Linear Algebra is a particularly appropriate course setting to do so, as it lends itself well to computational explorations of many abstract topics. Concepts such as vector spaces, spanning sets, linear transformations, and eigenvectors can all be conceptualized via Matlab and Octave software so that interest, understanding, and retention are all enhanced at both ends of the spectrum. To this end, I will demonstrate a series of Inquiry Based Learning computer labs and modules. These class sessions have infamously become to be known as "Application Fridays."

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MS10

Addition by Subtraction: Expanding Applied Math Education by Cutting to a Two Term Calculus Curriculum

Applied mathematics is utilizing an expanding array of mathematical disciplines and reaching into an increasing number of other fields every day. New courses in mathematical biology and financial mathematics are seen along with applied graph theory. This poses a big challenge to applied mathematics at many small liberal arts colleges, which lack resources to schedule a wide array of courses. Cornell College is no different in this regard. We find it hard to schedule courses for majors (including applied math courses) and teach the breadth of service courses our colleagues in other departments require. Our approach to this issue has been to trim calculus from a traditional 3 course sequence to a 2 course sequence. Some traditional material has been moved to different courses, while other material has been cut from the curriculum altogether. This approach requires both intra and inter department negotiations, but has resulted in increased applied mathematics offerings that would not be possible otherwise. In this talk, I will discuss some of the trade-offs that have been made in the restructuring of the curriculum, issues that have arisen in conversations with other departments, and benefits that have been realized.

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MS10

Undergraduate Research as a Complement and Supplement to Coursework

Limited course offerings at small schools can mean that students are unprepared for applied math research. This can result in uninteresting or unrealistic research projects on topics neither the student nor faculty advisor prefers. Even worse, students may graduate without the knowledge they need for advanced study in engineering, science, or applied math. In this talk I will discuss how I have used research projects as a vehicle to introduce material to undergraduates that they would have otherwise missed in their coursework, from partial differential equations, to numerics, to modeling.

Haley Yaple
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MS10

Leveraging Collaboration and Sustaining Research at a Teaching-Focused Institution

Excellent teaching is a key expectation at a primarily undergraduate institution. Maintaining an active research program can be challenging given the multiple demands on faculty time with teaching, service, and research. One way to develop both a sustainable and sustaining research program is through collaboration with external researchers. This presentation focuses on strategies to leverage external collaborators to maintain a sense of vibrancy in a research field. An integrative model of teaching, scholarship, and service will be presented using examples based on my experiences as a new hire through tenure.

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MS11

Mathematical Modeling at the Undergraduate Level

Math modeling has long appeared in the undergraduate curriculum as an upper level course (if it appears there at all), typically for math majors who have already had differential equations. In addition to advocating for incorporating modeling earlier and throughout the major, we discuss reasons why departments should develop a course in modeling as an exciting alternative to fulfill non-majors' math general education requirement. Such a course can make math relevant and interesting, and can even support critical non-math skills.

Karen Bliss
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MS11

Assessing Mathematical Modeling

Math modeling, at all levels, is often perceived to be difficult to assess. In this talk we will share approaches one can use to evaluate student work throughout the math modeling process. In particular we will highlight classroom experiences using the assessment tools found in the GAIMME Report.

Benjamin J. Galluzzo
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MS11

Mathematical Modeling in the Early Grades

In the GAIMME report, the Early and Middle Grades section encompasses a very wide range of grades from K-8. In this session I'll share ideas from the GAIMME report as well as experiences from the IMMERSION program, which is focused on modeling in K-6. If audience members come with questions and experiences to share, we can make this session interactive.

Rachel Levy
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MS11

Mathematical Modeling in High School

The mathematical content of the high school curriculum offers a vast array of new tools appropriate for mathematical modeling. At the same time, the life experiences and interests of high school students are rapidly expanding, opening the door to a variety of real-world problems from every discipline for their investigation. The High School section of the GAIMME Report focuses on these unique opportunities and some of the special issues that arise in teaching modeling in high school. This presentation will highlight some distinguishing features of modeling in the high school curriculum.

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MS12

Mathematical Modeling with Inservice Teacher Education

Abstract not available

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MS12

Undergraduate Stem Scholars Inspiring Young Math Modelers

Abstract not available

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MS12

Teachers Roles in Promoting Mathematical Modeling in the Classroom

Abstract not available

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MS12

Mathematical Modeling to Promote 21st Century Skills and Computational Thinking

Abstract not available

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MS13

Reu Site: Interdisciplinary Program in High Performance Computing

Our REU Site combines scientific, statistical, and parallel computing together in one program and in applying these techniques to interdisciplinary problems from outside mathematics and statistics. Since 2010, we have trained over 100 participants, with a high percentage of underrepresented minority background, in 26 teams resulting in several journal and conference papers for the participants. We want to highlight our experience in growing an REU Site program and initiate a discussion on needed priorities and resources.

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MS13

Simulation and Analysis at South Dakota State University REU Site

Our REU program focused on simulation and analysis techniques in a variety of STEM disciplines, namely mathematics, statistics, computational science, and engineering, which use similar techniques but have significantly different applications. REU students gained a broad perspective of the theory and application of simulations. We will discuss the lesson we learned from our experiences and what can be readily applied to our new REU Site: HPC in STEM Disciplines at South Dakota State University.

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Stephen Gent
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MS13

Sumar Math REU, Undergraduate Research During the School Year, Accessibility in Math, and Preparation for Graduate School

In this talk I will describe how we have been successful in opening access to REUs to traditionally under-represented populations in Math over the past 7 years, and how we go about better preparing these populations, as well as our own undergraduates, for graduate school. I will present tracking information of 7+ years of REU alumni and 10 years of alumni of our Center for Integration of Undergraduate, Graduate, and Postdoctoral research including the generation of similar centers and the spontaneous appearance of a network available for graduate students and young faculty. This shows the versatility and usefulness of vertical integration beyond a single department and within a network of groups working together to mentor and train young mathematicians. I will address what practices and philosophy appear to help a diverse group of students do well, confirming recent findings in education of diverse populations resulting from research carried out on students in the Math Alliance network.

Marianne Korten
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MS13

Involving Undergraduate Students in Emerging Parallel Computing Research

The NSF funded Research Experiences for Undergraduates (REU) site: EXERCISE (Explore Emerging Computing in Science and Engineering) project has been run at Salisbury University since 2012. The goal of the EXERCISE project is to offer students valuable research experiences in the emerging computing field and promote parallel thinking at undergraduate level. This talk will address how to immerse students into parallel computing research through interdisciplinary projects with data and compute-intensive applications in science and engineering.

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MS14

Game Theory and Evolution

Abstract not available

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MS14

Game Theory as a Mathematics General Education Course

Abstract not available

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MS14

An Evolving Introduction to Game Theory

Abstract not available

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MS14

A Game Theory Course for Mathematics Students

Abstract not available

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MS15

Math Modeling for First-Year Non-Stem Majors – Making Connections Across the Curriculum

Mathematical modeling is a powerful tool that can and should be introduced to students in non-STEM disciplines, assuming only high-school-level mathematics background. We discuss why and how Virginia Military Institute is developing a two-semester sequence in modeling which stands to motivate and inspire these students to think about how mathematics can be leveraged to answer messy, real-world questions across a spectrum of disciplines. We discuss how we made choices about technology and mathematical content, as well as how we have included both students and faculty on our campus in developing the course and materials, truly making this an interdisciplinary effort.

Karen Bliss
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MS15

Teaching Math Modeling with Software; Teaching Computational Science Through Modeling: An Integrated Approach

Abstract not available

Joe Skufca
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MS15

A First Look at Getting Solutions: A Students Perspective

As a future high school mathematics educator, I'm very conscious of providing realistic mathematical learning experiences for my students, but how and why? In this talk I'll share how my experiences as a student modeler have helped develop my teaching philosophy. In particular, I will discuss how technology can allow for authentic mathematical exploration and can also be connected to the curriculum.

Brandon Weiser
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MS15

Training for Mathematical Modeling Competitions

Mathematical modeling competition focuses on understand and transform the practical problems to mathematical problems. The ability of mathematical modeling is required and cannot be trained in a short period. What are your suggestions if someone is going to participate in a mathematical modeling competition? In this presentation, I will introduce a few factors that made the Chinese teams dramatic participation rate increment and outstanding performance in the MCM. I will also summarize my four year experiences while participating in COMAPS training at Clarkson University.

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MS16

Undergraduates Helping You Get Strawberries

Abstract not available

Kathleen Fowler
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MS16

Adventures in Mathematical Biology

In this talk, we will discuss several different computational mathematical biology projects that were completed by undergraduate students at WPI. The projects were tailored to each of the students, ranging from a sophomore to senior level and varied in duration from a summer to two years, including independent studies and a senior capstone experience. One model involved developing and solving a system of differential equations and another project involved image processing for experimental movies of swimming microorganisms. The third project involved solving a computational biofluids problem. The mathematical and computational material for each project was introduced and used as needed, with many group presentations and written logs kept of all work completed. The outcomes of the projects and lessons learned from these research experiences will be highlighted.

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MS16

REU in Mathematics at NC State: Modeling and Industrial Mathematics

In this talk, we highlight several undergraduate research opportunities and student training in mathematics at NC State University that have made an impact in the preparation of students for the varied roles of interdisciplinary research mathematicians. These include the development and integration of a number of research training activities as well as courses and curriculum development targeting topics that are fundamental to applied mathematics. One specific and novel course development by our faculty is the experimental teaching module that provides students with truly exciting, engaging learning opportunities that connect mathematics to genuinely meaningful applied problems. Finally, some successful research projects involving undergraduates will be highlighted including interdisciplinary collaborations between North Carolina State University and Calabazas Creek Research, Inc. as well as with the Beth Israel Deaconess Medical Center.

Hien T. Tran
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MS16

Student Research Experiences with Applications to Geography, Economics, and Politics at Youngstown State

Mathematics students at Youngstown State have been engaged in interdisciplinary research experiences in biology, geography, economics, and politics. In this talk, we highlight these experiences, which range from REU-style summer (or year-long) research experiences, the PIC Math program (Preparing Students for Industrial Careers in Mathematics), to individualized projects and theses. Through these experiences, students have worked on projects involving measuring gerrymandering in the State of Ohio, redistricting beats for the Youngstown Police Department, determining the return on investment for services in our Center for Student Progress, and the analysis of neighborhood interventions of the Youngstown Neighborhood Development Corporation. We will discuss getting students involved in these projects and share ideas for successfully designing and mentoring such projects.

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MS17

A Final Project Poster Presentation at a Science Festival

In a course on linear algebra, probability and statistics for the life science majors, students had to complete a final project, consisting of learning new mathematics applied to the life sciences. Students then chose between a final presentation in front of class, or a poster presentation in front of children of all ages and their families at a science festival. In this talk I will report on the festival presentations, including what worked well and what didn't, and how and why this was set up.

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MS17

The Teaching of Linear Algebra from an Engineer's Point of View

Abstract not available

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MS17

Linear Algebra as a Template for Applied Mathematics

Abstract not available

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MS17

A Second Course in Applied Linear Algebra

Abstract not available

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MS18

Musings on Mathematical Modeling: Reflections on an Upper-Level Undergraduate Course

This talk will reflect on the formulation of a first course on mathematical modeling at Swarthmore College. The course explores the development and analysis of continuous, discrete, and graphical models of diverse phenomena, drawing from applications including kinetics, epidemiology, population dynamics, diffusion, traffic flow, and neuroscience. A primary course goal is to give students exciting insights into connections between mathematics and real-world problems, examining from various perspectives mathematical tools useful in investigating interdisciplinary problems.

Victor Barranca
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MS18

Case Studies: A Capstone Course in Modeling

The math department at Lafayette College offers a senior level modeling course, Case Studies in Mathematical Modeling. This class serves as a capstone for the joint mathematics-economics major, but is regularly subscribed by math majors and occasionally students from other disciplines as well. The focus of the course is, as its title suggests, projects rather than techniques, making it unusual among courses offered in the department. Over the

course of the semester, students in the class work in groups to complete three projects, then present their findings both orally and in writing. In this talk I will describe the content and structure of the Case Studies course, teaching tips, sample projects, and student reactions. I will also describe some community-based projects that have been successfully incorporated into the class.

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MS18

The Design and Implementation of a Project-Based Modeling Course at the Undergraduate Level: Lessons Learned

This talk will review the design and implementation of an upper-level undergraduate course in mathematical modeling. The learning objectives, successful outcomes, and lessons learned will be addressed. The modeling course was designed to provide students with experience in the process of developing and utilizing mathematical models to solve complex real-world problems of current interest in research and industry. The course builds upon differential equation and modeling concepts covered in a standard undergraduate course in ordinary differential equations, and introduces students to advanced modeling concepts including nonlinear dynamics, parameter estimation, sensitivity analysis, bifurcation analysis, and optimization. This project-based course consists of a mixture of formal lectures, computer laboratories, individual and group projects, and PowerPoint presentations. During the course of the semester, students gain hand-on experience in developing mathematical models from stated problems; using mathematical software packages to build, test, and analyze models; creating graphical representations of modeled phenomena; and running numerical simulations to make predictions.

Leona Harris
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MS18

Mathematical Modeling, at the Crossroad of Imagination, Equations and Real World Problems: Teaching Challenges

As scientific computing is pervasively used in science with a significant impact on different fields of engineering, science and society, mathematical modeling is becoming a critical step in many respects. Teaching of mathematical modeling techniques is challenged by the diversity of the problems to address, of the techniques to use and the substantial role of imagination. We report the experience of Emory University, where the presence of the Hospital at a walking distance from the Department of Mathematics stimulated the students (and the instructor) in problems with a clear impact on healthcare.

Alessandro Veneziani
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MS19

Leveraging Students' Cultural Competencies Through Mathematical Modeling

Mathematical modeling demands students to apply the mathematics they know to solve problems in everyday life situations. The modeling process can be especially meaningful when the situation context is relevant to the students communities and lived experiences. I will highlight professional development work in mathematical modeling for middle grades teachers in rural communities with diverse student populations. The goal was to prepare teachers for posing modeling tasks that leverage students mathematics knowledge and background cultural competencies, resulting in successful student-created models.

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MS19

Supporting Underrepresented Groups at the Undergraduate Level

In this talk I will first provide a brief overview of initiatives and funding opportunities that aim to increase participation of minorities in mathematics, at all levels, in and out of the classroom or school. I will then describe numerous projects undertaken in the Mathematics Department at Harvard University, including some involving the Applied Mathematics Department. Simply starting a reading and discussion group on issues of inclusion and diversity is what led us to take action.

Rosalie Belanger-Rioux
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MS19

Instem (Inspiring Stem in Girls): a 3-Tiered Mentoring Approach

Recently, a near-peer mentoring concept has become more prevalent in education. This framework provides students from disadvantaged communities with an opportunity to develop their leadership skills and interact with other diverse peers. Drawing off the near-peer mentoring model with an emphasis on middle school-age girls, we have exposed this population to leadership skills in STEM work and incorporated a multi-peer model (high school, college, and teacher leaders) that will allow participants to learn content from this alignment of mentors with high school students working directly with middle school students. This program will be outlined in the presentation.

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MS19

Completing the Circle, Going Back to the Source: Indigenizing University Mathematics

Indigenization is a notion gaining widespread adoption in Canadian universities, as a means for increasing diversity and inclusion with respect to Indigenous (Native) people. This talk will examine the concept of Indigenization in general; its current implementation, benefits, and drawbacks in the context of university-level mathematics and statistics courses; and its potential for transforming mathematics education at all levels. Examples of Indigenization in various mathematics courses will be provided.

Edward Doolittle
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MS20

How Might Physics Education Research Facilitate the Computational Revolution

Computation has revolutionized how modern science is done. Modern scientists use computational techniques to reduce mountains of data, to simulate impossible experiments, and to develop intuition about the behavior of complex systems. Much of the research completed by modern scientists would be impossible without the use of computation. And yet, while computation is a crucial tool of practicing scientists, most modern science curricula do not reflect its importance and utility. In this talk, I will discuss the urgent need to construct such curricula in physics and present research that investigates the challenges at a variety of all scales – from the largest (institutional structures) to the smallest (student understanding of a concept). I will discuss how the results of this research can be leveraged to facilitate the computational revolution. This research will help us understand and develop institutional/departmental incentives, effective teaching practices, evidence-based course activities, and valid assessment tools.

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MS20

Integrating Computing in the Introductory Physics Education

Computing is an integrated part of the practice of physics in research and industry, but computing is only sparsely integrated into the form and the contents of traditional physics educations. We have developed a physics program where computing is integrated from day one. This allows us to make fundamental changes in how and what we teach in the basic physics courses, since we are no longer limited to problems that can be solved exactly. Students can therefore work on realistic, applied problems early in their education, and the students learn to apply a problem-solving workflow which is similar to that found in research or industry. This change in curriculum opens for a series of pedagogical approaches allowing for student-active learning methods, and students are provided the basic skills needed to participate in real research projects early in their studies. Here, we present examples of how this curricular change has been implemented at the University of Oslo, and how the changes are have changed the courses where computing is integrated into the course curriculum. We also present studies of the students' learning processes and examples of students' participation in active research projects.

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MS20

Reforming the Undergraduate Mathematics Curriculum with a Computational Perspective

The worlds fastest computer can perform 1017 operations per second, and our laptops 10^{12} operations per second. This computational power has transformed both the research and the practice of mathematics and disciplines that make use of mathematics. In education the computer has found many uses, e.g. for communication, as a pedagogical tool and as a calculator. However, the core content of the mathematics curriculum has changed surprisingly little at most universities over the past fifty years. Broadly speaking we may say that computers have dramatically changed the wrapping of education, but not the content. In the mini symposium Computing across the curriculum we attempt to address this issue. In this particular talk we are going to discuss how computers and computing may influence the elementary mathematics curriculum more broadly than just as an advanced calculator. Some key questions that will be discussed are What does it mean to solve an equation?, What does it mean to evaluate a definite integral?, and How should the answer to these questions be reflected in the curriculum? We will also describe how we have reformed the elementary mathematics education at the University of Oslo in light of these questions, and touch on some deep, inevitable challenges. The other talks in the mini symposium will discuss similar changes at another university and the consequences for physics education.

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MS20

Using Programming to Promote Theory in First Semester Calculus

At Lund University in Sweden, we are currently integrating Python in the mathematics and physics undergraduate programs. This effort is inspired by the Oslo model (described by Knut Mrken in the same session). Briefly, the idea is to require that the students follow a programming course in the first semester of their undergraduate studies, and to use this as a resource in the other courses. In this talk, we report on the experience so far from Lund with emphasis on the implications for the first semester Calculus course. We note that since this course is quite heavy on the theory, a main goal has been to make abstract concepts such as the formal definition of the limit, convergence of series and continuity more accessible. The basic idea is to use numerical simulations to give students a feeling for "mathematical phenomena" and the need for formal definitions to properly "model" them.

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PP1

A "Flipped" Developmental Math Course Model for the Liberal Arts Institution

Many large institutions are now using the Math Emporium model of teaching. However, this model may not be possible or practical at smaller liberal arts colleges. In this presentation, the development of a flipped developmental math course is described. Initially the course was taught a traditional lecture format but data collected on student performance motivated a change in approach. This model attempts to incorporate the best features of the Math Emporium format.

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