



Phillips Exeter Academy

Anja S. Greer Conference on Mathematics and Technology

Morning Courses (8 AM – 10 AM)

01 - Foundations of Data Science for High School Students

Leader: Mahmoud Harding, North Carolina School of Science and Mathematics

In this course, we will engage in activities that focus on three core aspects of data science: exploration, inference, and prediction. We will learn the basics of the Python programming language along with commands and functions for investigating and graphically displaying data. Throughout the course we will manipulate data sets, plot visualizations, make predictions, and quantify our level of certainty. The course will conclude with participants learning how to design activities that can be distributed to students through Jupyter notebooks.

02 - Making It Relevant: Algebra I/II

Leader: Dashiell Young-Saver, KIPP Texas Public Schools

If Covid-19, recent election cycles, and discourse in the digital age have shown us anything, it's this: We need citizens who can use math to analyze complex issues. So, let's bring real issues into math class. In this course, we will create and practice Algebra activities that discuss relevant topics (gerrymandering, food deserts, electric cars, sports, etc.). We'll explore how to use these activities to boost learning, engagement, critical thinking, and social awareness. Finally, we will discuss strategies for facilitating productive and balanced classroom conversations on such topics.

03 - Just Five Good Precalculus Labs

Leader: Dan Butler, The Lovett School

Let's spice up our precalculus curriculum with some amazing labs. We will use Excel, The Geometer's Sketchpad, GeoGebra, the TI-84, hands-on materials and anything else we decide we need to explore some of the concepts of precalculus through great problems and interesting constructions. We will also take some time to discuss what needs to be in a precalculus course in light of the current state of mathematics education.



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04 - A Novel Approach to the Teaching of Function Transformations

Leader: Rachel Chou, Menlo School

This workshop will include ready-made student-tested materials that give students a deep understanding of linear transformations of functions. From an initial task that will anchor student understanding, to advanced challenges that really make students (and their teachers!) think deeply about transformations, participants will be fully immersed in the world of transformations. In the latter part of the week, we will apply our work with transformations to polar functions, parametric functions, and the derivatives of single variable functions and their transformations.

05 - Recreational Mathematics - Inspiration, Engagement, and Enrichment

Co-Leaders: Ken Collins, Charlotte Latin School, Charlotte, NC, Ron Lancaster, University of Toronto, Toronto, Ontario, Canada

Recreational mathematics involves patterns, games, puzzles, mathematical magic tricks, origami and mathematical curiosities. In this course we will demonstrate a variety of ways to use recreational mathematics in the classroom; for example, as a class warm-up; a link to applications; an enrichment activity and a way to encourage collaborative learning and the development of mathematical imagination. Making mathematics engaging and interesting in this way will show students that mathematics is a pleasurable activity that can be enjoyed throughout their lives.

06 - Teaching a Discussion-Based Math Course

Leader: Diana Davis, Phillips Exeter Academy

Discussion-based courses are so wonderful for student engagement and understanding, but they're challenging to teach well, especially the first time. In this course, you'll learn to create a classroom environment that fosters student discussions. You'll have the powerful experience being a student in this kind of a classroom yourself, and we'll discuss our class dynamics to learn from them, while leaving time for the many questions you may have about implementing it in your own classroom.

07 - Beginning Math Teacher Workshop

Leader: Jessica Schenkel, Porter-Gaud School

This course is designed for teachers in their first 5 years of teaching. Regardless of your background, this course will provide an opportunity to reflect on past experiences and leave you refreshed and full of ideas for the



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2022-2023 school year. Jessica will share her experiences, successes, and failures as a teacher and department chair in public, day, and boarding schools. We will review trends in math education, how to put relevant research to practice, classroom management techniques, curriculum design, and how to create a classroom that supports the development of a growth mindset.

08 - Mathematically Model Real-World Data with Social Implications: Opioids, Climate, COVID, US Debt, ...

Leader: Tom Reardon, Austintown Fitch High School and Youngstown State University, Youngstown, OH

Analyze, model, and interpret real data, while creating social awareness of important current issues. Use modeling equations to interpolate, extrapolate, calculate percent inc/dec/error. Interpret the data and its consequences using graphs, tables, normal curves. Relevant topics to investigate include Opioids, Hot Car Temp Deaths, Climate Change, US Debt, COVID, Payday Loans, Plastic Straws, Vaping... Learn how to create your own modeling activities. Graphing calculators are provided but data can be used with any graphing technology. Get all data sets, student sheets, teacher notes, solutions.

09 - The Exeter Math Program - A Problems Oriented Approach

Leader: Jeff Ibbotson, Phillips Exeter Academy

The Exeter Math Curriculum consists of a number of problem collections that have been organized in such a way as to emphasize learning through discussion. We will dive into the problems for Math 2, Math 3, and some additional ones from Math 4 if time allows (all Exeter Math books are available on-line). We will work some of these problems in order to get a hands-on idea of how it all fits together, in particular, vector approaches to geometry, parametric equations, geometric dissections, three dimensional geometry, and combinatorics and probability problems (including Markov Chains).

10 - Bottles, Bags, and a Bus Stop: An Investigation of Middle School Students' Graphical Reasoning

Leader: Laurie Cavey, Boise State University, Boise, Idaho

We will explore three math tasks that elicit a range of students' ideas about graphical representations of related quantities. The tasks challenge students to interpret discrete points, recognize proportional and nonproportional relationships, and coordinate quantities that change together. We will examine written and video-based evidence of middle school student reasoning to build



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awareness of the ways students intuitively communicate their productive ideas. Come to be wowed by the amazing things students know and can do. Leave with ideas on how to meet them where they are!

Late Morning Courses (10:30 AM – 12:30 PM)

11 - Exeter Math 1: A Student-Centered Problem-Based Approach to Algebra 1

Leader: Julie Van Wright, Phillips Exeter Academy

Use the Exeter Math 1 materials to explore problem solving through a Harkness discussion-based format to build content with students, rather than for them. Empower students to discover, develop, and apply general principles and transferable techniques through accessible and contextual problems. Content spans Algebra 1 topics, including linear relationships, absolute value, quadratics, and typical and atypical "word" problems. We will use graphing technology to supplement learning in this dynamic classroom format. Come see what Exeter Math is all about, at this introductory level!

12 - Number Theory for Teachers - A Problem-Based Approach

Leader: Jeff Ibbotson, Phillips Exeter Academy

Number theory is currently a hot topic in the news. Its uses in cryptography are well known and this topic can open the door for many students to explore some deep math involving simple curves. We will explore Pythagorean triples and their construction through simple circle geometry. We will also look at elliptic curves and solve for rational points on those curves. The instructor has written a problem-based approach to the subject and has taught such a course for high school students. We will use Desmos, Excel and the graphing calculator to assist in solving diophantine equations.

13 - Mathematical Modeling in Algebra 2 and Precalculus

Leader: Christine Belledin, North Carolina School of Science and Mathematics, Durham, North Carolina

Mathematical modeling can inspire curiosity in students and allow them to think creatively. We will explore ways to help students navigate the modeling process to work on interesting real-world problems. The problems will include optimizing the passage of ships through the Suez Canal, modeling the path of playground swing, and optimizing the number of samples in pooled blood tests. The topics will span from advanced algebra to precalculus. We will also



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explore how to use Desmos activities as a tool to guide students through modeling problems and to promote exploration and independence.

14 - Making It Relevant: AP & non-AP Statistics

Leader: Dashiell Young-Saver, KIPP Texas Public Schools

If Covid-19, recent election cycles, and discourse in the digital age have shown us anything, it's this: We need citizens who can use math to analyze complex issues. So, let's bring real issues into math class. In this course, we will create and practice statistical activities on relevant topics (race & policing, immigration, online dating, sports, etc.). We'll explore how to use these activities to boost learning, engagement, critical thinking, and social awareness. Finally, we will discuss strategies for facilitating productive and balanced classroom conversations on such topics.

15 - Just A Bunch of Good Geometry Labs

Leader: Dan Butler, The Lovett School

By the time students get to precalculus, a great deal of their geometry know-how has gone the way of the slide rule. Let's bring some excitement back into geometry through great problems and great explorations, and rediscover how geometry really lies at the heart of all mathematics. In this course we will explore some interesting geometry problems that will excite both the students and the teacher. We will make use of GeoGebra, calculators, straw, plexiglass, soap bubbles, and, of course, our creativity.

16 - Using Computer and Hands-On Activities with Exeter's Math 1 and Math 2 Problem Sets.

Leader: Eric Bergofsky, Phillips Exeter Academy, Exeter, NH

This course will feature both computer/tablet activities with Desmos, Geometer's Sketchpad and/or GeoGebra, as well as complimentary or similar hands-on classroom activities for motivating students and enhancing their understanding of various problems in Exeter's Math 1 and Math 2 problem sets. Activities and problems will be selected based on the interests of the participants. The selected problems will be at the level of algebra and geometry, and can be integrated into a problem-based learning setting or a non-PBL curriculum.



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17 - Using Physics to Teach Mathematics with Purpose, Power, Passion, and Fun!

Co-Leaders: Ron Lancaster, University of Toronto, Toronto, Ontario, Canada, Drorit Weiss, TanenbaumCHAT

This course will demonstrate how to use physics to make mathematics more meaningful and accessible to students. We will examine ways to introduce more physics into our mathematics classes, such as using physics experiments to collect data; providing activities that promote inquiry; and making mechanical and physical models to solve mathematical problems. These experiments, activities, and models can make mathematical problems more accessible to students. They can also be used to provide evidence that a mathematical solution is correct, sound, and reasonable. Soap bubbles will be provided.

18 - Writing a Problem-Based Curriculum

Leader: Diana Davis, Phillips Exeter Academy

Exeter's problem-based curriculum works very well for Exeter students. Your students, with their background and in your school environment, likely need something different. We will do two things in parallel: (1) We will carefully study how the Exeter materials are constructed, with exploratory problems that build day by day. (2) You will write your own curriculum, and we will discuss and revise it as a group. All are welcome, whether this is your first experience with a problem-based curriculum, or whether you've already written something and want to refine it.

19 - Inquiry-based Abstract Algebra

Leader: Aviva Halani, Phillips Exeter Academy, Exeter, NH

Experience being a student by learning through a problem-based course! Materials for this course were developed for a Math 790 Special Topics course at Exeter. You'll have the opportunity to "re-invent" many of the concepts in a traditional Abstract Algebra course. We'll start by determining axioms for a mathematical structure called a group by exploring several sets and the properties they have in common. By playing with examples and generalizing from there, we'll uncover rather sophisticated mathematics. There are no prerequisites other than a willingness to learn with your peers.



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20 - From Australia to Zombies: Using Python to Model Classic Calculus Problems

Leader: Greta Mills, Oxbridge Academy

Learn the basics of Python programming to create models rooted in Calculus. We will explore population dynamics (exponential and logistic growth), pursuit curves, predator-prey models, optimization, and related rates through modeling scenarios including the rabbit population in Australia, wolves vs rabbits (vs plants), trapping zombies in a zombie apocalypse, and more. No prior experience in Python programming is necessary, and participants can bring their favorite Calculus problem to model.

21 - An Alternative to Traditional Precalculus

Leader: Jessica Schenkel, Porter-Gaud School

What course(s) does your school offer to students who struggled through Algebra 2? An Alternate to Traditional Precalculus gives you a free, full-year course of eight units that is built around problems and topics that engage teenagers. You can teach the entire course or choose parts to supplement an existing course at your school! A laptop is required (CODAP, DESMOS and EXCEL/GOOGLE SHEETS). Check out <https://www.jschenkelmathstudio.com/> and sign up for this course to learn more about how you can use these resources to get your students excited about math again!

Afternoon Courses (1:30 PM – 3:30 PM)

22 - Mathematical Modeling in Calculus

Leader: Christine Belledin, North Carolina School of Science and Mathematics, Durham, North Carolina

Mathematical modeling can bring calculus to life and allow students to see how math can be used to investigate important and interesting real-world problems. We will explore problems that give students an opportunity to think creatively, deepen their understanding of calculus concepts, and develop their mathematical modeling ability. Problems will span a variety of contexts, including the measurement of income inequality, the spread of disease, and the path of a spacecraft around the moon. We will use Desmos and Geogebra as tools to help students explore and solve modeling problems.



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23 - Gems Of Geometry

Leader: Philip Mallinson, Phillips Exeter Academy, Exeter, NH, retired

This course will explore gems of geometry ranging in time from 2300 BCE to 2000 CE. We will develop results seldom taught in a traditional geometry course but which are accessible to high school students. We will work through problem sets written in the style of the Exeter math materials, working collaboratively, discussing the material and presenting conclusions, creating our own take-aways. The material will range from theorems of Euclid, by way of the invention of projective geometry, non-Euclidean geometry, tessellations and polyhedra, to some recent results in the geometry of origami.

24 - Using Technology to Invoke Curiosity in the Math Classroom

Leader: Curtis Brown, Texas Instruments Inc.

By exploring math through phenomena, we give students opportunities to engage with the questions they have about the world. Join us for this exciting week where we'll explore the joy and beauty of mathematics, and consider ways to pass a legacy of curiosity to our students. We will use graphing calculators, sensors, and coding with physical computing devices to dive into a variety of topics from Algebra 1, Algebra 2, a bit of Calculus, and more! Come see how asking questions about the way the world works opens the door for exciting mathematics experiences.

25 - Mastery-based Assessment in Algebra using Exeter Math PBL

Leader: Eric Bergofsky, Phillips Exeter Academy, Exeter, NH

Assessing for mastery of specified learning objectives is a paradigm shift from the traditional grading system that uses partial credit and a cumulative average of tests to determine a grade. This course will help teachers learn more about this mastery approach, examine in detail the successful pilot program launched at Phillips Exeter Academy for 9th graders in the Fall term of 2021, and start the process of developing learning objectives, assessments, and grading rubrics for participants' own courses. Mastery-based assessment also addresses concerns raised recently about grading for equity.

26 - Alternative Engaging Activities & Approaches for a Precalculus Course

Leader: Rachel Chou, Menlo School

Are you in search of student-centered challenging tasks that foster depth of understanding in a Precalculus course? We will look at student-tested engaging activities for studying polar, parametric, and exponential functions.

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Have you ever compared different types of polar spirals? Let's really look at Lissajous curves! Did you know that all exponential functions of the form: $f(x) = ab^x + c$ are geometrically similar to each other? Additional topics that we will explore if there is time include the binomial expansion and combinatorial proofs, and an alternative approach to studying matrices.

27 - Using Mathematics To Analyze Issues of Social Justice

Leader: Ken Collins, Charlotte Latin School, Charlotte, NC

Many educators now recognize the important role that mathematics teaching can play in helping students to understand and overcome social injustice and inequality. A rich and rigorous mathematics curriculum can encourage students to investigate issues related to elections, public health, poverty, living wage, housing costs, insurance, pandemics, education funding, climate change, finance, debt, wage discrepancies, and transportation. Our goal will be for each participant to develop a unit so students understand "why we are learning this" and help them become responsible citizens of the future.

28 - Problem-Solving and Harkness - Deepening Understanding and Discovering Mathematics

Leader: Aviva Halani, Phillips Exeter Academy, Exeter, NH

This course will provide participants the opportunity to both discuss pedagogy and be active problem-solvers. We will discuss the pillars of Exeter's math curriculum, exploring how to use problem-solving and a student-centered classroom to introduce new mathematical concepts without direct instruction. We will also delve into some rich problems designed to deepen understanding. Finally, if there is interest, participants will have the opportunity to develop a problem strand themselves and receive feedback. Most examples will be from the secondary level.

29 - Big Data and Python: A First Step in Data Science

Leader: Greta Mills, Oxbridge Academy

Data science has become one of the fastest-growing careers - but what is data science? At its core, data science is an umbrella term encompassing a wide range of areas of study, including analysis of large data sets. This course will introduce participants to Jupyter Notebook, an open-source platform for writing, executing, and sharing code. Participants will examine, clean up, and analyze large data sets, including roller coasters, college rankings, and more. If time, we will explore the iris data set, also known as the "Hello World" data set of machine learning. No prior experience required!



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30 - Individualized Applied Activities and Other Modeling Problems and Ideas for Precalculus and Trig

Leader: Tom Reardon, Austintown Fitch High School and Youngstown State University, Youngstown, OH

Individualized activities include 60 different student versions and 60 complete solutions with intermediate answers of these applied activities: Baseball Problem, Nail in the Tire, Plane Wind Vectors, The Great Applied Problem. Learn how to create your own individualized activities. Modeling includes: 12 Days of Christmas, Wolf Population, Field Goal for the Win, Derive Summation Formulas. Transformation graphing ideas: use technology to discover patterns, given the graph, write the equation exercises, modular 250+ video series. Teach conceptually with parametric equations. Get all the materials.

31 - Bottles, Bags, and a Bus Stop: An Investigation of Middle School Students' Graphical Reasoning

Leader: Laurie Cavey, Boise State University, Boise, Idaho

We will explore three math tasks that elicit a range of students' ideas about graphical representations of related quantities. The tasks challenge students to interpret discrete points, recognize proportional and nonproportional relationships, and coordinate quantities that change together. We will examine written and video-based evidence of middle school student reasoning to build awareness of the ways students intuitively communicate their productive ideas. Come to be wowed by the amazing things students know and can do. Leave with ideas on how to meet them where they are!