

Talk Topics for 2025-2026 School Year

Below are some possible topics. I hope these include something for each taste.

Mathematics Education

1. Here is an article on proving that $\sqrt{2}$, $\sqrt{3}$ and $\sqrt{5}$ are irrational numbers geometrically.
<https://maa.tandfonline.com/doi/epdf/10.1080/0025570X.2023.2168436>
2. A visual proof that $\sqrt{2}$ is an irrational number using a balanced beam.
<https://maa.tandfonline.com/doi/epdf/10.1080/07468342.2023.2201569>
3. This paper gives a proof of Heron's formula at the middle school level.
<https://maa.tandfonline.com/doi/epdf/10.1080/0025570X.2024.2312796>
4. Geometric Solutions of Cubic Equations - The 11th century Persian poet, mathematician, and astronomer Omar Khayyam devised a geometrical method to also solve the cubic equation $ax^3 + bx^2 + cx + d = 0$. There are many references for this problem.
5. The Conway Circle Theorem. The following paper has a generalization of this theorem. The original theorem itself is a very interesting geometry result.
<https://maa.tandfonline.com/doi/epdf/10.1080/0025570X.2023.2294673>
6. Short biographical talks on female mathematicians, for example, Margherita Piazzolla Beloch, Elizabeth Smith, etc. See
https://en.wikipedia.org/wiki/List_of_women_in_mathematics.
7. Tower of Hanoi is a well-known problem in mathematics education circles. Since the solution can be long, you might wonder if you are on the right track. The paper *The Solution to a Hanoi-ing Little Problem* by John Bonomo answers this question. You can present Tower of Hanoi problem and, more importantly, this paper. See
<https://www.tandfonline.com/doi/pdf/10.1080/07468342.2018.1502983>
8. Present the paper *An Alternative to Integration by Partial Fractions Technique*. This is the title of a short paper by Yusuf Gurtas published in The College Mathematics Journal, vol. 50 (2019), no. 2, 140-142, and available at
<https://www.tandfonline.com/doi/full/10.1080/07468342.2019.1561125>.
9. Present the paper *A Simple Proof of Descartes' Rule of Sign*. This is the title of a short paper by Xiaoshen Wang published in Amer. Math. Monthly, vol. 111 (2004), no. 4, 525-526, and available at
<https://www.tandfonline.com/doi/abs/10.1080/00029890.2004.11920108>.
10. With the discovery of an Einstein shape to form an aperiodic tessellation, a talk about the tessellation history, results and the newest discoveries is very timely. See
<https://www.scientificamerican.com/article/newfound-mathematical-einstein-shape-creates-a-never-repeating-pattern/>.
11. On the theme of tessellation. Here is an article that discusses *Integral Tiling Pentagons* from all possible convex tiling families,
<https://maa.tandfonline.com/doi/epdf/10.1080/0025570X.2023.2176101>

12. Here is an interesting “Proof Without Words” involving Fibonacci numbers.
<https://maa.tandfonline.com/doi/epdf/10.1080/0025570X.2023.2176682>. Here is another neat result using golden ratio.
<https://maa.tandfonline.com/doi/epdf/10.1080/0025570X.2022.2125732>

Applied Mathematics

13. This article discusses mathematics involved in using miter saws to build things.
<https://maa.tandfonline.com/doi/epdf/10.1080/0025570X.2022.2093547>
14. This article uses a balance beam to proofs of Mean Inequalities.
<https://maa.tandfonline.com/doi/epdf/10.1080/0025570X.2023.2167431> The next article gives a generalization of Pythagorean Means (three of the means discussed in the last article) using geometry.
<https://maa.tandfonline.com/doi/epdf/10.1080/0025570X.2022.2125729>
15. Padovan numbers arise in architecture. This article discusses them in rectangular tilings. <https://maa.tandfonline.com/doi/epdf/10.1080/0025570X.2023.2165864>
16. Presentation of the calculus based proof of $\frac{1}{1} + \frac{1}{4} + \frac{1}{9} + \cdots = \frac{\pi^2}{6}$. You learned in Calculus II that this infinite series is convergent (p -series with $p = 2 > 1$). In Boundary Value Problems, you use Fourier series to find its value. But this can be done elegantly using calculus and is included in the book *Proofs from THE BOOK* by Martin Aigner and Günter Ziegler, available in the library. However, there are other proofs. The paper <http://math.cmu.edu/~bwsulliv/basel-problem.pdf> lists several solutions with references.
17. Here is another proof of $\frac{1}{1} + \frac{1}{4} + \frac{1}{9} + \cdots = \frac{\pi^2}{6}$.
<https://maa.tandfonline.com/doi/epdf/10.1080/0025570X.2024.2312093>
18. With COVID-19 epidemic, the interest in mathematical models of diseases is on the rise. They span statistical, discrete, and continuous models. For example, discrete or continuous SIR or SEIR models. Any overview talk of such models or specific development of models for COVID-19 will make an interesting talk.
19. Here is an article on spread of an infection, like COVID-19, in a network.
<https://maa.tandfonline.com/doi/epdf/10.1080/0025570X.2022.2125732>
20. Fibonacci Day is Nov 23 (1123). There are many aspects of Fibonacci numbers that can easily be discussed.

Mathematics

21. Here is an interesting article on a series test not typically covered in calculus books.
<https://maa.tandfonline.com/doi/epdf/10.1080/0025570X.2023.2168433>
22. *Can the Derivative of an Inverse Function Equal the Inverse of a Derivative* is the title of an interesting paper at
<https://maa.tandfonline.com/doi/epdf/10.1080/07468342.2024.2392476>
23. Pi Day (Mar 14, 3/14). A talk about number π ; history, calculation, properties, and applications. Last year we had a talk on its irrationality, a talk on pi being transcendental will complete proof of these important properties.

24. *Many Goats Grazing in a Square Field* is the title of an article generalizing the calculus problem of finding grazing area of an animal tethered to a rope on a side of a cylindrical silo at <https://maa.tandfonline.com/doi/epdf/10.1080/0025570X.2025.2460390>
25. In the article the author shows different and interesting ways to approximate the number π . <https://maa.tandfonline.com/doi/epdf/10.1080/07468342.2023.2265282>
26. Proof of Convergence of Fourier series. Read, understand, and rewrite the proof in your own words. Reference: David Powers, BVP's and PDE's, 6th edition, ISBN 978-0-12-374719-8.
27. Present the paper *Finding Real Roots of Polynomials Using Sturm Sequences*. This article compares Descartes' Rule of Signs, the Budan-Fourier Theorem, and versions of Sturm's Method in contrast with the approximate root count gleaned from graphing utilities. This article is published at PRIMUS, (30)1:36-49, 2020, and also available at <https://www.tandfonline.com/doi/full/10.1080/10511970.2018.1501626>.
28. Present the paper *Inflating the Cube Without Stretching*. This is the title of a short paper by Igor Pak published in Amer. Math. Monthly, vol. 115 (2008), no. 5, 443-445, and available at <http://www.math.ucla.edu/~pak/papers/milka2.pdf>. In this article the author describes a way to deform a cube that distances between points are maintained while the volume is increased. The beauty of this article is that one can actually construct the deformed cube!
29. Address the conjectures in the paper <https://maa.tandfonline.com/doi/pdf/10.1080/0025570X.2020.1704613> regarding certain primes. One such prime is 29 for which $2(29) + 9 = 67$ is also a prime and again $6(67) + 7 = 409$ is another prime.
30. The Arithmetic Mean – Geometric Mean (AM-GM) Inequality has many proofs and applications. A new proof is at <https://maa.tandfonline.com/doi/pdf/10.1080/07468342.2020.1697605>. An overview of this topic and presentation of interesting proofs will make a nice talk.

Probability and Statistics

31. *On the Probability Distribution of the Number of Distinct Outcomes in Repeated Trials* is the title of an interesting paper at <https://maa.tandfonline.com/doi/epdf/10.1080/0025570X.2025.2451582>
32. The weight of a ten-pound bag of potatoes is almost certainly not exactly ten pounds. This paper investigates the distribution of these weights. <https://maa.tandfonline.com/doi/epdf/10.1080/07468342.2023.2265282>
33. Is there a better strategy to buy scratch-off lottery tickets? Dr. Joan Ginther won four large lottery prizes and was declared the luckiest woman on earth by Harper's magazine. <https://maa.tandfonline.com/doi/epdf/10.1080/07468342.2023.2266315>
34. Give a talk on probability of randomly selected positive integers being relatively prime. A quick search will result in many references.

35. Present the paper Absent-Minded Passengers published in American Mathematical Monthly, 126:10,867-875, and available at <https://www.tandfonline.com/doi/full/10.1080/00029890.2019.1656024>. Here is the abstract of the paper. Passengers board a fully booked airplane in order. The first passenger picks one of the seats at random. Each subsequent passenger takes his or her assigned seat if available, otherwise takes one of the remaining seats at random. It is well known that the last passenger obtains her own seat with probability $1/2$. We study the distribution of the number of incorrectly seated passengers, and we also discuss the case of several absent-minded passengers.
36. Present the paper Three Persons, Two Cuts: A New Cake-Cutting Algorithm in Mathematics Magazine, Vol 95, Issue 2, 110-122, and available at <https://maa.tandfonline.com/doi/full/10.1080/0025570X.2022.2023300>

Possible Research Problems

37. In the Dynamical Systems course, we discuss behavior of solutions of systems of planar ordinary differential equations and graph them using Mathematica. Of course, this requires a full theoretical understanding of the systems. It would be very useful to build a Mathematica program that the user just inputs coefficients of the ODE's and then Mathematica draws the phase portrait demonstrating the behavior of the solutions.
38. Also, in Dynamical Systems, there are still questions on the number of limit cycles of planar systems with just quadratic growth rates. There has been ongoing work in this area for many years. We can start by understanding current examples, building new ones. This is part of the Hilbert's Sixteen Problem on the maximum number and relative position of the limit cycles of such systems.
39. A while ago, Professor Ondrus mentioned Collatz conjecture in his talk. Here is a modified Collatz conjecture that we may be able to solve. We define a sequence of integers starting with any positive integer as follows. If the integer is even, divide it by two. If the integer is odd, square it and subtract one. Repeat the procedure with the new integer. For what choices of the initial integer values, the resulting sequence will end at a zero? (Starting with 2 we get zero in the second step; $2, 2/2=1, 1^2-1=0$) Try to identify, with proof, all such starting integer values. Does there exist initial integer values that the series will never end (at a zero)?
40. In her talk, Amber Deamer showed an animation of an ellipse with tangent lines of the same length drawn at each of its points and discussed the area between the shape formed by the endpoints of the tangent lines and the original ellipse. Professor Ondrus suggested studying the shapes obtained by starting with a curve, open or closed, and drawing tangent lines of the same length at each point of it to get a new curve and then repeating the process. Are there limiting shapes for this process? Are there any interesting properties?