St. Gregory College Preparatory School

Michael Herzog
Department of Mathematics
St. Gregory College Preparatory School

Sarah Edge Mann
Interdisciplinary Program in Applied Mathematics
University of Arizona

Creating Leaders and Innovators

About Us

Michael earned a BS in Electrical Engineering from the University of Arizona in 1981, and worked as an electrical engineer for 23 years. In 2004 Michael left his engineering job to attend the Teach for Tucson program at the University of Arizona. He received his Masters Degree in Elementary Education in 2005 and now teaches mathematics at St. Gregory College Preparatory School.

Sarah earned a BS in Mathematics from Harvey Mudd College in 2006, and MSc in Applied Mathematics from the University of Arizona in 2009. She is currently working on her PhD in Applied Mathematics at the University of Arizona. Her research interests are in information theory, specifically coding theory, data compression, and quantum information theory.

Michael and Sarah teach two sections of Quantitative Analysis, one section of Algebra II, and one of Geometry.

The History of Polynomial Equations and Évariste Galois

Find the side of a square given that the area minus the side is 870.

This problem and its solution was found on a Babylonian clay tablet from 1600 BC! The problem can be expressed by the quadratic function

$$x^2 - x = 870$$

and can be solved by completing the square. People having been thinking about the roots of polynomial equations for thousands of years and using the same methods to solve them as are taught in Algebra classes today.

In the 1500s, mathematicians found formulas for the roots of cubic and quartic polynomials, similar to the quadratic equation for quadratic polynomials. They were eager to find a similar equation for quintic polynomials.

(See the introduction to "Galois Theory" by Ian Stewart for more on this subject.)

Évariste Galois (1811 - 1832) was a French mathematician who was interested in the roots of polynomials.

He showed that the quintic is unsolvable, there is no algebraic expression that gives the roots to a general quintic polynomial. His methods for proving this created a rich field of mathematical research. He tragically died in a duel at the age of 20.

Quantitative Analysis: A Fourth Year Math Class

This year, St. Gregory is offering a new fourth year math class, Quantitative Analysis (QA), which Michael and Sarah have been developing. Students in this course have completed Algebra II, but are not interested in pursuing the traditional Pre-Calculus then Calculus mathematics curriculum. This class focuses on problem solving skills, communication of mathematical ideas, and strengthening students' understanding of Algebra II material. In addition, students will complete a unit on financial math and learn to program in Python.

Problem Solving

During the first semester, QA students followed the book *Problem Solving Strategies: Crossing the River with Dogs and Other Mathematical Adventures* by Ted Herr and Ken Johnson. Each chapter in this book explores a different problem solving strategy and provides a variety of problems that can be solved using each strategy. Students work together on these challenging problems and present their solutions to the class as well as turn in in-depth, written explanations of selected problems.

Problem Solving Strategies

1. Draw a Diagram
2. Systematic List
3. Look for a Pattern
4. Guess-And-Check
5. Identify Subproblems
6. Work Backwards
7. Algebra

Sample Problem

The triangle shown below is called Pascal's triangle. Find a pattern that will produce the next row.

1
1 1
1 2 1
1 3 3 1
1 4 6 4 1
1 5 10 10 5 1

Student Comments

- "I like this course because I think the problem solving will be more relevant and helpful to me in the future than other math classes."
- "The skills I have learned have helped me in other classes and on the PSAT."
- "I like how we can work together and collaboration is encouraged."
- "This course is awesome. It teaches us the most relevant math I have ever learned."

Computer Programming

In the second semester students are learning the Python programming language. They will use Python to write programs that aid in solving mathematical problems. For example, they will write programs that:

- Calculate the value of $\frac{x-2}{x^2+3x-10}$ for a value of x provided by the user,
- Play the game "Rock, Paper, Scissors"
- Find the roots and vertex of any quadratic function $f(x) = ax^2 + bx + c$ provided the coefficients a, b, and c,
- Find the roots of any given function using an iterative method,
- List the first 100 prime numbers

(Images from http://en.wikipedia.org/wiki/Rock-paper-scissors.)