Number and Quantity

The Real Number System

• Extend the properties of exponents to rational exponents.

Beyond the Golden Ratio: A Calculator-Based Investigation
Peter L. Glidden
February 2001, vol. 94, no. 2, pp. 138–44

N.RN.2
N.RN.3

MP1	MP2	MP3	MP4	MP5	MP6	MP7	MP8
●	●		●			●	

Using a discovery-oriented approach to examine the golden ratio, the author shares four activities: (1) computing a continued radical to approximate the ratio; (2) investigating repeated radicals to identify which values they approximate; (3) exploring the golden-rectangle interpretation of the continued radicals; and (4) investigating a golden-section interpretation. The article also makes connections to trigonometry, the quadratic formula, and the Pythagorean theorem.

T

Quantities

• Reason quantitatively and use units to solve problems.

Precision: The Neglected Part of the Measurement Standard
Donald Nowlin
December 2006/January 2007, vol. 100, no. 5, pp. 356–60

N.Q.1
N.Q.2
N.Q.3

MP1	MP2	MP3	MP4	MP5	MP6	MP7	MP8
					●		

In the activities in this article students explore precision of measurement. Presented with a question related to volume, they come up with different solutions, though all the students are using mathematically sound solving methods. The author explores the idea of precision and how the following factors affect students' understanding of and experiences with precision: using a calculator, incorporating the NCTM standards, considering implications from textbook practices, varying student responses, using a minimum/maximum approach, revising the problem, looking at a follow-up. Recommendations for teachers are included.

Racing Ratios

Michael D. Hardy

April 2014, vol. 107, no. 8, pp. 586–91

N.Q.1
N.Q.2

MP1	MP2	MP3	MP4	MP5	MP6	MP7	MP8
●					●		

Using an activity focused on scale models of cars, students are engaged in unit conversions in a realistic context. A problem set that contains questions related to unit conversion is organized into the following parts: car and driver, the race, and the winner. The author includes directions for implementing the activity, suggestions for discussion of each part of the problem set, solutions, and samples of student work.

The Complex Number System

- **Perform arithmetic operations with complex numbers.**

Visualizing the Complex Roots of Quadratic and Cubic Equations

Alan Lipp

May 2001, vol. 94, no. 5, pp. 410–13

N.CN.1
N.CN.7
N.CN.8
N.CN.9

MP1	MP2	MP3	MP4	MP5	MP6	MP7	MP8
●					●		

This article presents the author's approach to developing a method where students can visualize the real and complex roots of a polynomial equation. He starts with an example and then generalizes to all quadratic equations. The method helps students visualize not only complex roots of a quadratic equation but repeated roots as well. The final connection is to cubic polynomials. The article includes several graphs of the branches shown in three dimensions.

Finding Complex Roots: Can You Trust Your Calculator?

John W. Watson and Barbara A. Ciesla

December 2005/January 2006, vol. 99, no. 5, pp. 366–71

N.CN.1
N.CN.4
N.CN.7

MP1	MP2	MP3	MP4	MP5	MP6	MP7	MP8
●	●					●	

The authors' purpose is to "investigate a specific instance when high school students found an answer that coincided with the textbook answer but was different from the one given by their calculators." The authors explain the reason for this difference and then address definitions related to powers of numbers, specifically where the base or exponent is a complex number. A TI-83 is the graphing technology used; screenshots of graphs and step-by-step explanations are included.

T

Thoughts on Why (–1)(–1) = +1

Tina Rapke

December 2008/January 2009, vol. 102, no. 5, pp. 374–76

N.CN.1

MP1	MP2	MP3	MP4	MP5	MP6	MP7	MP8
	●	●					

The author uses the distributive property to explain why (–1)(–1) = +1 to help students understand very clearly why this is the case. The article explores resources and pseudo reasoning, mathematical concepts and the distributive property, and an attempt at answering why (–1)(–1) = +1. The author concludes with a discussion.

Vector and Matrix Quantities

• Represent and model with vector quantities.

Angry Birds Mathematics: Parabolas and Vectors

John H. Lamb

December 2013/January 2014, vol. 107, no. 5, pp. 334–40

N.VM.2
N.VM.3

MP1	MP2	MP3	MP4	MP5	MP6	MP7	MP8
●	●		●	●		●	

With a focus on vectors that extends beyond the scope of the Common Core, the author explores the mathematics behind the game Angry Birds—specifically, projectile motion. By connecting with a context that is of high interest to them, students are engaged in the mathematics and see firsthand how mathematics is used to create a virtual game.

T

• Perform operations on matrices and use matrices in applications.

Promoting Conceptual Understanding of Matrices

Laura J. Worrall and Robert J. Quinn

January 2001, vol. 94, no. 1, pp. 46–49

N.VM.6
N.VM.7
N.VM.8

MP1	MP2	MP3	MP4	MP5	MP6	MP7	MP8
●			●				

With an emphasis on conceptual development, the authors share an approach that moves students away from merely following steps to connecting the ideas with real-world situations. The context of the problem is a toy company that has three factories, four models of toy motorcycles, and three kinds of jobs. Given this information in a table, the students used technology to find the time in hours that it takes to make each toy, considering the type of work and the cost to produce these items. This approach led to a better understanding of what a product of two matrices actually represents. Sample activity sheets and a piece of student work are shared.

T

MP1	MP2	MP3	MP4	MP5	MP6	MP7	MP8

Visualizing Transformations: Matrices, Handheld Graphing Calculators, and Computer Algebra Systems

Michael Todd Edwards

January 2003, vol. 96, no. 1, pp. 48–56

N.VM.12

MP1	MP2	MP3	MP4	MP5	MP6	MP7	MP8
				•			

The author provides a detailed description of using a computer algebra system (CAS) and graphing calculator to explore and visualize transformations, specifically through the use of matrices. A matrix plotter program is introduced, and details of executing the program are provided. Also included are instructions for how to use the program for reflections over the *x*-axis and *y*-axis and for discovery of the 180-degrees rotation matrix. Further investigations examine general rotation matrices and transformations, area, and determinates. The author provides ample detail for teachers to replicate this learning experience in their own classrooms.

T

The Constant Feature: Spanning K–12 Mathematics

James E. Schultz

March 2004, vol. 97, no. 3, pp. 198–204

N.VM.6
N.VM.8

MP1	MP2	MP3	MP4	MP5	MP6	MP7	MP8
•	•			•			•

Using the constant feature on the calculator, the author explores ways to foster conceptual understanding and problem solving through examples related to counting and operations, consumer mathematics, algebra, probability, and iterative processes. One section focuses specifically on matrices. Keystrokes and solutions are included.

T

Squaring Matrices: Connecting Mathematics and Science

Robert M. Horton, Elaine M. Wiegert, and Jeff C. Marshall

September 2008, vol. 102, no. 2, pp. 102–6

N.NV.6
N.NV.8

This article focuses on matrix multiplication—specifically, why students need to know matrix multiplication—through an investigation of food chains. In this real-world application connecting mathematics and science, students first are given a simple scenario that sets the context. Next, they are introduced to the problem, which is organized into two parts, both of which are explained in detail. The authors include a section summarizing key points that students should learn from this activity, as well as matrices and the sequence of questions to ask students throughout this task.

I

MP1	MP2	MP3	MP4	MP5	MP6	MP7	MP8
	●		●				

Enhancing Understanding of Transformation Matrices

Jonathan Dick and Maria Childrey

April 2012, vol. 105, no. 8, pp. 622–26

N.NV.12

Students explore transformations through matrices. The authors first focus on matrix multiplication and then make the connection to transformations using 2 × 2 matrices. Next, three dimensions (3 × 3 matrices) are discussed. Examples are provided.

MP1	MP2	MP3	MP4	MP5	MP6	MP7	MP8
	●						