

SMS Field Trip Report

by Kathy Besser

“Imagination is more important than knowledge.” Albert Einstein

On October 26, 2010, I accompanied 300+ middle school students to the Flint Center in Cupertino to see a math play called "Eureka!" The trip was organized by two math teachers, Rose Weller and Beverly Winegar. They managed to take most of the 7th and 8th grade Algebra and Geometry students along with the 6th grade pre-Algebra students.

Not being particularly math-oriented, I hoped my husband would chaperone in my place (since I prefer art/history/literature field trips). However, he had a business commitment so I was semi-forced to confront my long-standing aversion to math. But guess what? I was completely wrong about math not being my cup of tea!

In the notes below, I use italics to indicate supplemental content (I needed to stay focused on the play in order to follow the math concepts and was only able to jot quick notes from time to time).

Play Synopsis (from the official website):

Sara is your typical teenager – good student, stellar athlete – but lately, she's been struggling with her math classes. On the eve of her big test, she's visited by some of the luminaries of the mathematical world, including Albert Einstein, Blaise Pascal, Lady Ada Lovelace and Pythagoras. Together, these mathematical luminaries show her how math is part of the world. They explore the Pythagorean Theorem, number theory, order of operations, probability, prime numbers, the Fibonacci sequence, Pascal's triangle, the origins of the calculator and the computer, lowest common multiples, greatest common factors, and more. They demonstrate the relationships between pineapples, pinecones, and the golden ratio, and help spark an interest in mathematics as the code that defines the universe.

Did you know mathematics is the language of movement? And that many number theories are found and proven in nature? I was really intrigued by the work of Fibonacci (who I only knew from reading The DaVinci Code, sadly). The play brought out facts and details I'd never heard of... did you know Fibonacci numbers 5, 8, and 13 are expressed in the spiral patterns of pineapples, pinecones and flowers? Fascinating stuff!

And who knew "Eureka!" comes from an ancient Greek word meaning "I have found it".

Some of the topics covered in the play include:

1. Order of Operations: PEMDAS

P: Parentheses

E: Exponent (Powers and Square Roots)

M: Multiplication (left to right)

D: Division (left to right)

A: Addition (left to right)

S: Subtraction (left to right)

In the play, they used a calculation to show PEMDAS. I forgot to write it down thus am using the examples below to illustrate the general way it was presented: (<http://www.mathsisfun.com/operation-order-pemdas.html>)

"Operations" means things like add, subtract, multiply, divide, etc. But, when you see something like ...

$$7 + (6 \times 52 + 3)$$

... what part should you calculate first?

Start at the left and go to the right?

Or go from right to left?

Warning: Calculate them in the wrong order, and you will get a wrong answer!

Long ago, people agreed to follow rules when doing calculations:

Do things in Parentheses First.

yes $6 \times (5 + 3) = 6 \times 8 = 48$

no $6 \times (5 + 3) = 30 + 3 = 33$ (*wrong*)

Exponents (Powers, Roots) before Multiply, Divide, Add or Subtract.

yes $5 \times 2^2 = 5 \times 4 = 20$

no $5 \times 2^2 = 10^2 = 100$ (*wrong*)

Multiply or Divide before you Add or Subtract.

yes $2 + 5 \times 3 = 2 + 15 = 17$

no $2 + 5 \times 3 = 7 \times 3 = 21$ (*wrong*)

Otherwise just go left to right.

yes $30 \div 5 \times 3 = 6 \times 3 = 18$

no $30 \div 5 \times 3 = 30 \div 15 = 2$ (*wrong*)

How to remember... ?PEMDAS !

2. Archimedes

Archimedes discovered that the volume of water displaced is equal to the volume of the body replacing it.

3. Pythagoras

The Pythagorean Theorem is very useful for calculating how much rope you might need if you were crossing a river filled with dangerous crocodiles (and, of course, you knew the approximate height of the cliff and width of the river). The play made hilarious use of Barbie and Ken dolls to illustrate this point!

4. Prime Factorization:

You can find the prime factorization of numbers by completing factor trees. Then, you can use a Venn Diagram to sort the prime factors. Multiply numbers in the intersection to find the Greatest Common Factor (GCF). Multiply all of the numbers in the Venn Diagram to find the Least Common Multiple (LCM).

5. Blaise Pascal/Probability Theory:

Did you know Blaise Pascal developed his probability theory to predict the outcome of games of chance? They simplified the facts within the play, but here is the official version (From *Calculus, Volume II* by Tom M. Apostol, 2nd edition, John Wiley & Sons, 1969)

A gambler's dispute in 1654 led to the creation of a mathematical theory of probability by two famous French mathematicians, Blaise Pascal and Pierre de Fermat. Antoine Gombaud, Chevalier de Méré, a French nobleman with an interest in gaming and gambling questions, called Pascal's attention to an apparent contradiction concerning a popular dice game. The game consisted of throwing a pair of dice 24 times; the problem was to decide whether or not to bet even money on the occurrence of at least one "double six" during the 24 throws. A seemingly well-established gambling rule led de Méré to believe that betting on a double six in 24 throws would be profitable, but his own calculations indicated just the opposite.

6. Ada Lovelace

Again, the section on Ada Lovelace was vastly simplified for the audience but the basic message they conveyed (from Wikipedia) was:

Augusta Ada King, Countess of Lovelace, was an English writer chiefly known for her work on Charles Babbage's early mechanical general-purpose computer, the analytical engine. As a young adult she took an interest in mathematics and in particular Babbage's work on the analytical engine. Between 1842 and 1843 she translated an article by Italian mathematician Luigi Menabrea on the engine, which she supplemented with a set of notes of her own. These notes contain what is considered the first computer program—that is, an algorithm encoded for processing by a machine. Though Babbage's engine was never built, Lovelace's notes are important in the early history of computers. She also foresaw the capability of computers to go beyond mere calculating or number-

crunching while others, including Babbage himself, focused only on these capabilities.

Overall, it was a terrific play for 6th-8th grade students. Some of the acting was a bit exaggerated for my taste, but the kids seem to really like it.

Having found beauty in math via the play, I can only say, of course, "Eureka!"

If you want to learn more about the "Eureka!", the official website is <http://www.chambertheatre.com/ourshows/math>

Additionally, a lot of interesting math information and exercises may be found at <http://www.maths.surrey.ac.uk/hosted-sites/R.Knott/Fibonacci/fibmaths.html#aandb> (The Mathematical Magic of the Fibonacci Numbers).