

# Eureka — Math Stories

A Teacher's Guide

by Mark Binder

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If you have any questions, comments or suggestions

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Goal: to educate, entertain and inspire elementary school students about mathematics.  
Curriculum elements: Volume and displacement, counting, comparative values, division, mathematics and the scientific process, exponential growth.

**Notes to educators:**

This program is adjusted according to the age group of the students. The teacher's guide is not. In other words, not all stories discussed in this guide may appear in the performance your school hosts. I've tried to adjust the questions according to difficulty.

Please keep in mind that I'm a storyteller, not a teacher's guide writer. This teacher's guide is a work-in-progress.

**BONUS FOR YOU:** If you use this teacher's guide or come up with any suggestions, corrections, or additions, email them to me and I'll send you a FREE story.

## Relating Stories to the Rhode Island Math Framework

To download the RI Math Framework, please visit:

<http://www.ridoe.net/standards/frameworks/math/default.htm>

### **Process Standards**

MATHEMATICS as PROBLEM SOLVING

- Archimedes

MATHEMATICS as COMMUNICATION

- How Marsha Teaches Og Mathematics

MATHEMATICS as REASONING

- It Ate My Sister
- Divide and Conquer

MATHEMATICS as CONNECTIONS

- Whatever the Old Man Does is Right
- Jack and the Beanstalk
- Abu Ali and the Donkeys

### **Content Standards**

NUMBER SENSE and NUMBER SYSTEMS

- Goldilocks and the Three Bears
- How Marsha Invented Math
- Seven Brothers
- Abu Ali and the Donkeys

MEASUREMENT

- It Ate My Sister
- Archimedes
- How Rabbit Drank Boiling Water

STATISTICS and PROBABILITY

- It Ate My Sister
- Archimedes

## Marsh Teaches Og Math

Og and Marsha are two of my favorite characters. Og is a caveman, and Marsha is a bit more advanced. At the beginning of the story, Og's understanding of number is limited to the basics: One, Two and Six. Everything in the world can be divided into those numbers. One, two or (more than two) six.

The story explores the development of counting. It is also an excellent example of the effect that math anxiety can have on students. Og's courage in overcoming his anxiety can be used as an example for students who stop their learning.

Discussion questions:

- Why did Og count so funny?
- What kinds of problems would you have if you could only count the way Og did?
- What sort of a life did Og and Marsha have?
- How would you teach Og about other numbers?
- Bonus: What other mathematic discoveries could a caveman (or woman) make?

NOTE: The Og story is also designed to address some issues about Math Anxiety. It can be used to talk with students who have problems with numbers and math-related issues.
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## Eureka! Archimedes discovery

Background:

Archimedes was one of the most famous mathematicians of Ancient Greece. Born in Syracuse on the island of Sicily, (287-212 BC) he was known for his many inventions, including the water screw (used for irrigation in less developed nations even until this day) as well as his weapons of war. Archimedes refined the catapult, enabling these crude missile launchers to be adjusted for distance. He also developed levers capable, it is said, of lifting ships out of the ocean, and dropping them on the rocks. Once story said that he used mirrors to reflect the sun's light and set the Roman ships on fire.

Archimedes second most famous quote: "Give me a long enough lever, and I can move the world."

Amazingly enough, Archimedes also discovered many of the principles of calculus thousands of years before Newton. He also devised a method for developing the first estimate of pi (3.14), by measuring the perimeters of polygons set inside and outside a circle.

The story about Archimedes discovery of volume displacement is probably not 100 percent true. During the reign of King Hiero II, a kinsman of Archimedes, a crown was commissioned. When the finished crown (a wreath made of gold) was presented to the king, he grew suspicious. Had the goldsmith used all the gold the king had given him, or was he stealing?

The King summoned Archimedes and posed the problem. Archimedes solves the problem, but not immediately.

Mathematical and Scientific principles illustrated:

- Trial and error
- The process of inspiration and discovery
- The distinction between volume and mass
- Early systems of measurement
- Mathematics made physical/tangible

Archimedes most famous quote, “Eureka!”

Q: How much heavier is gold than silver?

A: Almost twice as much.

On the Periodic Table, Silver (Ag) is #47 and has a Standard Atomic Weight of 107.86.

Gold (Au) is #79 and has a standard atomic weight of 196.97

Follow-up questions:

Note: Be careful to validate unusual ideas rather than dismissing them. Since this is about the process, even unworkable ideas are worth considering.

1. What did Archimedes do to solve his problem?
2. Can you think of any other methods that Archimedes could have used to solve the problem?
3. Why was his solution the most practical?
4. What sorts of tools do we have today that could solve the problem?
5. What other sorts of materials could Archimedes test be used for?
6. What kinds of materials would the test not work with?

Discussion

What makes something a “good idea” or a “bad idea” when it comes to science?

### **How Rabbit Drank Boiling Water and Married the Princess**

Based on an African folk tale from Benin told by Raouf Mama from the collection, “More Ready To Tell Tales from Around The World.”

Follow-up Questions:

- Can animals really talk?
- Why didn't rabbit die when he drank the boiling water?
- How does Rabbit know that the water is cool enough?
- How long do you think it would take for the water to cool? What kinds of factors would be involved? (How hot it is outside, the thickness and material of the container, etc.)
- How hot can water be without killing you? (or hurting you?)
- When would boiling water be a good idea?

Answer: To kill bacteria

- How hot is boiling water?  
Answer: About 212 degrees Fahrenheit or 100 degrees Centigrade
- Is boiling water always that hot?  
Answer: No. For every 500 feet above sea level, the temperature of boiling water drops by 1 degree Fahrenheit.  
On Mars, where the air pressure is 6/1000 that of earth (.6 percent) water will boil at 50 degrees Fahrenheit!
- How else could the Rabbit have cooled the water?
- At what temperature will water boil in Denver, CO (Mile High City)  
Answer: About 201 degrees. Denver is about 5,000 feet above sea level.

### **Abu Ali and the Donkeys**

This story is based on a number of Arabic folktales.

#### Discussion Questions:

- Did Abu Ali get what he wanted from the market?
- Did the donkey salesman cheat him?
- How could Abu Ali have kept track of his donkeys?

### **Goldilocks, Jack and the Beanstalk**

Old Favorites

These stories are generally used to ease students into a learning situation. Nearly any story can be adapted to focus on numbers, counting, measurement, distance, and time. Most stories have elements of relative value – which is worth more? (See “Whatever the Old Man Does is Right”) Most tales also turn the expected value upside down.

#### Questions and Areas of Discussion

- What kinds of things can be counted in these stories?
- If Jack can climb a mile in an hour and it takes him all day to get to the top of the beanstalk, can you measure how high a beanstalk goes?
- What is worth more, a cow or some beans?

### **Whatever the Old Man Does is Right**

A famous Noodlehead story about values

#### Discussion Questions:

- Are the trades the old man makes good ones?
- How do you know?
- What is the most valuable thing that the old man has?
- How do you know?
- Would you bet a dollar that your dollar was more valuable than a rotten apple core?

A suggestion: The most valuable thing that the old man has is the trust of his wife – or perhaps the knowledge of that trust.

## The Father and His Seven Sons

This is a simple story about strength in numbers. It makes an interesting contrast with the story of Divide and Conquer.

## It Ate my Sister

### Math Questions:

- Can science occur without mathematics?
- What kinds of measurements were used in the story?
- What other kinds of measurements could have been used?
- How do scientists construct experiments using mathematics?
- What kinds of results can be derived through mathematics?
- What happens if your measurements are inaccurate?
- Do you think putting salt on slugs is cruel? Why/Why not?

### Bonus Questions

- At what point did the story cross over from non-fiction to fiction?
- Do you think putting salt on slugs is cruel? Why/Why not?
- What would you do to protect your garden from slugs?
- Research: How much vegetation can slugs eat?

## Divide and Conquer

This story is a combination of history, myth, and fiction.

During their heyday, the Mongols ruled much of the known world – from China to India, from the Middle East to the edges of Europe. The story takes place during the second Mongol conquest of Tibet, in 1578 during the reign of Altan Kahn.

### Math Questions:

- If the Mongols typically “Divided and Conquered” using 10 of their men for every one of their opponents soldiers, how many soldiers would they need to conquer China, if China had an army of 100,000?
- If the Mongols relied on faster tactics and quicker firing of arrows (it was said that they could fire six arrows per minute while the Chinese could only fire three) how many soldiers would they need to conquer a 100,000 man army?
- How many would they need to conquer Tibet, if Tibet had an army of 10,000?
- If it takes one acre of land to feed 10 men, how many acres of land would the Mongol Army need to subsist in Tibet? Tibet has 471,700 square miles of land. Could the Mongol army survive in Tibet?
- Hint: **1 square mile = 640 acres**

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---. **The Everything Bedtime Story Book**, Adams Media Corporation, 1999  
---. **Tall Tales, Whoppers and Lies** (audio cd), Light Publications, 2003.  
---. **The Brothers Schlemiel From Birth to Bar Mitzvah** (audio book), Light Publications, 2001  
---. **The Brothers Schlemiel**, a serialized novel of Chelm., January 20002.  
---. **Crumbs Don't Count (The Rationalization Diet)**. Avon, 1987.

Mark Binder's website is [www.markbinder.com](http://www.markbinder.com)  
Mark Binder's work is available at [www.lightpublications.com](http://www.lightpublications.com)

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Jeanne Bendick. **Archimedes and the Door of Science**, Bethlehem Books, 1995

Barbara Lipke. **Figures, Facts & Fables, Telling Tales in Science and Math**. Heinemann, Portsmouth, NH 1996

Diggins, Julia E. **String, Straightedge & Shadow**. Whole Spirit Press 2005.  
Whole Spirit Press has acquired the publishing rights to this book and recently reissued it, so teachers, parents and students can once again enjoy reading this wonderful book and viewing the beautiful illustrations. If you are interested in ordering this book or making your customers aware that the book is once again available, it can be purchased by going to <http://wholespiritpress.com>.

Tobias, Sheila. **Overcoming Math Anxiety**. W.W. Norton & Company, New York, NY, 1993.

Johnson, Art. **Classic Math – history topics for the classroom**. Dale Seymour Publications, Parsippany, NJ, 1994.

Smith, Sanderson. **Agenesi to Zeno – Over 100 Vignettes from the History of Math**. Key Curriculum Press, Emeryville, CA, 1996.

## Web Links:

### Divide and Conquer

The Mongol Kahns - <http://www.friesian.com/mongol.htm>

Lonely Planet. Com -

[http://www.lonelyplanet.com/destinations/north\\_east\\_asia/tibet/history.htm](http://www.lonelyplanet.com/destinations/north_east_asia/tibet/history.htm)

Mongol Tibet Network: <http://www.ibiblio.org/mongol-tibet/>

## **Some other books and web sites recommended by Rhode Island Librarians and Storytellers:**

Muriel Benjamin, Babcock Middle School, Westerly:

There was a request for math related stories recently on the list. I noticed this source today. (<http://www.ksu.edu/smartbooks/gradeindex.html>) Hope it helps. A few of my favorites are missing.

Robbie Bourgeois, Governor Pothier School, Woonsocket RI

I like the Marilyn Burns' "Brainy Day Books"

Spaghetti and Meatballs for All - Burns

Cloak for a Dreamer - Friedman

Greedy Triangle- Burns

Amanda Bean's Amazing Dream - Neuschwander

King's Commissioners - Friedman

Sir Cumference and the First Round Table - Neuschwander

Among the Odds and Evens - Turner

Pat Treanor

Try a book by Demi titled One Grain of Rice--much like mortgage interest that keeps multiplying. Perma Bound Books has a bibliography that connects to Investigations -- a math curriculum.

Anne-Marie Forer, retired librarian and storyteller

Math Curse is really funny by Jon Scieszka. There's also the Grapes of Math.

One Riddle, One Answer by Lauren Thompson is a lovely picture book with a Persian flavor