Living Math!

*"One can invent mathematics without knowing much of its history.
One can use mathematics without knowing much, if any of its history.
But one cannot have a mature appreciation of mathematics without a
substantial knowledge of its history."* Abe Schenitzer, *Five Fingers to Infinity.*

LIVING MATH THROUGH HISTORY LESSON PLANS

Cycle 1, Unit 1 (C1U1)

Intermediate Level – SAMPLE LESSON

Early Cultures Through the Classical Age

Lesson 2: Ancient Roots of Mathematics in Africa and Mesopotamia

Lesson 3: Ancient Roots of Mathematics in Asia

Lesson 4: Ancient Roots of Mathematics in the Americas

Lesson 5: Thales and the Egyptians

Lesson 6: Pythagoras and the Early Greeks

Lesson 7: Archimedes' Geometry

Lesson 8: Eratosthenes, and Archimedes' Large Numbers

Review Activities

Living Math Through History
C1U1 Intermediate Level Lesson Plans
Early Cultures Through the Classical Age

**If you are not familiar with the format of the Living Math lesson plans,
refer to the** Parent Introduction Letter **for notes on how to use resources.**

Living Math Lesson Plans Icon key

To be used or done with two or more people   Writing or drawing activity

Book resource in print and/or online   Quote to think about or discuss

Highly visual resource, pictures   Discussion questions

Printable handout   Internet website

Hands on activity   Calculator recommended

P Primary, I Intermediate or   Video resource

    A Advanced level   ✓ Solutions

Living Math Through History
Thales, The Egyptians and Measurement
Intermediate Level Lesson 5

Synopsis - Thales of Miletus lived his life during an age in which few written works survived the ravages of time. We know much about him, however, because he was written of in multiple ancient accounts, and he was referred to as one of the "Seven Wise Men" or "Sages" of ancient times.

Thales is the first ancient known to use the process of observing patterns and deducing logical conclusions that could be applied to other problems. Reading about his life, we find several problems he tackled that are world famous: predicting crop production from weather cycles, measuring the height of the Great Pyramid (so great it covered 12 acres), and solving the entertaining "donkey and the salt mine" problem.

Thales made great contributions to mathematics and astronomy. He proved that if an angle is drawn in (inscribed) in a half circle, it will always be a right triangle. It's one thing to be able to observe something that appears to be true, but quite another matter to logically **prove** it will work every time.

It is not believed that Thales left any writings of his own, although there are a few works scholars debate may have been written by him. Most of what we know about Thales is from ancient writers such as Herodotus, Diogenes and Sosicrates. Because of the second and third hand nature of the sources, much of what we know about Thales is considered "anecdotal," based on stories handed down, of which we are not sure all the details are true. That Thales lived, however, and produced many highly original ideas in mathematics, science and even business is widely accepted to be true.

For more, visit: http://www-groups.dcs.st-and.ac.uk/~history/Biographies/Thales.html

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✿ **Joy of Mathematics** (vignettes to inspire exploration):

    p. 36 Thales and the Great Pyramid p. 93, Cannon Balls and Pyramids
    p. 119 The Penny Puzzle   p. 214 Triangular, Square, Pentagonal Numbers

👥 **Math Talk Poetry in Two Voices:** "Triangles" pp. 41-42

📖 **Mathematicians Are People, Too Vol. 1** pp. 1-8 Pyramids, Olives and Donkeys. Fun story about Thales' famed deductive reasoning and problem solving skills.

Living Math Through History
Thales, The Egyptians and Measurement
Intermediate Level Lesson 5

📖 *Math History Readers,* one or more as desired:

The History of Counting is an especially good follow up to the past two lessons. Finish up the book if you haven't already. For younger kids in this level.

Counting Systems: The Familiar and the Unusual by Marnie Luce, out of print but excellent if you can find it.

Number Stories from Long Ago by David Eugene Smith – Chapter 3, How Hippias and Daniel and Titus Wrote Their Numbers

The Secret Life of Math by Ann McCallum pp. 84-85 the Rhind or Ahmes Papyrus

Why Pi? by Johnny Ball: pp. 18-21. The Right Angles and Measuring Land; pp. 36-37 Why Measure *Any Body*?

Mathematics: The World of Science by Irene Fekete: pp. 24 – 27 - excellent.

The Pantheon Story of Mathematics for Young People - pp. 29-33. Upper level used for Advanced, but a 5th+ could enjoy, or read aloud.

The Wonderful World of Mathematics by L. Hogben, pp. 15 – 25

Advanced reading / read aloud: **String, Straightedge & Shadow** pp. 58 - 91

📖 **Millions to Measure** by David Schwartz

📖👁 **Pyramid** and **Unbuilding** by David Macaulay and/or **Kingfisher World of Pyramids** (all are excellent)

📖👁 **Science in the Past – Ancient Egypt.** Very good for Egyptian Mathematics (Chapters 3 and 4 coincide with other reading very well)

📖 **The 5,000 Year Old Puzzle, Solving a Mystery of Ancient Egypt** by Claudia Logan and Melissa Sweet and/or **Seeker of Knowledge, The Man Who Deciphered Egyptian Hieroglyphs**, by James Rumford – picture books for younger kids in this level.

📖 **MathFocus**

Challenge Math for the Elementary and Middle School Student by Ed Zaccaro. Chapter 11: Ratio and Proportion

Think of a Number by Johnny Ball: pp. 52-53 Shapes with Three Sides

Living Math Through History
Thales, The Egyptians and Measurement
Intermediate Level Lesson 5

📖 Optional Historical Context:

SOTW Vol. 1 – Chap 18 Life in Early Crete; Chap 19 The Early Greeks; Chap 20, Greece Gets Civilized Again; Chap 21 The Medes and the Persians

Seeker of Knowledge, The Man Who Deciphered Egyptian Hieroglyphs, by James Rumford, picture book for older kids

The Egyptian News by Scott Steedman (fun tabloid-style book)

📺 Nice five-minute video on **measurement history**:
http://www.youtube.com/watch?v=DQPQ_q59xyw&feature=related

📺 **History of Science: Antiquity to 1700** (Teaching Company Series) Lecture 3, the Pre-Socratics – Adult level parent resource

🔔 **Mathematical Ideas associated with Thales**:

Measurement	Area, perimeter
Geometry of triangles	Egyptian multiplication
Problem Solving	Mathematical Reasoning

✒ **Vocabulary related to this lesson:**

Theorem	Proof	Deductive	Inductive	Reasoning
Philosopher	Scientist	Ratio	Proportion	Prediction

Quotes to think about and discuss:

☀ "Know Thyself." Thales is given credit for this, and for being one of the Seven Sages. What is a "Sage"? Why do you think this quote would be passed down for thousands of years?

Do you think you are on the road to "knowing yourself"?

✗ "[Sesostris] divided the land into lots and gave everyone a square piece of equal size, from the produce of which he exacted an annual tax." Herodotus

Sesostris was king of Egypt approximately 1322 BC. Herodotus, a Greek known as the "Father of History," wrote the first account of history about 900 years later.

What kind of mathematics would the Egyptians need in order to do this division fairly?

What kind of mathematics would they need to compute annual taxes?

Discussion or ✍ journaling questions

🗪 Why were the Egyptians such good geometers (literally, "earth measurers")? This would be a good question to revisit after doing some of the activities in the mathematical activities section.

🗪 What is the Rhind or Ahmes Papyrus, and who wrote this?

Why is this so interesting to the study of mathematics?

🗪 **Thales** was considered a **philosopher, mathematician** AND a **scientist**.

Do you know what each of these are? How could one person be all of them?

Thales' story is an example of mathematical ideas being exchanged through one person's travels. He likely learned geometry from the Egyptians and astronomical science from the Babylonians, and took this knowledge back to his native Asia Minor.

☞ **Geography and Timeline**: When reading about Thales, follow his path through his birthplace of Miletus (a Greek colony in what is now Turkey / Asia Minor) through Babylonia and Egypt, and correspond these with the modern day countries in these regions.

⧗ **What Was Happening When** . . . What major event do ancient writings say that Thales predicted in 585 B.C.?

Mathematical Activities

▤ **Rhind Papyrus math:** See if you can solve the following math problems from the ancient Egyptian Rhind Papyrus. The hardest part is following how they are worded, the math isn't that difficult.

   1) A quantity and its 1/5 added together become 21. What is the quantity?

   2) A quantity, its 1/2 , and its 1/4 added together become 10. What is the quantity?

   3) How many cattle are there in a herd when 2/3 of 1/3 of them make 70, the number due as tribute to the owner?

   4) Sum the geometrical progression of five terms of which the first term is 7 and the multiplier is 7.

   Solutions at the end of this section.

✋ If you observe the world around you, you will notice that triangles are everywhere. This is particularly true of structures – buildings, bridges, towers – all are supported by triangles. Since Thales and the Egyptian pyramids were a focal point of the reading, seeing the structure in David Macaulay's books, **Pyramid** and **Unbuilding** is suggested. These books show the insides of structures, and you can see that triangles are built into all structures, even seemingly square or rectangular structures.

   Find or create several forms of squares, cubes, triangles and pyramids. These can be constructed from Zome Tools (http://www.zometool.com/) , K'nex or other building sets. Use the forms to show the strength of the triangle structure compared to the square. This is an excellent way to demonstrate why triangles are engineering marvels. See the Straw Tower project below, a great extension activity.

✍📖 **Science in the Past – Ancient Egypt** introduces Egyptian numerals. Compare these to the numeral systems studied in the previous lessons. It can be a lot of fun writing some of the larger numbers; the "surprised man" for 1 million is a hoot. **Think of a Number** by Johnny Ball also has very nice pictures of many types of ancient writing, including Egyptian hieroglyphs.

✋ A **Straw Tower project** is a fantastic activity, particularly if you do a complete activity including designing and testing the model. We have done this several times with a group and had competitions. Supplies are very inexpensive, all that is required is straws, paperclips and tape.

Here is one version of this project, it is best done in a group where different designs can be tested, so that you can see which designs hold the most weight. I suggest if you like this project that you save a copy of the plans.

http://www.ces.ncsu.edu/depts/fourh/old/greenlight/afterschool/StrawTowers.pdf

📖✋ **The Secret Life of Math** by Ann McCallum has several hands-on activities.

Make an Eye of Horus Amulet, instructions on pp. 86-87

Problem-Solving Made Oh-So-Easy (Finally!) p. 106

Do Some Math in the Egyptian Style! p. 107

✋ **Measuring Egyptian Cubits:** In ancient times, people measured things with the measuring sticks they took with them everywhere – their hands, arms, fingers and feet of course!

A **cubit** is the length of a forearm, from the elbow to the fingertips.

A **palm** is the width of your four fingers excluding the thumb.

A **finger** is the width of, well, a finger.

In Egypt, a royal cubit was equal to the length of seven of Pharaoh's palms.

Try measuring your own personal cubit, and your own palm this way. To do this in a tactile way, measure it with a piece of string and cut the string the length of your cubit and palm, you can then compare the length of the palm to the cubit. Or, measure both lengths with a measuring tape and record the lengths. How many times can you stretch the palm along the cubit, or divide the cubit length by the palm length. Is it close to seven times? If not, what guess would you make about the physical proportions of the Pharaoh?

If you can do this with one or more persons, compare your measurements. Are they the same? If the cubits are different, what about the **ratio** (number of times you can stretch the palm along the cubit length) of the palm to cubit – is that the same? Did you expect it to be different, or the same?

✋ **Pyramid math activity** – see the Living Math 📄. Accuracy counts with this activity! Also, allow plenty of time, this can take an hour or more.

You can encourage calculator usage with this activity. As you will be measuring and calculating in tenths of centimeters, you don't want to spend hours doing manual arithmetic, especially since a number of the results may involve repeating decimals.

Some children are less familiar with calculators than others. See if your child knows the basics of entering data into a calculator, and discuss why we need to be proficient in mental math for everyday computation, but how an activity like this benefits from the power of calculators. Remember, "garbage in, garbage out" - the calculator is only accurate if the input is accurate.

🖱📄 Deductive reasoning requires logic. See how you do with these deductive reasoning logic puzzles, these are printable handouts
http://www.abcteach.com/free/l/logic_mysterymathball.pdf

🖱 Websites recommended for **Egyptian multiplication,** this is quite interesting!
http://atozteacherstuff.com/pages/296.shtml explains how to do it

http://mathforum.org/library/drmath/view/57542.html is another example. No multiplying needed to multiply! It is related to binary numbers, can you see how?

🖱 **Stock Market Simulation** – If you are participating in a stock market simulation, continue to explore the math involved. Concepts include rounding up to allow enough cushion for commissions and stock prices fluctuations, estimating, and mental vs. written arithmetic. See Lesson 3 if you would like more information about the simulation.

📖📄✍ **Algebra Activities from Many Cultures** by Beatrice Lumpkin, portions available online at http://books.google.com/books or for purchase. Activity 6: Egyptian multiplication, Activities 9, 10, and 11

📖📄✋ **Historical Connections In Mathematics Vol. 2** by Wilbert and Luetta Reimer, Chapter 1 contains handout activities. While the content will differ, * indicates there is some overlap with Living Math Handouts, or that the same puzzle is available online.

Smart Shadows, * an outdoor version of the Shadow Math Living Math activity.

Stars Around the Moon*, this is also known as the Petals Around the Rose puzzle

Puzzling Pyramids   Dominoes on a Checkerboard *

Who's Who on the Baseball Team?

📖✍ **Famous Problems and Their Mathematicians** by Art Johnson. p. 84 – 85 Head in the Clouds - geometry / algebra activity only for advanced kids in this level

🖑 More activities and information may be found on the Thales page at Living Math http://www.livingmath.net/ Math Sites: C1U1 Ancients and Cultures.

✓ Solutions to Rhind Papyrus questions:

a) 17-1/2   b) 5-5/7   3) 315   4) 19,607

🗐 Living Math Handouts

Great Pyramid Math instructions and templates

Shadow Math

Think Like Thales - Leader Notes and Student Handout developed for a two-hour math group teaching unit, adaptable to home use. Heavy math focus in these activities, ranging from easy to difficult.

📖 **Additional enrichment reading** if you have time and interest

Twelve Snails to One Lizard: A Tale of Mischief and Measurement
How Tall, How Short, How Faraway by David Adler
The Greedy Triangle, Marilyn Burns
Inchworm and a Half, Elinor Pinczes