Living Math Through History
Lesson 1: Math is Everywhere!

Materials Needed: 3x5 cards pencils	1) ***What is math?*** Virtually all children that have any formal math education will say, numbers, or, 1 plus 1 equals 2, etc. For this age group, pass out 3x5 cards, and ask them to write the first thing they thought about when they thought of math. It could be a picture, a phrase, a word, etc. I then collect and shuffle them so I don't know whose is whose, and read them off to the group. The responses are usually predictably number and arithmetic oriented across the board. They may define math as their Saxon or Singapore text. Some may draw very unflattering pictures :D
Materials Needed: Dictionaries	2) Pass out one or more dictionaries, and asked them to look up the definition of MATHEMATICS. Our dictionary began the definition with the word 'science', and defined that it included arithmetic, but was much more than that. You can have different kids look up other terms such as a "point" or "line and see how many different definitions there are. But there is only one mathematical definition.
Materials Needed: Pictorial representations of math in books	3) I then define mathematics simply as the science of patterns, according to Keith Devlin's definition. I put out a large stack of picture books, art, architecture, nature, music, science, Greg Tang and other books that have <u>clear patterns</u> in some portions, **<u>but no numbers</u>**. Ask each child to select a book. Ask if any of them can see any math in the books. At this point they are generally smiling but shaking their heads. Then I described *what a pattern is, and how a pattern doesn't have to have numbers.* ***Black dot / white dot / black dot / white dot*** – a pattern causes you to expect something, to predict something, and you are surprised if a red dot randomly appears. We innately recognize patterns and have expectations that patterns continue. Based on the definition that math is the science of patterns, I asked them again to look for math – patterns – in their books. Each child finds a pattern in a book, and holds it up for others to see. They describe how they see math pattern in the picture.

	I would then see if we could find other patterns, and I showed them the value of patterns, how our eyes enjoy and gravitate toward patterns. I compared pages that had randomly arranged objects to pages with orderly rows and we saw how much easier it is to count or estimate with patterns and order. Encourage creativity, you would be surprised what can be seen when you are looking at things with different eyes. Several pages had twos, threes, or fours. I asked them how many, and covered it up quickly so they couldn't count. They realized they could **see** these numbers without counting. We turned to a picture with sets of twos, or threes – they could see sixes in three sets of 2, or two sets of 3, etc. without counting. A few skeptics still had a hard time accepting that something can represent math if there isn't a number there. The analogy of letters to literature is powerful to helping understand the role of numbers to math. *Do letters make a book?* They are building blocks, but words and sentences put together in a specific order make a book. Can we enjoy and experience stories without reading? Yes, of course, before we read, we can listen to stories. As picture after picture was shown and they could see amounts, patterns, order, size, scale, etc. this idea seemed to gain more acceptance.
Materials Needed: Assortment of objects from around the house: Candles, coins, glass balls, nesting dolls, shells, a large pine cone, a protractor, a trapezoidal vase, even an irregularly shaped rock.	4) I brought together a number of miscellaneous objects I had around our home. We've even thrown in a few challenging objects in there, such an irregularly shaped rock. We collected candles, coins, glass balls, nesting dolls, shells, a large pine cone, a protractor, a trapezoidal vase, all very different objects. I asked each child to select one object and to study it. How would they describe it using mathematical words? Math has its own language, but many of the words we learn from early on. Shape – oval, circle, square, rectangle; size, compared to other objects; were there lines or other identifying features? An object I demonstrated with was a small ceramic vase that was larger at the base than the top, and had four faces, alternating between a plain and decorated face. I showed them that if I decided to call one face "one" and the other "zero", I could describe the faces as one-zero-one-zero. I could say, big square, little square for the top and bottom squares.

	Each group I've taught had one that did take the rock! That was a creative challenge, but all got that it was somewhat oval, and the cracked portion gave clues that there were streaks of color running through it in lines. We could predict what was in it if we cut it in half based on what we observed in the cracked portion. This was a good time to introduce a quote from an unlikely source – Paul Cezanne, the famous Impressionist artist, who said***: "Everything in nature adheres to the cone, the cylinder and the cube."*** How do our observations of nature support the truth of this?
Materials Needed: Card, scissors	5) We discussed the idea of symmetry– I folded a card in half, and cut half a heart, unfolding it to show the symmetry. We discussed with each object whether it was or wasn't symmetrical. Most objects are only symmetrical from one direction. A perfect sphere is symmetrical any way you "cut" or fold it if the fold goes through the center point. I did a lot of q&a regarding these type of observations.
Materials Needed: Poetry with meter – limerick, haiku, Latin poetry	6) I selected a poetry book that had a predictable pattern, and showed them how the rhythm could be described in mathematical symbols. We used limericks and haikus as examples of mathematical poetry.
Materials Needed: **The Yellow Umbrella** by Liu and Sheen, audio player / speaker	7) I asked how many of them had taken music, whether they knew the quarter – quarter - half-note rhythm. Music is full of math – fractions and proportions. We discussed how much easier fractions might be to understand if you were learning this at an early age. We listened to music, counted it out, and I demonstrated how it wouldn't be attractive in the same way without that regular rhythm which is fractions/proportions. A wonderful resource to demonstrate math in rhythms is **The Yellow Umbrella** by Liu and Sheen.
Materials Needed: None, discussion	8) Another concept I challenged this group to think about is that math is only precise in the abstract world of ideas. In nature, there are no perfect shapes, none at all. If you have one apple, and add another, you get two apples, but they do differ in size / shape. Two plus two does not always equal four. "Clock arithmetic" is a form of modular arithmetic where addition follows different rules. Two hours plus twelve hours will equal two. If you add one atom to another atom, even of the same substance, you can create another substance entirely!

	We discussed the "tipping point" concept of a Japanese water feature – the bucket takes drop after drop until it reaches a tipping point – the point where one more drop tips it over and empties the bucket. If it takes 56 drops to fill the bucket, and the 57th drop tips the bucket, 56 plus 1 equals what? Zero! There are branches of math that are based on real physical phenomena like this that do not follow the rules of traditional arithmetic, and it is exciting to know that math is not always as precise, and exact as people might expect. Sometimes there isn't just one right answer and all the other answers are wrong. Discussions along these lines can move into situations where precise accuracy is needed (designing a space rocket) and situations where it isn't (budgeting for groceries).

If you cover some or all of these ideas in your week, you will get a good portion of what I've covered in classes and simple life observation with my children. This forms a good base for the rest of the course.

The attention span for this group for these activities can be much longer than you expect. Done right, this could be a dynamic hour for a group, or can be split into multiple sessions. I would have also had them draw pictures of what they saw mathematical. You can spread this activity over an entire week and have a lot of fun finding math in the most unlikely places!

Reading to extend the theme that math is everywhere:

The Great Number Rumble: A Story of Math in Surprising Places *by Lee and O'Reilly* is a great reader for this age group that highlights many ways math exists in our world.