Unit Plan Title: Shape and Space
Framework: Romantic
Target Age: 10-13
Unit Length: 3 to 4 weeks
Unit Author: Sherri Mohr
Description Lesson Plan:
The following is an introduction to the subject of geometry.
Cognitive Tools used:
Heroic Quality, Narrative, Image, Extremes and Limits, Collections and Hobbies, Connection to Hopes and Fears, Change of Context, Literate Eye, Sense of Wonder, Embryonic Philosophic, Somatic (Rhythm) and Mythic (Binary Opposites)
Keywords:
Geometry, Accuracy, History of Mathematics, Angles, Shapes, Building

1. Identifying "heroic" qualities
What heroic human qualities are central to the topic? What emotional images do they evoke? What within the topic can best evoke wonder?

The main heroic human quality that is central to this topic is accuracy. This human quality appropriately describes many aspects that encompass the world of geometry. Measurements, size, relative positions, shape and space are all significant elements of geometry that require a great deal of accuracy in order to understand. Students will be engaged by the great deal of effort and tribulation that went along with the many works of the Ancient Greek mathematicians. The emotional images that are presented in the human quality of accuracy are of the precision that these ancient people were able to generate within the limits of their technology.

Alternative heroic human qualities that are central to the topic of geometry are meticulousness and strength. These were chosen because the Greeks were known for paying attention to detail that also relates to the degree of accuracy that they were able to achieve in their understandings of shape and space. Strength is the other heroic human quality because it demonstrates the perseverance through trial and error that the Greeks must have possessed in order to come up with their theories.

2. Shaping the lesson or unit
Teaching shares some features with news reporting. Just as the reporter's aim is to select and shape events to bring out clearly their meaning and emotional importance for readers or listeners, so your aim as a teacher is to present your topic in a way that engages the emotions and imaginations of your students. To do so, consider which of the following dimensions of your students' emotional and imaginative lives can be used to shape your lesson or unit—all related to the skills the good reporter works with:

2.1. Finding the story or narrative:
What's "the story" on the topic? How can the narrative illustrate the heroic qualities of the topic?

Imagine a world without shapes and measurement. What would it be like? How would you accurately describe what something looks like without hinting at its shape and size? Interestingly, this unit covers how shape and space were once undefined until ancient peoples figured out a way to understand it using their skills and the forms of technology available for their times.

Did you know that geometry is one of the oldest sciences around? This science can be traced as far back as the Ancient Greeks and even earlier to the times of the Ancient Egyptians and Babylonians. The word geometry comes from the Greek, "geo" meaning "earth" and "metri" meaning "measurement". The Ancient Greek along with the Ancient Egyptians and Babylonians were the first to uncover much of the knowledge that is learned today. The measuring of earth is a very complex and interesting area of study that was very important to the everyday life of these ancient peoples. How difficult do you think it would have been during their times to study this subject area without the technology that is available today?

Imagine people not knowing the time of day, how long it would take to travel from one place to another or how to construct safe buildings or bridges? How would our world be different? Shape and measurement are very much a part of our everyday lives. Let's explore how geometry is part of our everyday lives!

Many may not realize how beautiful accuracy is or how dependent we are on shape, space and size…think again! Geometry is a subject that is very much a part of daily life. For example, when constructing a home you must know the area of the floor. Any construction, as a matter of fact, involves using geometry; laying carpet and tiles, erecting beams and walls, and building stairs. These are just a few things that require you to be able to measure area, angles, and piece together shapes.

Think about your hobbies for a minute. Playing baseball on a field that is precisely measured. The bases are pentagon shaped and the field is a diamond or rhombus shape, the baseball a sphere. Could we play baseball without measurements? What might it be like? An activity might be that they take a scenario or a game and try to imagine everything that would go wrong without measurement. Any sport can be interpreted using geometry. Now take another hobby, quilting for example. It uses geometry as well because you have to be able to carefully measure each piece of fabric in order for it to fit together evenly. You also have to be able to estimate; this is where you need to determine how much material is needed to complete these sorts of projects. There are endless possibilities for the use of geometry in many fields of work and hobbies.

Now think about nature and how geometry plays a role. Let's go for a nature walk and discover just how much geometry surrounds us. Look around you, what do you see? Do you see the angles that the one tree branch is making with another? Is it an obtuse, acute or right angle? What about that fence around the playground? What shape are the metal wires forming? Look at the goal posts; what does it remind you of? What angle does the goal post make with the ground? Do you see any shapes in the clouds? Look at the school; its windows, doors and roof. Remind you of anything? As you can see, geometry is everywhere! There is no escaping it….so let's explore!

2.2. Finding extremes and limits:
What aspects of the topic expose extremes of experience or limits of reality? What is most exotic, bizarre or strange about the topic?

Let's explore the Great Pyramid of Giza in Egypt. It is one the oldest and largest of the three pyramids of Giza and is also the oldest of the Seven Wonders of the Ancient World. How did the ancient Egyptians build such a structure with their limited technology? Sure we can imagine such a structure being erected in today's times with the vast amount of technology we have, but think about it; how did they do this? Some say that it is a mystery and some also believe that the Gods built it. One theory even suggests that aliens built them. There are several theories surrounding this topic but there is proof that the Ancient Egyptians were very intelligent people that were ahead of their time. The mystery here is how did they build the pyramids? Without the tools that are available today, how were the angles measured so accurately to allow for the structure to still be standing today?

2.3. Finding connections to human hopes, fears, and passions:
To what human hopes, fears, and passions does the topic connect? What ideals and/or challenges to conventions are evident in the content? Through what human emotions can students access the topic?

I think that the subject area of geometry connects with the excitement of discovery and exploration. The students could make personal connections to the lives of the great mathematicians such as Euclid of Alexandria, the "Father of Geometry", Thales of Miletus, Pythagoras of Samos, Archimedes of Syracuse, and so on. By studying the contributions that these figures made to the subject of mathematics, students can get a sense of what it was like to challenge others' theories, think outside the box and get an overall sense of what it must have been like to live in the times when such

discoveries were being unearthed. The students would get a feeling of the hopes and fears of these famous mathematicians and how this may relate to their lives. While exploring geometry, the students would stop to think of all the history behind it; how angles, area, shapes and space were explored and defined. It would make them think of all the countless years that went into the discovery and make them appreciate it more.

2.4. Employing additional cognitive tools of Romantic understanding:
What kinds of activities might you design to deploy other tools in your students' cognitive toolkits? Consider the following:

- **Collections and hobbies:** *What parts of the topic can students explore in exhaustive detail? What activity might engage students in learning everything they can about some aspect of the topic?*

  While working with shape and space, students could explore aspects of 3D modeling. They can build known shapes or create their own, name different angles and measure angles, area and volume. The students could build structures, starting small by building 3D shapes with household materials, such as toothpicks and marshmallows, to building on the more grand level of creating geodesic domes that they could paint and customize to make into a fort of some sort that they could play in. The students could also take pictures of the different shapes in nature and make a collective portfolio of their interpreted shapes. Each student could become an expert on a particular shape – finding in the community as many examples of its use, reading about its strengths and mastering its mathematical dimensions.

- **Change of context:** *What kinds of activities could change the context in the classroom? How might drama or role-play be employed or how might students engage the body's senses in learning?*

  In order to incorporate drama or role-play into the classroom the students could create shapes with their bodies and have other classmates try to guess what they are. From this the students could list specific attributes that the shape possesses. Another activity that would engage the students' body senses in learning would be to have a magic bag containing pattern blocks of different shapes. By sticking their hand in the bag and using only touch as a sense, the students would have to describe what shape they have by listing its attributes. For example, a quadrilateral could be described as having four sides and four vertices, and so on. This would engage the sense of touch making it more powerful than the common sense of sight to see attributes.

- **The literate eye:** *How could graphs, lists, flowcharts or other visual formats be employed in learning about the topic?*

  Geometry is a very easy subject to employ visual representations for learning about the subject. For example, students could be given or create their own graphic organizers that list attributes for each shape. A Venn Diagram could be employed to compare and contrast two different shapes. On a nature walk students could make a chart of all the different shapes that occur in nature and after collecting the data the students could return to the classroom and create graphs that could be used to compare their findings; which shapes are found more commonly in nature. The students could also explore tangrams and discover that there are shapes within shapes (eg. 2 small triangles can make 1 large triangle). They could also build shapes with the tangrams, trace them, and have other students try to figure out how they made them.

- **The sense of wonder:** *What kind of activity might evoke students' sense of wonder? How could you use that sense of wonder to draw students forward in thinking about further dimensions of the topic?*

  In order to evoke the students' sense of wonder I would have them construct mini bridges using different types of triangles that they construct out of their own materials. Here they would have to discover which bridge would be the strongest and why. This would encourage the students to

think further into the construction and what it is about the different triangles or other shapes and aspects that make a more structurally sound bridge. This would also make them think of other ways in which other structures such as buildings and such are built. They could use remote control cars to test the strength of their bridges.

- **Embryonic tools of philosophic understanding:** *Consider how to frame the topic in terms of a general idea or theory. How can students begin to move from the particular aspects of what they have been learning to a more general explanation? How can students' sense of agency be engaged?*

  The students' sense of agency can be engaged by seeing how everything works together through the processes. For example, the students could hypothesize and experiment with Euclid's axiomatic system. These axioms were geometric facts that he tested and proved. The students could play around with these axioms and make their own assumptions.

2.5. Drawing on tools of previous kinds of understanding:
Somatic understanding - *How might students use some of the toolkit of Somatic Understanding in learning the topic? How might their senses, emotions, humor, musicality, and so on, be deployed?*

As mentioned previously, in order to use senses other than sight to understand the topic, the students could play the shapes in a bag game to test their knowledge of attributes that coincide with a specific shape using only touch. Using gesture and imitation the students could create shapes and angles using their bodies, for example, you could ask them to show you a 90 degree angle, an obtuse or acute angle, using their arms. With gestures you could help them to remember that an acute angle is cute and small and an obtuse angle is large and obese. In order to introduce surprise to the topic you could have the students make 3D shapes with straws and dip them in liquid soap and water and watch the shapes that form out of the bubbles! To emotionally engage with this topic the students could envision what it would be like if things were not accurately measured; what would it be like to live in a house that was not measured precisely when being built or what would it be like to cross a bridge that was not supported with the right angles of beams? From this the students could create stories about a land where there was no geometry describing how strange it would be.

Mythic understanding – *How might students use some of the toolkit of Mythic Understanding in learning the topic? How might abstract and affective binary oppositions, metaphor, vivid mental imagery, puzzles and sense of mystery, and so on, be deployed?*

Some binary opposites that could be used to learn the topic of geometry when it comes to shape are "belong" and "not belong." Here the students could identify which attributes of a shape belong or not belong; for example, lines of symmetry, contains specific types of angles, etc. "Power" and "weakness could also be used to discuss this topic because it could be related to the structures that they build or to other structures found in nature. Linear and cyclic could also be used to describe 2D and 3D shapes. The mystery that can be explored in this topic could be studying the construction of the Pyramid of Giza. It is the oldest of the Seven Ancient Wonders of the World, so how it was built is a mystery. There are several different theories surrounding the construction of it. Again, as mentioned above, the magic bag game could be used as a mythic tool to engage the students' senses. Humor could be incorporated by having the students create their own funny story or joke about shapes. Rhyme and rhythm could be used either by having the students create their own poem or one could be read to them to help them remember specifics about a geometric shapes. To give the students a vivid mental image you could ask them to close their eyes and think about what it would be like to not know the time of day, how long it would take to travel from one place to another or how to construct safe buildings or bridges? How would our world be different? Have the students share their images with the rest of the class.

This is a poem, written by Carole Somerville, that I really enjoy that describes geometry quite well. http://www.helium.com/items/1586181-poem-about-geometry

Horizontal, parallel, intersecting, perpendicular
Different widths, lengths, heights, numbers
Base times itself gives the square's area
In a circle, radius is half the size of the diameter
Calculations, facts, theories to conquer
Angles that are obtuse, straight, acute they appear
In all degrees, some find it fascinating,
Have no trouble understanding
All the facts, computations and complex
Workings; precision essential, exactness
Vital, problems that call for meticulousness
Without which
All would crumble, there would be no order
Geometry brings sequence and stability
In a world where there is also volatility
Each complimenting each other
A world of opposites; yin and yang
Ever since time began.

3. Resources
What resources can you use to learn more about the topic and to shape your story? What resources are useful in creating activities?

The resources I would use to help learn more about the topic and to shape my story would be:

- **Geometry Civilized: History, Culture and Technique by J. L. Heilbron**
- **The Greedy Triangle by Marilyn Burns**
- **Sir Cumference and the First Round Table by Cindy Neuschwander**
- **What's Your Angle, Pythagoras? A Math Adventure by Julie Ellis and Phyllis Hornung**
- **Sir Cumference and the Great Knight of Angleland (A Math Adventure) by Cindy Neuschwander and Wayne Geehan**
- **Mummy Math: An Adventure in Geometry by Cindy Neuschwander and Bryan Langdo**
- **http://www.helium.com/items/1586181-poem-about-geometry**

These are just a few of the resources that could be used to incorporate the topic of geometry into the classroom. I think that stories are a great way to help students connect and envision a topic. They make mental pictures and can also see the vivid illustrations in some of the picture books that also help students to visualize concepts and make them more concrete. Other resources I would use would be geoboards and other manipulatives that allow for hands-on activity because I think it is the best way to learn.

4. Conclusion
How does the narrative end? How can one best bring the topic to a satisfactory closure and how can students feel this satisfaction? Alternatively, what new questions can draw students to think more deeply about the topic? How can you extend students' sense of wonder?

This narrative ends by having the students explore their surroundings and realize that geometry is a very valuable subject to learn, even though they may think in the beginning that they will never need to use it in their daily lives. The students can be made appreciative of all the contributions that ancient mathematicians made for this area math. They can now look at the homes they live in, the streets they drive on, the bridges they cross, the buildings they enter, and realize the complexity that goes into making such things and how it all connects to geometry! There is also natural geometry that the students could explore. For example, what about the building that animals do? Is there a sense of wonder in the spiral of a shell, the ellipses of the planets, a beaver's den? Is there a difference between natural geometry and human geometry? Angles and

shapes and space…oh my! Hopefully by the end of this unit students will have a better understanding of the history of geometry and how it affects our daily lives.

5. Evaluation
How can one know that the content has been learned and understood and has engaged and stimulated students' imaginations?

To know that the content has been learned, understood and has engaged and stimulated the students' imaginations I would have the entire class work together, with each student having a particular role in creating a life sized geodesic dome for all the students to sit in, where they could admire their efforts. I would then have them write a short essay in their journals commenting on the complications they encountered and how they overcame them. They would also have to relate their trials and tribulations to those of the ancient mathematicians in order to prove that they made that connection with them.