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**GRADE:** 6th Grade

**TYPE OF LESSON:**   Inquiry, Group-worthy lesson

**TIME:** 2 hours :40 minutes, five “E” lessons/sessions

**LEARNING GOAL:**

Students will design a two dimensional net and transfer it into a three-dimensional shape.  Students will distinguish between different types of pyramids.  Students will determine the surface area of the two-dimensional pyramids.

**KEY QUESTION:**
The Pharaoh's Architect was recently crushed under a 5,000 block of marble. Many slaves were lost in this tragic accident. How can you design and construct a pyramid that will prove worthy enough for your group to be chosen as the Pharaoh's new architect?

* Comparing similarities and differences between 2D and 3D and calculating surface area.
* Mathematically prove why your pyramid model is architecturally sound with symbolic hieroglyphic language.

**RATIONALE:**
This lesson is part of a unit on Ancient Egypt.  In previous lessons, the students have been studying the history, culture, and significance of Ancient Egypt.  In particular, they have been studying the ancient pyramids of Giza.  Explored in previous lessons are questions such as how were the pyramids built?  Who built them?  Why is the Great Pyramid considered one of the Seven Wonders of the World?

The students also have studied ancient Egyptian hieroglyphics including the writing, art, and religious beliefs that they embody.  They have explored ideas of symbolism and communication in art and writing.
In math, students have previously studied the concepts of nets (with cubes), surface area, and scale.

**TARGET EALRs:**
6.4. Core Content: Two- and three-dimensional figures (Geometry/Measurement, Algebra) Two- and three-dimensional figures (Geometry/Measurement, Algebra)
6.4.F Determine the surface area of a pyramid.

**RELATED EALRs:**
EALR 4:  HISTORY
4.1.2 Understands how the rise of civilizations defines eras in ancient history.

**MATERIALS:**
Isometric dot paper- <http://www.teachervision.fen.com/geometry/printable/6186.html>
Pencils, Tape, Pyramid Worksheet, Markers/Colored Pencils
Post-it notes (for deciphering hieroglyphics)
Materials for large Pyramid (assorted material choices on back table)

* Thin cardboard, Construction Paper, Tag-board

Pyramid Worksheet, Hieroglyphic and Geometric Symbols Guide, Task Sheets, Links to videos

**ENGAGE:** Time: :20

**Show one of the videos about the pyramids:**
Video of the great pyramids
<http://www.youtube.com/watch?v=czISLzICp9s&feature=player_embedded>
History Channel
<http://www.youtube.com/watch?v=EVQoqQauJ6Y&feature=related>
Right Rectangular Pyramid
<http://www.learner.org/interactives/geometry/3d_pyramids.html>
Seeing Egypt through symbolist eyes
<http://www.youtube.com/watch?v=GaInDIv3-V8&feature=related>

* Quick review of what they learned about the building of the pyramids - built a long time ago, aligned with the stars, slave labor, in shape of a right pyramid
* Ask, “How did they design these?”
* Pose Key Question (create a PPT slide, project onto ActiveBoard)

**EXPLORE:** Time: :40
The teacher demonstrates how to construct a net for a pyramid with a square base.
Following the task cards (see attached), each group chooses and constructs an initial net for one of the following pyramids:

a. A pyramid whose base is an equilateral triangle
b. A pyramid whose base is an isosceles triangle
c. A square-based pyramid constructed so that the four triangular faces are NOT all congruent to each other.
d. A pyramid with a rectangular base.
e. A pyramid with a rhombus base.

Groups test each their net.  Each group calculates the surface area of their pyramid.
Students record their math calculations as evidence on one triangular side.
Once their nets and initial 3-D pyramids are constructed, students will enlarge their nets using what they know from scale drawings to build a larger pyramid.

**EXPLAIN:** Time: :20
Students will explain the results of their explorations of geometric concepts
through a whole class discussion.

* What is the same/different between your 2D net and your 3D pyramid?
* How did you go about constructing their nets?
* How do you calculate the surface area of your two nets?
* How do solutions compare/contrast to other student groups?
* What patterns do you notice in how groups calculated surface area?
* Can we generate a formula for calculating surface area that works for all the pyramids that the class made?

**ELABORATE:** Time: :40
**Discuss:**  Why did the Egyptians use a right pyramid?

**Art:** Hieroglyphics and more: <http://www.discoveringegypt.com/e-name.htm>
Teacher shares hieroglyphic and geometric keys and instructs students to communicate a secret mathematical message to self-assess their learning.

Students may customize new symbols if they provide a key.

**Example:** Our equilateral triangle pyramid has 4 faces, 8 edges and 1 vertex

**EVALUATE:** Time: :40

Students will create a three-dimensional pyramid based on a two-dimensional drawing (net).  They will calculate the surface area and embellish the surface area with techniques learned from the hieroglyphics lesson.  They will record their findings on their worksheets. (Time :20) Teacher will assess the accuracy and completeness of their worksheets, the accuracy of their 2-D nets and 3-D pyramids, and the appropriate use of hieroglyphics.

Students will conduct a gallery walk of all group projects. (Time :20) Students will use mathematical language (symbols) to describe their ideas. Students will decipher secret messages to learn why each pyramid model is architecturally sound, and why that group should be chosen as the new architect.

**RUBRIC – Pyramid Worksheet**

**2 points:** The response/worksheet demonstrates a complete
understanding and analysis of a problem.

•  Response uses the terms face, edge, and vertex to compare
figures.
•  Response names the number of faces, edges, and vertices
correctly.
•  Response makes the connection that figures are 3-
dimensional and contain 2-dimensional shapes
as faces.

**1 point:** The response/worksheet demonstrates a minimal
understanding and analysis of a problem.

•  Response uses some of the terms face, edge, and vertex,
but does not use to compare and contrast.
•  Response uses the terms face, edge, and vertex, but
does not name the numbers correctly.
•  Response makes partial connection between 3-
dimensional figures and 2-dimensional shapes as faces.

**0 points:** The response/worksheet is completely incorrect, irrelevant to
the problem, or missing

**Extension / Modification:**
Students solve for volume.
Students explore interactive manipulative - Right Rectangular Pyramid
<http://www.learner.org/interactives/geometry/3d_pyramids.html>
Video of the great pyramids - good intro, ties into the “Golden ratio”
<http://www.youtube.com/watch?v=czISLzICp9s&feature=player_embedded>
History Channel – aligned to constellation “Orion”
<http://www.youtube.com/watch?v=EVQoqQauJ6Y&feature=related>