MATH IS ALL FUN AND GAMES

BY MARGARET MIURA

How can games and art be a tool in learning math?

ELEMENTARY FOURTH GRADE

TIMEFRAME THREE 50-MINUTE BLOCKS

COMMON CORE MATHEMATICS STANDARDS

4.MD.5 - Recognize angles as geometric shapes that are formed wherever two rays share a common endpoint.
4.G.1 - Draw points, lines, line segments, rays, angles (right, acute, obtuse and perpendicular and parallel line. Identify these in two-dimensional figures.
4.MD.3 - Apply the area and perimeter formulas for rectangular shapes in real world and mathematical problems.

NĀ HOPENA A’O LEARNING OUTCOMES

Belonging: reflects personal preferences in the artwork
Responsibility: looks to do quality work
Excellence: explores new ideas
Aloha: gives gifts made for that person in mind
Total Well-Being: thinks about repurposing items instead of just throwing it away
Hawai‘i: gains an understanding for Hawaiian culture
ENDURING UNDERSTANDINGS:
Mathematics is more than just learning algorithms to get the right answers. Math is a way to make sense of the world around us including games and art.

CRITICAL SKILLS AND CONCEPTS:
Identify repeated patterns and recognize how sequence affects the outcome of string games that are played in many cultures around the world including Hawai'i.

Duplicate the shapes formed by string figures to create stamp art. Make pepa kāpala (paper stamps) to stamp cardstock, paper bags, and other printable items.

AUTHENTIC PERFORMANCE TASK:
Produce greeting cards, bags, and decorative paper.

AUTHENTIC AUDIENCE:
Finished products were given to parents, guests, and friends.
PART 1 - Pukaula (String Trick), Hei (string figures) (50 MIN)

1. Background
   - Explorers and anthropologists discovered string figure games in many different parts of the world: Arctic, N. America, S. America, Pacific Islands, Australia, New Zealand, Africa, and South East Asia.
   - Earliest evidence – Greek 4th Century AD
   - The practice of making a loop out of string-like material dated to upper Palaeolithic (late Old Stone Age, 40-10,000 BC). Beads of necklaces (if not the loop itself) have survived in graves.
   - Hairnets found at burials suggest fishing nets from the Mesolithic period. The strings at the intersections of the meshes were either twisted or knotted together.

2. String Figure Glossary
   - Finger names – thumb, index, middle finger, ring finger, little finger
   - Position 1 – insert thumbs and little fingers into the loop and extend (draw hands apart until the string is taut)
     i. Palm/palmar string – string that runs across either palm
     ii. Traverse/frame string – string which runs across from one hand to the other
   - Pick up – to pick up a string, pass the tip of the finger under the string and raise the string on the back of the finger, returning the finger to its normal position
   - Opening A
     i. Put the string in Position 1, then with the right index pick up the left palmer string, then pass the left index between the two strings on the right index and with the left index pick up the right palmar string, and extend
     ii. There will now be six loops, one on each thumb, index finger, and little finger
     iii. Each loop consists of two strings: Near string (string nearest the body) and far string
   - Hook up – Reach over a string with the tip of finger and pull up with soft pad of finger
   - Navajo – To Navajo the loops on a finger, lift the lower loop up over the upper loop and off the finger altogether

3. Pukaula (String Trick)
   - E Loli E, E Loli E, Nahu I ke Kalo [Turn, Turn, Bite the Taro] – Pun on words. Loli means turn and the word for sea slug. The shape of the loli (turn) resembles the leaf of the kalo.
   - Explain why/how you “get caught/bit” or not “get caught/bit”.
   - Practice step by step procedures to doing the trick.

4. Hei (String Figure) Cat’s Cradle
   - [1 ‘anana, 1 iwilei or 1 ½ ‘anana]
   - With partner, explore the game Cat’s Cradle

5. Hei (String Figure) Honu (Turtle)
   - [1 ‘anana or 2 iwilei or 4 ha’ilima]
   a. Begin with a loop on left and right index fingers.
   b. Using the thumbs pick up the far string.
   c. Using the little finger, pick up the far string.
   d. Using the right index, pick up the loop from back of the left index and transfer it to right index. Using the left index, pick up the bottom loop from the right index and transfer it to the left index.
   e. With the right index and thumb, reach into the loop of your left index, take off the left thumb loop, pull the loop out and place it back over the left thumb. Repeat steps on right thumb, then left little finger, and then on right little finger forming a diamond with two far triangles and two near triangles.
   f. Put your index fingers into the two far triangles picking up the left and right far side of the diamond. You will now have two loops on both index fingers.
   g. Navajo the bottom loop from both right and left index fingers.
PART 1 - Pukaula (String Trick), Hei (string figures) (continued)

6. Hei (String Figure) Open the Gate [5 ha'ilima]
   a. Start from “opening A” Position.
   b. With thumbs, reach over and pick up the second to the last string.
   c. With little fingers, reach over two strings and pick up the string.
   d. Curl your index fingers into the triangle formed by the palm string and index finger loop.
   e. Keeping hold of the loops with your index fingers by placing the tip of your index fingers onto your palms, drop the loops from your thumbs and little fingers.
   f. Turn your hands so that your palms are facing you and carefully pull your hands apart. When only the two loops that your index fingers were holding are clear, grasp the two loops with your index, middle, ring, and little fingers. As you pull your hands apart, you will see the gate open.

7. Hei (String Figure) Witches’ Broom [5 ha'ilima]
   a. Start with a loop around your thumb and little finger on your non-dominant hand. Let the loop drape so that the palm string is across your palm.
   b. With your dominant hand, hook up the palm string with your index finger and pull until the remaining loop forms another palm string. Drop the loop from your index finger.
   c. Repeat the previous step.
   d. Reach into the loop with your dominant hand and hold the loop so that the two strings are now between your thumb and index finger.
   e. With your thumb and index finger of your dominant hand, reach over the loops of the corresponding thumb and index finger.
   f. Once your thumb and index finger is in the corresponding loops, pinch your thumb and index finger so the loops will not slip out when you pull it through the loop draped on your dominant hand.
   g. With dominant hand thumb and index pointing down and taut, pull your thumb and index slightly apart to separate the two loops so that the four strings form three distinct sections.
   h. With your non-dominant index, middle, and ring fingers reach over and put each finger in the adjacent section.
   i. Rotate your non-dominant hand towards your body until your fingers are point up. Drop the loops from your other hand.
   j. Using the index finger from your free hand hook the near palm string. As you pull up with your dominant index finger, turn your other hand palm facing up.

8. Hei (String Figure) Eagle’s Claw [5 ha'ilima]
   a. Start in Position 1. With your pointer of your dominant hand, hook the palm string of the opposite hand and twist it twice around your index as you pull apart.
   b. Reach in and pick up the palm string of the loop on the dominant hand’s index finger and pull apart so all the loops are taut.
   c. Drop the loops on your thumb and little finger of your dominant hand and pull taut forming the Eagle’s Claw.

9. Hei (String Figure) Cat’s Whiskers & Jacob’s Ladder [5 ha'ilima]
   a. Start from “Opening A” position. Drop the thumb strings.
   b. Reach under with both thumbs and pick up the last string.
   c. With both thumbs, reach over and pick up the second string.
   d. Drop the little finger loop from both hands.
   e. With both little fingers, reach over the last string and pick up the second to the last string.
   f. Drop the thumb strings. You have Cat’s Whiskers.
   g. With both thumbs, go over the first two strings and pick up the third string.
   h. Using right hand, lift the string from the outside of the left hand’s index finger and place it over the left thumb. Navajo the both thumb loop. Repeat on the other hand.
   i. Looking down into the design, stick your index fingers into the triangle that is next to your thumb. Turn your hands down and out away from your face and drop the loop on the little fingers. Spread thumb and index fingers to form a right angle. Index finger points up to display Jacob’s ladder.

10. Describe and choose a design for pepa kāpala.
PART 2 - Choose and sketch a design inspired by a string figure (50 min)

1. Draft a design and determine what part will be recessed (not inked)
   a. On graph paper draw points, lines, line segments, rays, angles.
   b. Identify the angles and shapes formed by the string figures.
2. Transfer the design onto a piece of foam cut into the desired length and width of a ruler.
3. Carefully use the pencil to push down the recessed part of the design.
4. Adhere the stamp to a flat ruler or strip of cardstock.
5. Stamp design and try using translations, rotations, and reflections.

PART 3 - Decorate cards and gift bags (50 min)

Optional. Find perimeter and area of pepa kāpala prints*

INSPIRATION:
“E Huki I Ke Kaula” Lesson by Kumu Darienne Dey
‘Ohe Kāpala Lesson by Kumu Phil Galicinao
Plastic Fantastic? Exhibit at the Spalding House

REFERENCES/RESOURCES:
Pukui, Mary Kawena and Alfons L. Korn. The Echo of Our Song: Chants and Poems of the Hawaiians.
Titcomb, Margaret. The Ancient Hawaiians How They Clothed Themselves. Hawaii, 1975
### PEPA KĀPALA PROJECT RUBRIC:

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<tr>
<td>4.MD.5</td>
<td>Recognize with assistance, angles that are formed by the loops in the string figures</td>
<td>Identify with assistance angles that are formed by the loops in the string figures</td>
<td>Identify and describe how angles are formed by the loops in the string figures</td>
<td>Apply the knowledge of how angles are formed by the loops in string figures to create aesthetically pleasing piece of art</td>
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<td>4.G.1</td>
<td>Draw and identify, with much assistance, points, lines, line segments, rays, angles (right, acute, obtuse and perpendicular and parallel lines).</td>
<td>Draw and identify, with assistance, points, lines, line segments, rays, angles (right, acute, obtuse and perpendicular and parallel lines).</td>
<td>Draw and identify points, lines, line segments, rays, angles (right, acute, obtuse and perpendicular and parallel lines).</td>
<td>Demonstrate a reasonable replication of the points, lines, line segments, rays, and angles in the making of a pepa kāpala.</td>
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<td>4.MD.3</td>
<td>Find, with assistance, area and perimeter of the geometric shapes, pepa kāpala, or medium being printed.</td>
<td>Calculate, with assistance, the area and perimeter of the geometric shapes, pepa kāpala, and medium being printed.</td>
<td>Calculate the area and perimeter of the geometric shapes, pepa kāpala, and medium being printed.</td>
<td>Calculate and determine placement of stamped image based which shows a logical understanding of area and perimeter.</td>
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