WAYNE STATE UNIVERSITY

STEM Day Lesson Plan

Lesson Plan Author(s) Names and Affiliation: This lesson plan is based on a compilation of resources and modified by Elsie Babcock/Leah van Belle, WSU College of Education Faculty.

Title: T^3: Tinkering with Tangrams and Technology

Subject Area: Mathematics, Science and Technology

Learning Activity Description: Students decompose and compose tangram shapes using transformations, identify fractional parts of the tangram puzzle. **Science connection:** use trial and error, insight (mental manipulation of available information), or a technique that has worked in the past (heuristics).

Lesson Activity Objective: Use transformations to compose geometric figures, use congruence and similarity to prove relationships in geometric figures and apply these techniques in the context of solving real-world and mathematical problems.

Mathematical Practices:

1. Make sense of problems and persevere in solving them.
3. Construct viable arguments and critique the reasoning of others.
4. Model with mathematics.
5. Use appropriate tools strategically.
6. Attend to precision.
7. Look for and make use of structure.

Lesson Activity Outcomes:

- Divide a shape into a series of smaller shapes, identify the smaller shapes into which the shape is divided and combine the smaller pieces to make the original shape.
- Compare and name fractional parts/percents of a given whole.

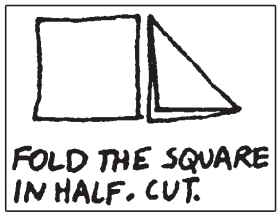
Materials/Supplies Listed:
Scissors (1 per student)
4-6 inch shapes w/a square face or precut if students have difficulty cutting (1 per student)
Class set of Tangrams (optional)
Chart Paper
Large envelops (1 per student)

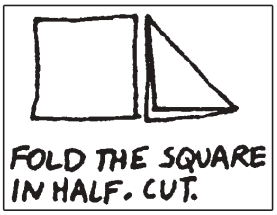
Teacher Procedures:

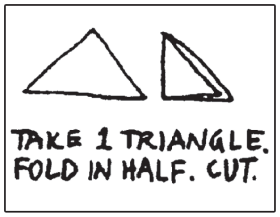
1. Introduced the lesson by telling the story of the tangram or read aloud to students one of the following books: The Tangram Magician, by Lisa Campbell Ernst and Lee Ernst; Three Pigs, One Wolf, and Seven Magic Shapes, by Grace Maccaron; Grandfather Tang's Story, by Ann Tompert; or the Warlord's Puzzle, by Virginia Pilegard (author) and

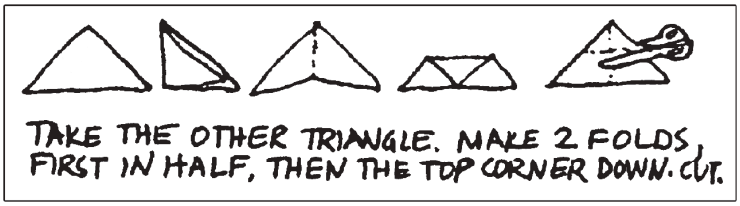
Nicolas Debon (Illustrator). You may opt to use Marilyn Burns' the *Story of Tangram* (based on a Chinese legend) at the end of this lesson plan.

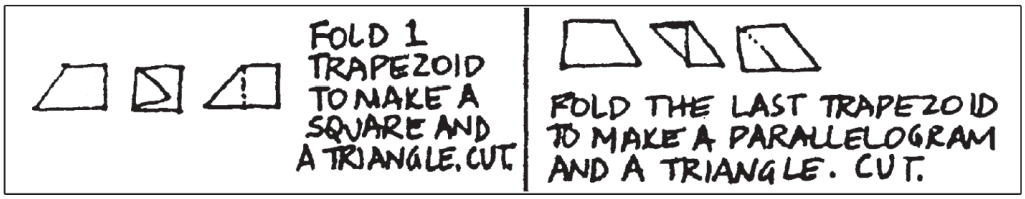
2. After reading the story, distribute the paper shapes to students. Next, hold up the shape and ask students what they notice. Record their responses/terms and discuss any misconceptions. (square, polygon, square corner/right angle, rectangle, congruent, diagonal, triangle, right triangle, line of symmetry, symmetrical, acute angle, similar, vertex, trapezoid, quadrilateral, obtuse angle, parallelogram, parallel lines, intersecting lines)
3. Again, hold up the shape and explain to students they will be cutting the shape to make seven tangram pieces.
4. Use the following steps to create the tangram puzzle.

A. 

B. 

C. 

D. 

E. 

5. Challenge students to put the 7 tangram pieces back together to make a "square", triangle", "parallelogram", "trapezoid".

Preparation Time for Learning Activity: 45 minutes (Day 2 optional)

Room set-up: Tables or desks configured for groups of 2 or 4.

Group Strategies (example, group size, expected time for groups, etc.): Students work independently when cutting the puzzle pieces and collaborate in pairs when composing other shapes.

Student Products/Artifacts/work pages: Seven piece Tangram puzzle.

Assessment Criteria/Rubric: N/A

Closing/Transition to next activity: Whole-group discussion comparing findings.

1. What two shapes can be combined to make a square? (triangles)
2. What shapes can be combined to make a triangle? two triangles, two triangles and a square, etc.
3. Into what seven shapes did we break our large square? (five triangles, one square, one Parallelogram)
4. How did you decide which shapes to combine to make other shapes?
5. What do you notice about the triangular pieces of your tangram set? (They are similar (congruent, different size), two small triangles make one medium triangle, etc.)
6. What do your results tell you about the relationships among the various tangram pieces? Can one shape be made from another (or others)? Is there a basic shape that could be used to make them all? How can you prove your answers?

DAY 2

Lesson Activity Objective: Compare two fractions with different numerators and different denominators, using the denominators 2, 3, 4, 5, 6, 8, 10, 12, and 100. Recognize that comparisons are valid only when the two fractions refer to the same whole. Record the results of comparisons with symbols >, =, or <, and justify the conclusions by:

- Reasoning about their size and using area and length models.
- Using benchmark fractions 0, ½, and a whole.
- Comparing common numerator or common denominators

Student Outcomes:

- compare fractional parts of a shape to other fractional parts and to the whole.

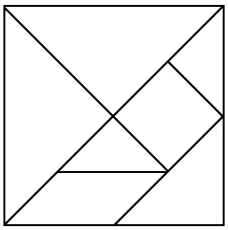
Math Language:

- denominator/numerator
- equivalent
- greater than/less than
- partition
- compare

Materials/Supplies Listed:
Class set of Tangrams
Chart Paper or document camera/computer

Exploring Tangrams (18-20 minutes)

1. Display the original shape ("square") from day 1 to students and state: This is the "square" that represents the whole in today's activity.



2. Explain that their job is to determine what fractional size of each tangram piece, if the large "square" has a value of one.
3. After introducing the activity distribute the set of tangram pieces or instruct students to use the puzzle they created in day 1. Allow students to explore with a partner to figure out the fractional size of each tangram piece. It is assumed that the entire square represents 1 or 1 whole. Look for students who place pieces on top of each other to compare them to each other. Observe: How are students making sense of the values? Can they identify the value of the two large triangles together as ½? As students work, ask similar questions:
    - How does this piece relate to the whole? How do you know?
    - What is the fractional name for this piece?
    - What is the relationship between these two pieces?
    - Can two pieces with different shapes have the same value?

Discussion of Tangrams (10-12 minutes)

Select students to share their strategies for finding the value of each shape using the document camera or have them sketch their solutions. You may want to have multiple copies of the tangram template handy so that students can visually see students' various strategies. Have students share their strategies for identifying the tangram pieces.
Ask questions to further the discussion, such as:

- How do these strategies relate?
- Is there another way to find the value of this piece?
- What other piece can we identify based on this thinking?
- How did comparing the fractional parts you already identified help?

Evaluation of Student Understanding:

Informal Evaluation:

- Observe and monitor students as they solved the problem. How are they making sense of the problem? Are they laying the pieces on top of each other? Can they identify the half?
- Have students write in their math journals the strategy they used to solve the problem.

Challenge:

- Allow students to repeat this activity with the large square not being the value of one. Choose one of the pieces in the tangram, and say that it is now 1, what size are the other pieces? What are the other sizes if the small square is half?

Meeting the Needs of the Range of Learners:

Intervention:

- Students who are having trouble with this activity may want to start with pattern blocks, if hexagon is the whole, what is the value of the trapezoid? Triangle?

Possible Misconceptions/ Suggestions

Possible Misconceptions	Suggestions
Students struggle to get started on the task.	○ "Can you see a way to divide the whole square into half?" ○ "What do you notice about the 2 large triangles?"
Students are unable to find the fractional value of smaller shapes.	○ "How many of the <shape> would it take to cover the entire square? Is there a way we could find out?"

Story of the Tangram

based on Chinese legend

"Once upon a time there was a great, wise, and kind emperor who was beloved by all in his kingdom. To show their great love and respect for him, his subjects hired the greatest tile maker in the kingdom to create the most magnificent, beautifully decorated ceramic tile ever. People from throughout the kingdom came to see the presentation of the tile to the emperor. The emperor was moved by this show of respect from his subjects. He thought long and hard about the perfect place to put the beautiful tile. His favorite spot in the world was his garden filled with flowers of every hue, huge shady trees, colorful birds, soft, cool grasses, and a waterfall. He decided that the garden was the only place for his tile. He set out one afternoon for his garden, gently carrying the tile with the greatest care. As he climbed the path to the garden, he tripped over a small stone and tumbled to the ground. So, did the tile. As the tile hit the ground, it shattered into seven pieces, the same seven pieces found in a tangram. The king was overcome with grief. After a short while, he decided he must attempt to reassemble the tile. He spent the rest of his life working to reassemble the tile but was unable to do so. Wise men from all over came to assist, but none was successful. Will you be successful at putting the pieces back together to form a square?"

Resources

1. *Learning Vocabulary with Tangrams* by Maryann Wickett, Math Solutions Online Newsletter, Summer 2008, Issue 30.
2. *The Tangram Conundrum* by Debra Thatcher, NCTM article *Mathematics Teaching in the Middle School*, 2001.
3. T*angram Tinkerings*, AIMS Education, 2009.

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Tinkering with Tangrams and Technology
STEM Day Resources

https://tinyurl.com/tangramsWSU

1. **ORIGINS OF TANGRAMS AND RULES OF THE GAME**

   Grandfather Tang's Story by Ann Tompert
   book begins at 1:02
   https://www.youtube.com/watch?v=x74l1ZM-zP0

   Wikipedia: Tangrams
   https://en.wikipedia.org/wiki/Tangram

   Archimedes' Lab: Tangrams
   http://www.archimedes-lab.org/tangramagicus/pagetang1.html

2. **VIRTUAL TANGRAMS AND TANGRAM-INSPIRED PUZZLES**

   Math Is Fun!
   https://www.mathsisfun.com/games/tangrams.html

   Mega Tangrams
   http://www.ejectamenta.com/HTML5-Games/MegaTangram.html

   Tangram Templates
   https://www.transum.org/software/Tangrams/Template.asp

3. **YouTube TANGRAM FUN**

   The Tangram Channel
   https://www.youtube.com/user/TangramChannel/videos

   Stop-Motion Animation Tangram
   https://www.youtube.com/watch?v=ua1QZfIEKvE

   Xtreme Tangram
   https://www.youtube.com/watch?time_continue=1&v=Ex-TT9s4OKk