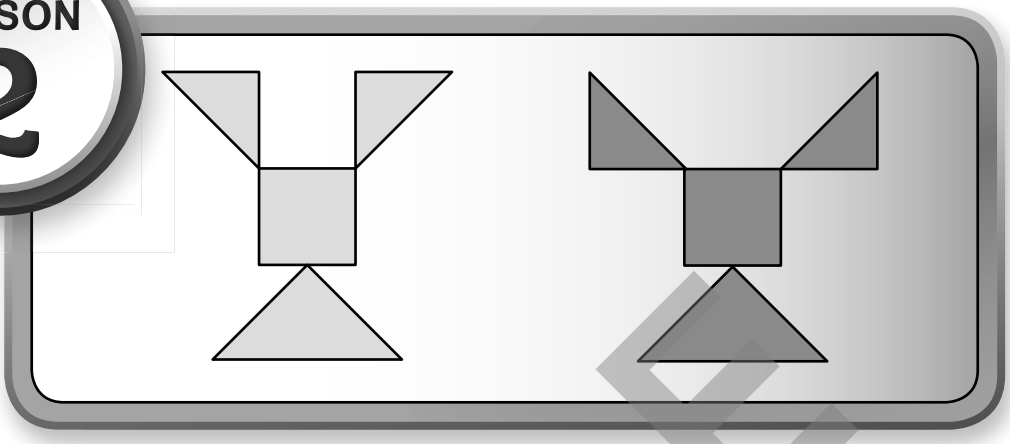
LESSON 2



Look, Make, and Fix

In Brief

This lesson builds on the skills developed in Lesson 3.1 by focusing on identification and location of shapes relative to each other in 2-dimensions and on improving students' visual memory. These skills can be developed over time, and students can learn strategies that improve their spatial visualization skills. Students examine designs constructed of different numbers of tangram shapes. They first look carefully at the design and memorize what they see, then reproduce it from memory using their own tangram pieces.

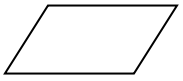
Objectives and Mathematical Focus

- Students identify squares, triangles, and parallelograms.
- Students describe 2-dimensional shapes.
- Students recognize how shapes are oriented in a design relative to each other.
- Students use positional language to describe how shapes are oriented.
- Students reproduce a design from memory consisting of several shapes.

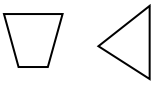
NOTES

Mathematical Language

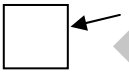
- ***Parallelogram** – a four-sided polygon with opposite sides parallel and congruent



- **Polygon** – a closed plane figure with three or more sides that are made up of line segments that do not cross



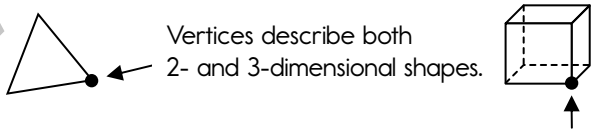
- ***Side** – each of the line segments that make up a polygon; this is a term used only with 2-dimensional shapes



- ***Square** – a rectangle with four equal sides

- ***Triangle** – a polygon with three sides and three angles or vertices

- ***Vertex (Vertices – plural)** – the point where two sides of a 2-dimensional shape meet; also the point where three edges meet in a 3-dimensional shape.



Materials

Whole-Class Investigation

- "Dear Farley" memo (p. 235)
- Small box containing:
  - 4 inch × 4 inch magnetic tangram puzzle inside the box
  - "Control Panel Outline" – (from Unit Introduction Lesson; fold and place it in the tangram box ahead of time) (p. 67)
- 4 inch × 4 inch tangram puzzle sets (1 per student in small zipper bags)

NOTES

- "Control Panel Outline" – (1 per student) (p. 236)
- 4 inch × 4 inch magnetic tangram puzzle for teacher use
- mat or colored paper to place tangram pieces on (1 per student)

Small-Group Space Labs

- "Look, Make, and Fix 1" (p. 237)
- "Look, Make, and Fix 2" (p. 238)
- "Look, Make, and Fix 3" (p. 239)
- "Look, Make, and Fix 4" (p. 240)
- "Look, Make, and Fix 5" (p. 241)
- 4 in. × 4 in. tangram puzzle sets (1 per student)
- Space Lab Quick Check (p. 242)

Think Deeply

- "Think Deeply" (Student Mathematician's Journal p. 35)
- "Hint Cards"
- "Think Beyond Cards"

Chapter Check-Up

- "Chapter Check-up: Part 1" (p. 247)
- Look and Make (p. 252)
- "Chapter Check-up: Part 2" (p. 253)
- Tangram sets (1 per student)
- Paper tangram pieces (optional)

Throughout the lesson use the "What to Look for in Responses" and "Possible Difficulties" to help focus discussions.

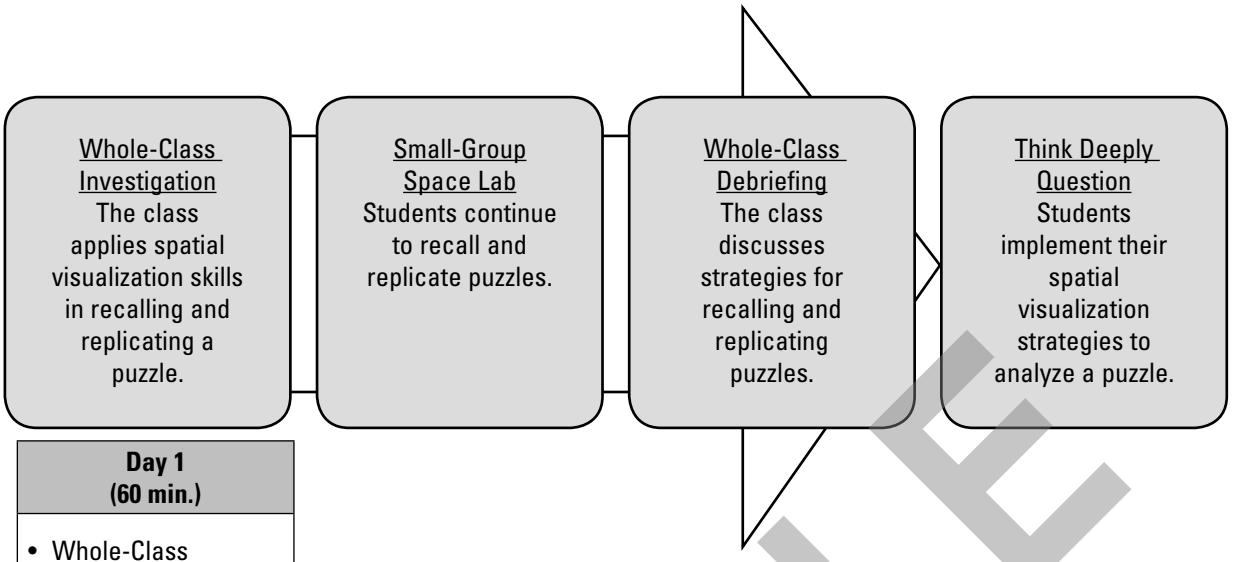
Lesson Development

Activities

Day 1 (60 min.)	Days 2 and 3 (60 min./day)	Day 4 (60 min.)	Day 5 (60 min.)
• Whole-Class Investigation • Space Centers Introduction	• Small-Group Space Lab (repeated with small groups) • Space Centers • Whole-Class Debriefing (at end of Day 3)	• Think Deeply Question (repeated with small groups) • Space Centers	• Chapter Check-up (repeated with small groups) • Space Centers

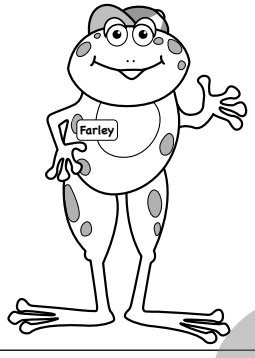
Note that all activities, other than the Space Centers, are teacher-facilitated.

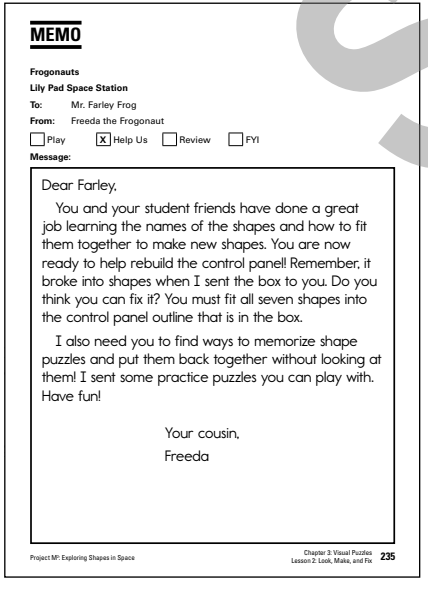
Math Overview



Day 1 (60 min.)
• Whole-Class Investigation • Introduction of Lesson Centers

Note that students participate in the Space Centers anytime they are not working with you in a small-group setting.





MEMO

Frogonauts
Lily Pad Space Station
To: Mr. Farley Frog
From: Freeda the Frogonaut
☐ Play ☒ Help Us ☐ Review ☐ FYI
Message:

Dear Farley,

You and your student friends have done a great job learning the names of the shapes and how to fit them together to make new shapes. You are now ready to help rebuild the control panel! Remember, it broke into shapes when I sent the box to you. Do you think you can fix it? You must fit all seven shapes into the control panel outline that is in the box.

I also need you to find ways to memorize shape puzzles and put them back together without looking at them! I sent some practice puzzles you can play with. Have fun!

Your cousin,
Freeda

Project M²: Exploring Shapes in Space
Chapter 3: Visual Puzzles
Lesson 2: Look, Make, and Fix
235

Teacher Guide p. 235

Day 1

Pacing Guide: 35 minutes

Whole-Class Investigation

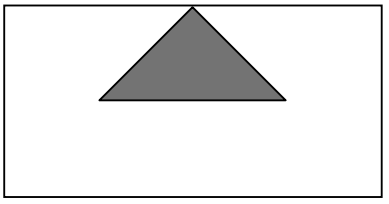
1. ***Open the session with the frogonaut handshake.***

2. ***Have Farley read the memo he received from Freeda.***
   Ask Farley about his memory. Is he very good at remembering? Not always! Also, ask students how they remember things. How might they help Farley remember how to place the shapes together? Solicit ideas from the students and list a few on the board. Then state: "Let's go look in the box for the copy of the control panel to see what Farley needs to remember."

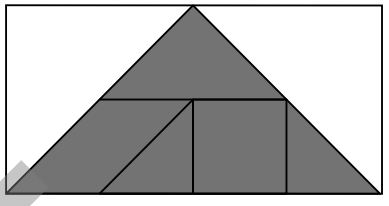
3. ***Re-examine the box from outer space.***
   Use Farley to rummage through the tangram box looking for the copy of the control panel mentioned in the memo. Have him look inside. Freeda is right! The control panel broke, and the shapes have fallen off the copy of the control panel. The shapes are just on the bottom of the box and there is only an outline of the control panel. Farley now has a real job ahead of him. He has to somehow figure out how to put them back together. There are seven shapes that used to fit inside the control panel outline.

NOTES

4. ***Have students or pairs complete the "Control Panel Puzzle."***
   Challenge students to help Farley place all seven of the tangram pieces into the shape of a rectangle. Pass out Control Panel Outline page 236 to each student. The medium triangle is outlined to get students started. Some students may be able to solve the puzzle multiple ways by placing the medium triangle elsewhere.

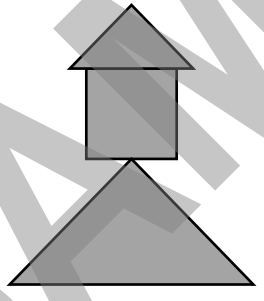


5. ***Set the stage for the investigation.***
   In her memo, Freeda also mentioned that Farley needs to be able to replicate designs from memory. The game Look, Make, and Fix will help him get better at this!



Here is one solution.

6. ***Have students look at a design and study it.***
   The Look, Make, and Fix game helps students learn to identify shapes by name and location. It develops their spatial visualization skills in a fun way. Each student should have a bag with a set of seven tangram pieces. Place three tangram pieces on the magnetic board as shown below (large triangle, square, and small triangle) and have students look closely at the design. Ask a few students to share what they notice about it, such as which shapes are used or the orientation of some shapes (e.g., the small triangle is above the square) and what they think it looks like (e.g., a house at the top of a hill, a person).



   Tell students to study the pattern "really hard" as you are going to cover it up, and they are going to make it from memory.

7. ***Have students make a design.***
   Cover the board or turn it around so students cannot see the design. Next, have them make it using their own sets of tangram shapes. Have them place the design on a piece of construction paper.

8. ***Have students fix their designs.***
   Once everyone has something in front of them, reveal the original design. Have students "fix" their design so the shapes are in the same positions as the one on the board. Encourage students to check that they have the right three pieces before starting. Suggest they help each other. Some students find it helpful to talk aloud about the locations as they place the shapes.

Teacher Tip

Write a list of strategies on chart paper to review and add to later.

NOTES

9. ***Briefly discuss strategies for remembering the design.***
   Have students pretend to be "frogonaut detectives" to motivate them to talk about their strategies.
   - Some students might remember a part of a design that "looked like a tree."
   - Some students might count the number of shapes in the design.
   - Some students may hone in on one shape, such as the triangles, and recognize that there are two different size triangles in the design. Have them share how they could tell the design used a small and a large triangle.

Introduce the Space Centers for the Lesson

1. ***Explain the Space Centers that will be set up for the lesson (Refer to the Space Center Guide).***
   Before students begin working independently at the Space Centers, introduce what tasks they will be doing and model how to complete the centers as necessary.
2. ***Have students begin working at the Space Centers.***
   If time permits, allow students to begin working at the centers. This will provide you the opportunity to observe students working at the centers and determine if additional guidance at any of the centers will be necessary.

Days 2 and 3 (60 min./day)
• Small-Group Space Lab (repeated with each group) • Space Centers • Whole-Class Debriefing

Days 2 and 3

Setting: Small-Group Space Labs, Space Centers, Whole Class Debriefing (Day 3)

Pacing Guide: 60 minutes each day

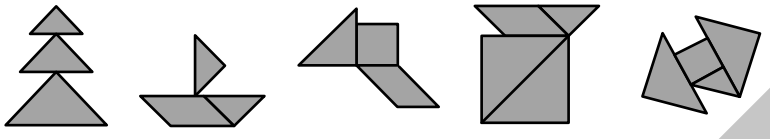
Space Centers (Days 2 and 3)

While you are working with students to complete the Small-Group Space Lab the other students will be working at the Space Centers that were introduced the previous day. You should schedule the Small-Group Space Labs so that you will have time to observe students working in centers.

Small-Group Space Labs (Days 2 and 3)

1. ***Open the session with the frogonaut handshake.***
2. ***Review the puzzle strategies.***
   Ask students ways that help them remember the original picture. Use the chart paper list generated earlier to review strategies. Add on to this list as students play the game.

3. ***Play Look, Make, and Fix a number of times.***
Designs that "look" like something such as a person, tree, or bird will be easier for students to reproduce than ones that are more geometric looking. Start with the tree design. After students have made it, ask them to talk with their partner about how they remembered the shapes and picked the correct ones for the design. Next show them the original tree design and have students fix their designs if necessary.



Continue to encourage students to share their strategies for how to fix the design and place the shapes. Use the *Repeat and Check* talk move to highlight directional words. Praise students who fix the design successfully and who explain their thinking.

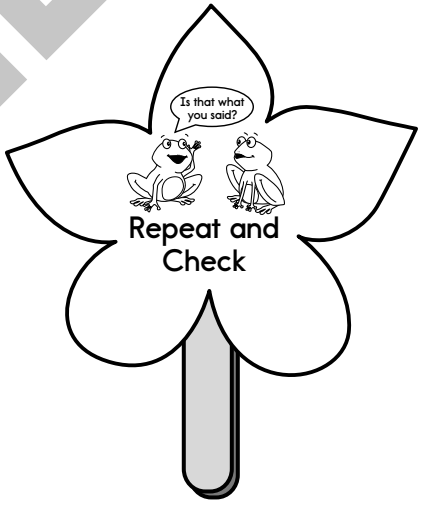
Depending on the skill level of your students, adjust the task by either increasing the number of shapes in the design to four or five or reducing the number of shapes to two. Note that the parallelogram likely will be the most challenging shape to work with for your students.

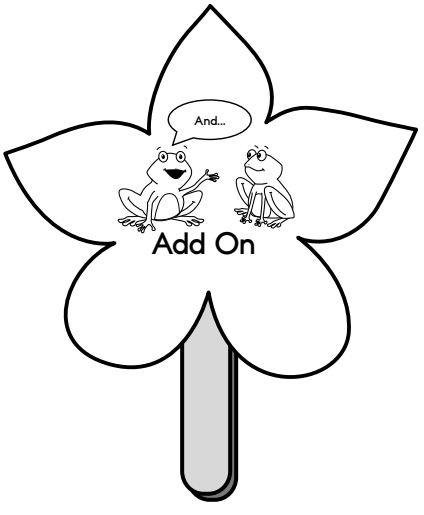
4. ***Have students complete the Look, Make, and Fix Space Lab.***
Students play Look, Make, and Fix sitting next to a partner. One is the "Maker" and the other person is the "Fixer." They both look at the black line master and try to remember the design. Together the students talk about the design. Then they turn the paper over, and the Maker uses his or her tangram pieces to make the design. The Fixer has to be quiet and not tell the Maker what to do at first. But after the Maker has had time to attempt the design, the Fixer can give hints to his or her partner but cannot touch the tangram pieces. This encourages the use of directional and geometric vocabulary (e.g., "Put the square on top of the large triangle."), and helps avoid a student recreating a design for another. *Add On* is a good talk move to use here. Then they turn the paper right-side up and the Fixer checks the design and fixes it, if necessary, so it matches the one on the paper. The students then switch roles and try another puzzle.

There are five "Look, Make and Fix Space Lab" puzzles to choose from. The higher numbers indicate more complex designs, so you may wish to direct students to complete particular puzzles. If a pair has completed all of the puzzles, encourage them to make their own Look, Make, and Fix puzzles for each other by building designs and then tracing them.

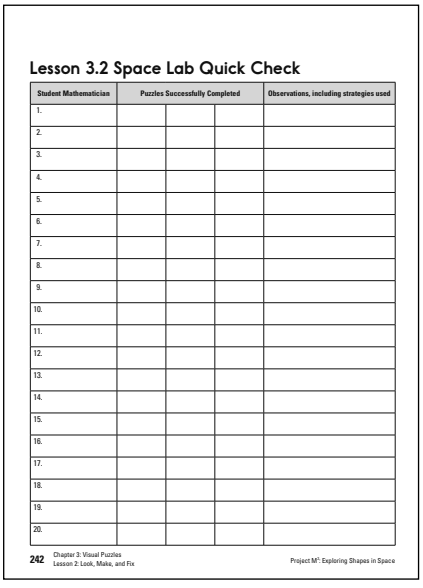
Some Puzzle Strategies

- Thinking about a similar picture
- Counting the number of shapes
- Finding patterns





NOTES

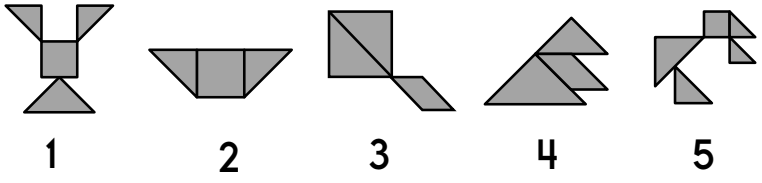


Lesson 3.2 Space Lab Quick Check

Student Mathematician	Puzzles Successfully Completed			Observations, including strategies used
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				
11.				
12.				
13.				
14.				
15.				
16.				
17.				
18.				
19.				
20.				

242 Chapter 3: Visual Puzzles Lesson 2: Look, Make, and Fix — Project M²: Exploring Shapes in Space

Teacher Guide p. 242



5. ***Use the Lesson 3.2 Space Lab Quick Check to assess student understanding.***
Record which puzzles students were able to complete successfully and any observations about their work, including the strategies they used when you asked them about how they solved the puzzles. You also may want to require all students to complete a particular Look, Make, and Fix puzzle.

Whole-Class Debriefing

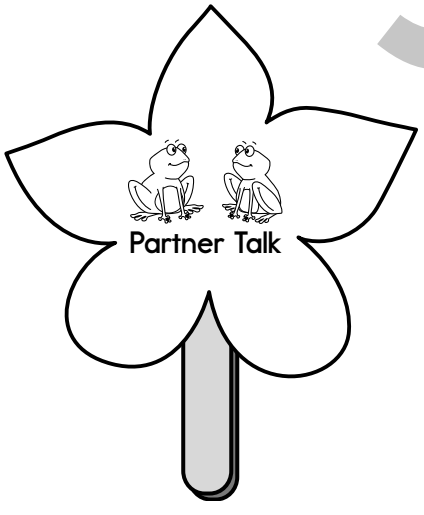
Pacing Guide: 10 minutes

Have students discuss their strategies for remembering the puzzle designs.

Choose one of the Look, Make, and Fix designs, such as puzzles 1 or 2, to discuss with students. Ask them to share their strategies for remembering the design. Also, ask them to talk about how they know where to place the pieces when fixing a design. Some students will have strong visual memories and just "see" the pattern, whereas other students will need to analyze the design and recreate it step-by-step.

Designs with the parallelogram are by far the most difficult. Students are the least familiar with this shape and have trouble orienting it to the others. This is not a good shape to use for a debriefing as it is not easy to describe how to place the parallelogram. Instead, encourage students to indicate the size of the triangles and to use directional words, such as right and left, with the other shapes. Questions that might help students analyze the designs include:

- *Which shapes are used to make the design?*
- *Can you use any of these words to help describe where to place the shapes: above, below, to the left, to the right?*
- *Let's start at the top of the design. Look at it again before I hide it. Think about the shapes from top to bottom. What is the top shape?*
- *Start with one shape in the design. Where do we put the next shape?*
- *How do you remember what the design looks like?*



Partner Talk can be a very effective method for sharing ideas. When you ask a question, have everyone turn to his or her

partner and talk about it. You can listen to the *Partner Talk* and call on pairs that had some interesting insights. Ask both partners to respond.

Days 4 Think Deeply Question

Setting: Small-Group

Pacing Guide: 60 minutes

Day 4 (60 min.)
• Think Deeply Question (done in small groups) • Space Centers

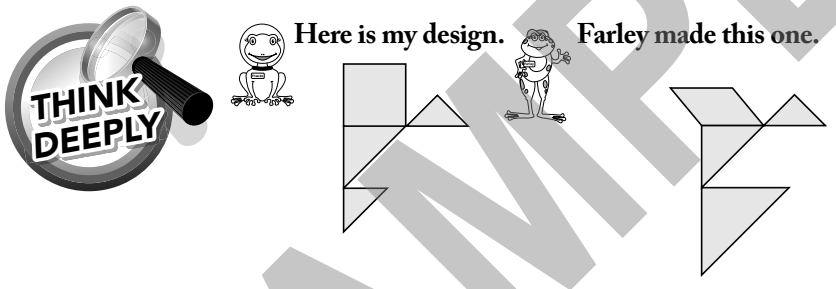
In each small group:

1. ***Open the session with the frogonaut handshake.***
2. ***Provide background about the Think Deeply question.***
   This Think Deeply has students fix Farley's design. They will soon discover that there are two mistakes in his design. One mistake involves an incorrect shape and the other has to do with the size of the triangle at the bottom.

Teacher Tip

Open the quieter Space Centers so other students can concentrate on their writing

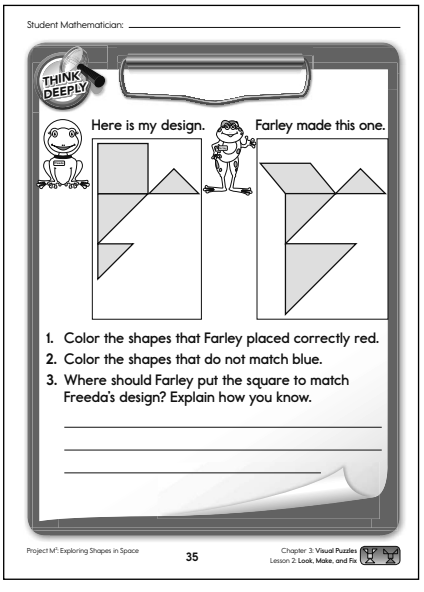
Mathematical Focus: Spatial Visualization and Recognition of 2-dimensional Shapes



1. **Color the shapes that Farley placed correctly red.**
2. **Color the shapes that do not match blue.**
3. **Where should Farley put the square to match Freeda's design? Explain how you know.**

What to Look for in Responses

- Students color the small triangle on Freeda's design and the large triangle on Farley's design blue, as well as the square and the parallelogram.
- Students color the other triangle shapes red.
- Students identify that Farley's design replaces the square with the parallelogram.
- Students use positional words such as "next to," "above," or to the "left" when describing where to place the square.
- Students can fix Farley's design to make it look like the original by replacing the parallelogram with the square.



Student Mathematician's Journal p. 35

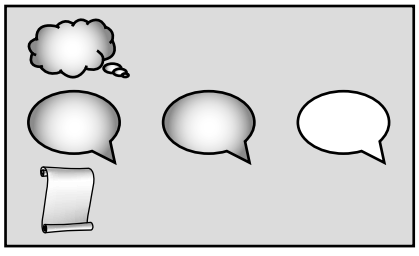
NOTES

Possible Difficulties

- Students may be confused by the complexity of the design. Encourage them to look at one shape at a time.
- Students might be unable to identify what is wrong with Farley's design in terms of shape and/or size.
- Students might not be able to clearly identify where to place the square.

3. Discuss and have students complete Questions 1 and 2.
Make sure students first identify which shapes were placed correctly and incorrectly before they color them. You may need to ask students guiding questions. Point to each shape, one by one, in Farley's design, and have students talk about if it is the right shape, the right size, in the right place, and positioned correctly. Praise students when they use vocabulary words correctly.

4. Help students understand Question 3.
Have students reword the question in their own words. What does Freeda need them to do to help Farley? Record the group's response at the top of the Think Section of the talk frame. They might say, "Tell Farley where to put the square."

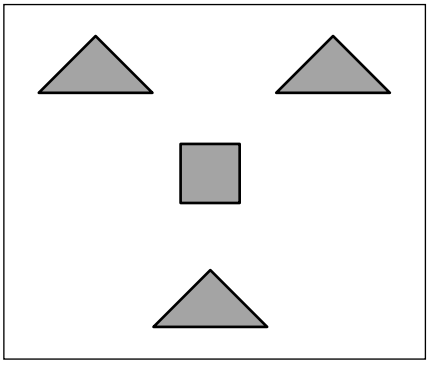


5. Gather student ideas on the talk frame.
Use key words to paraphrase student ideas under the Talk Ideas about how they know where to place the square. Use the *Add On* talk move with the word wall to encourage appropriate vocabulary.

6. Have students record their ideas and look over each other's work.
Again, provide support to individual students as needed. Students should be able to represent their ideas in some written form at this point. Having them review what others are writing and having them focus on specific aspects can help them further understand ways of expressing themselves.

Differentiating Instruction

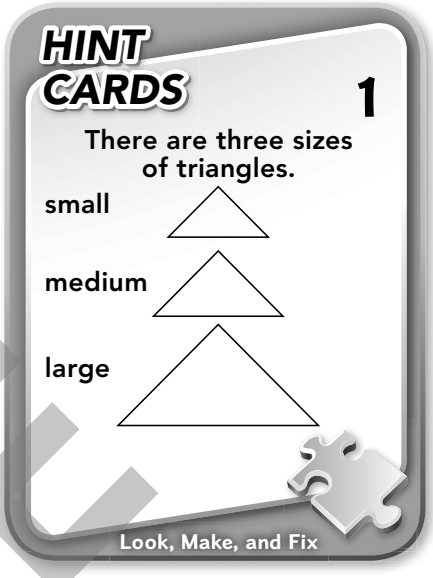
Supporting Students



- Simplify the complexity of a design by using fewer shapes.
- Another way to simplify the complexity of a design is to place shapes so they do not touch other ones, and/or place shapes to look like common objects (see example in the margin).
- Have students talk aloud about the location of the shapes.
- Scaffold the process. Start the "fixed" design for students by, for example, placing one shape down.

NOTES

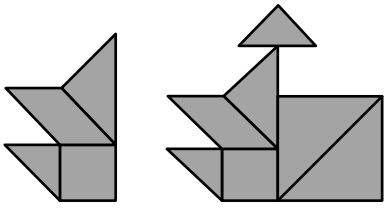
- Use the Hint Cards to remind students that there are three different sizes of triangles: small, medium, and large. A Hint Card also focuses on how to flip or turn shapes to orient them differently.



Challenging Students

Think Beyond Question 1

Play Look, Make, and Fix using more shapes.

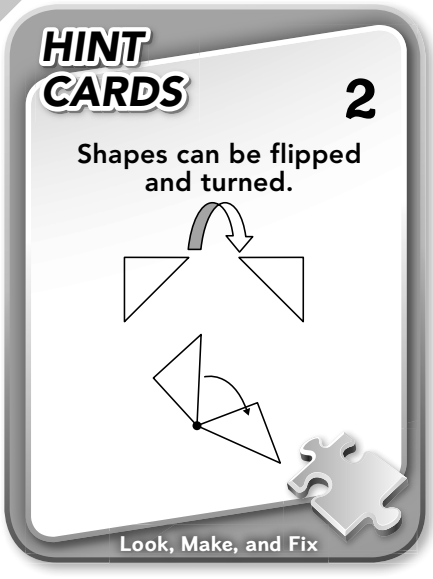


Design more complicated puzzles for students who have strong visualization skills. Use four to seven tangram pieces.

Think Beyond Question 2

Make your own design. Play Look, Make, and Fix.

Ask students to use the tangram pieces and make a design using at least five pieces. You can trace the actual shapes or use virtual tangram pieces at http://nlvm.usu.edu to reproduce the design for other students.



Day 5

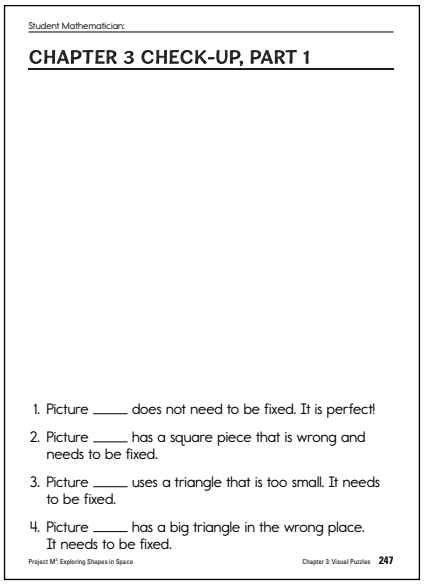
Formatively assess students' understanding of the main chapter concepts using the "Chapter Check-up." Administer each part to the whole class and/or to small groups. Part 1 should be teacher-led, and students can work more independently on Part 2. Close the chapter with the Wrap Up activity.

This assessment will help you determine students' understanding of lower- and higher-level concepts as well as their writing. Part 1 uses performance-based tasks while Part 2 includes an open-ended question similar to the Think Deeply questions.

Chapter Check-up

Part 1

Point out to students the picture on top of Part 1. Display the four tangram pictures so that all students in the group can see them. Explain that they should compare the picture on their page with the numbered pictures and fill in the blank with the appropriate picture number.



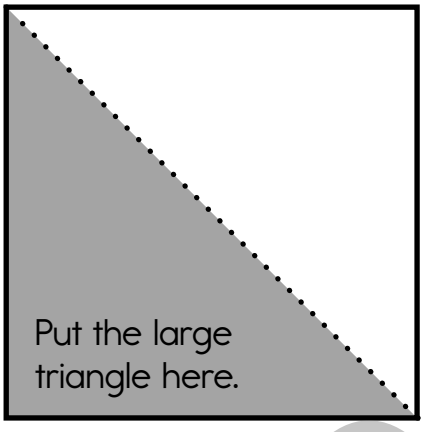
Student Mathematician:

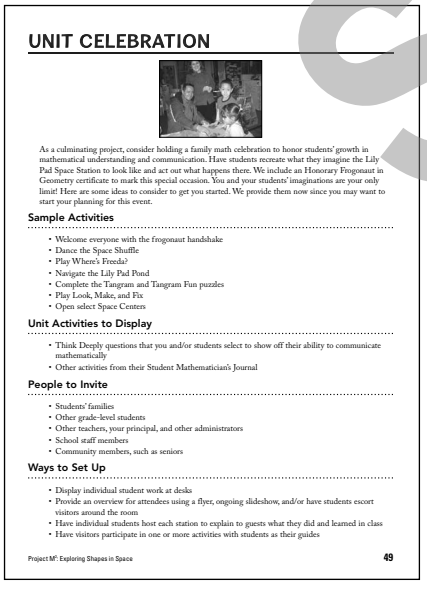
CHAPTER 3 CHECK-UP, PART 1

1. Picture ____ does not need to be fixed. It is perfect!
2. Picture ____ has a square piece that is wrong and needs to be fixed.
3. Picture ____ uses a triangle that is too small. It needs to be fixed.
4. Picture ____ has a big triangle in the wrong place. It needs to be fixed.

Project M²: Exploring Shapes in Space Chapter 3: Visual Puzzles 247

Teacher Guide p. 247





UNIT CELEBRATION

As a culminating project, consider holding a family math celebration to honor students' growth in mathematical understanding and communication. Have students recreate what they imagine the Lily Pad Space Station to look like and act out what happens there. We include an Honorary Frogonaut in Geometry certificate to mark this special occasion. You and your students' imaginations are your only limit! Here are some ideas to consider to get you started. We provide them now since you may want to start your planning for this event.

Sample Activities

- Welcome everyone with the frogonaut handshake
- Dance the Space Shuffle
- Play Where's Freeda?
- Navigate the Lily Pad Pond
- Complete the Tangram and Tangram Fun puzzles
- Play Look, Make, and Fix
- Open select Space Centers

Unit Activities to Display

- Think Deeply questions that you and/or students select to show off their ability to communicate mathematically
- Other activities from their Student Mathematician's Journal

People to Invite

- Students' families
- Other grade-level students
- Other teachers, your principal, and other administrators
- School staff members
- Community members, such as seniors

Ways to Set Up

- Display individual student work at desks
- Provide an overview for attendees using a flyer, ongoing slideshow, and/or have students escort visitors around the room
- Have individual students host each station to explain to guests what they did and learned in class
- Have visitors participate in one or more activities with students as their guides

Project M²: Exploring Shapes in Space 49

Teacher Guide p. 49

1. Picture _____ does not need to be fixed. It is perfect!
2. Picture _____ has a square that is wrong and needs to be fixed.
3. Picture _____uses a triangle that is too small. It needs to be fixed.
4. Picture _____ has a big triangle in the wrong place. It needs to be fixed.

Look and Make:

Next, pass out a set of tangram shapes to each student. Show them the picture on "Look and Make." Hold it up for several seconds. Place it down so students cannot see it. Record observations as to whether or not students were able to correctly replicate it with their own tangram pieces.

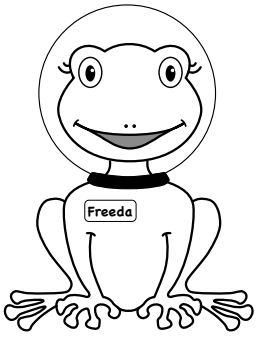
Part 2

Explain to students that they need to fill in the square (the same size as two large triangle tangrams) using their tangram pieces and trace their solutions. Make sure they start with one large triangle placed on top of the gray area. They can fill in the rest of the puzzle using any shapes, and can use the same shapes from puzzle to puzzle. However, each design should be different from the last. You can provide cut-out paper tangram pieces for students who might have difficulty tracing shapes.

Wrap Up

To close the unit, ask students to reflect on what they have learned. You may want to have students look over their Student Mathematician's Journal and recall their work at the Space Centers. *What advice do they have for Farley and/or Freeda about their trip or work in space?* Also finish planning for and hold your Unit Celebration.

MEMO



Frogonauts

Lily Pad Space Station

To: Mr. Farley Frog

From: Freeda the Frogonaut

☐ Play ☒ Help Us ☐ Review ☐ FYI

Message:

Dear Farley,

You and your student friends have done a great job learning the names of the shapes and how to fit them together to make new shapes. You are now ready to help rebuild the control panel! Remember, it broke into shapes when I sent the box to you. Do you think you can fix it? You must fit all seven shapes into the control panel outline that is in the box.

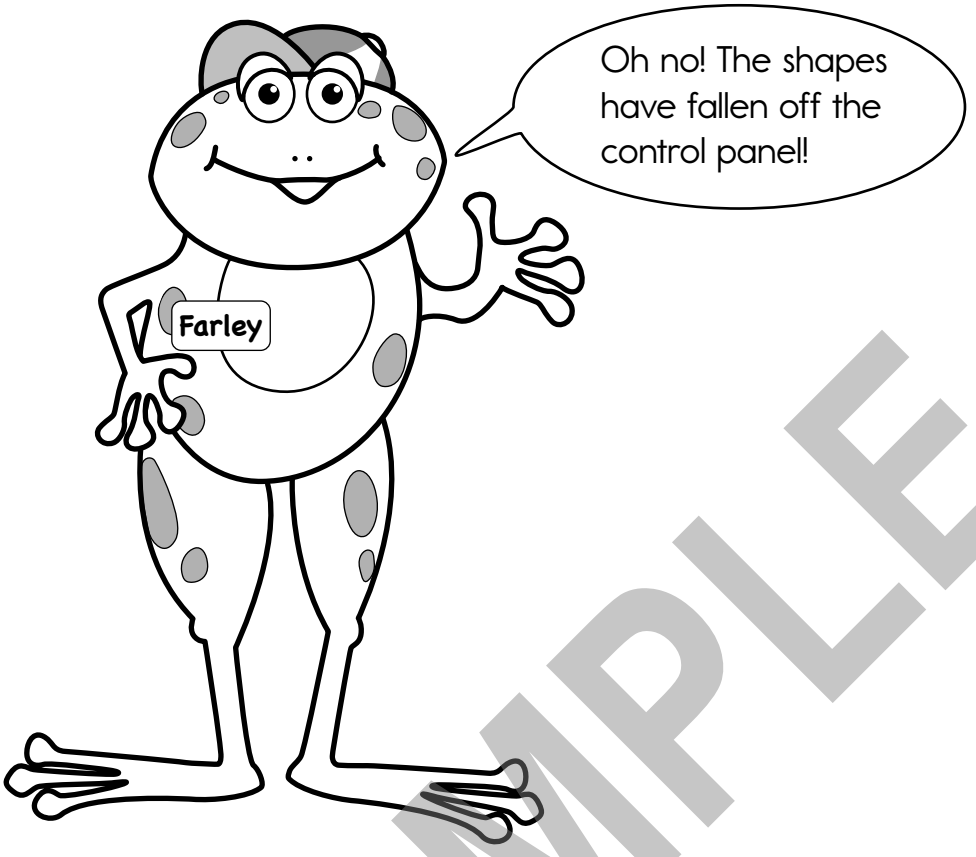
I also need you to find ways to memorize shape puzzles and put them back together without looking at them! I sent some practice puzzles you can play with. Have fun!

Your cousin,

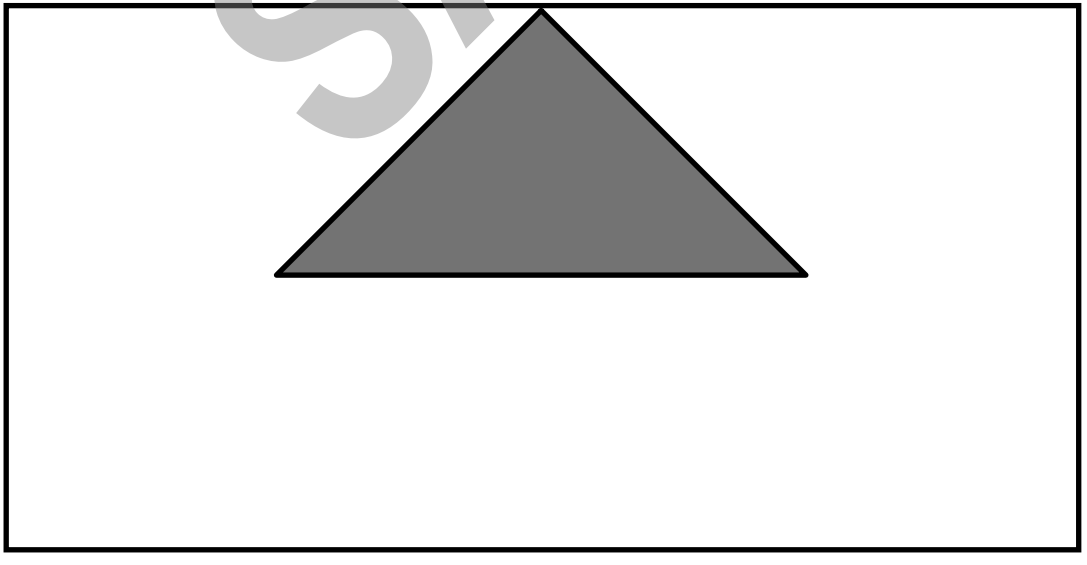
Freeda

Student Mathematician:

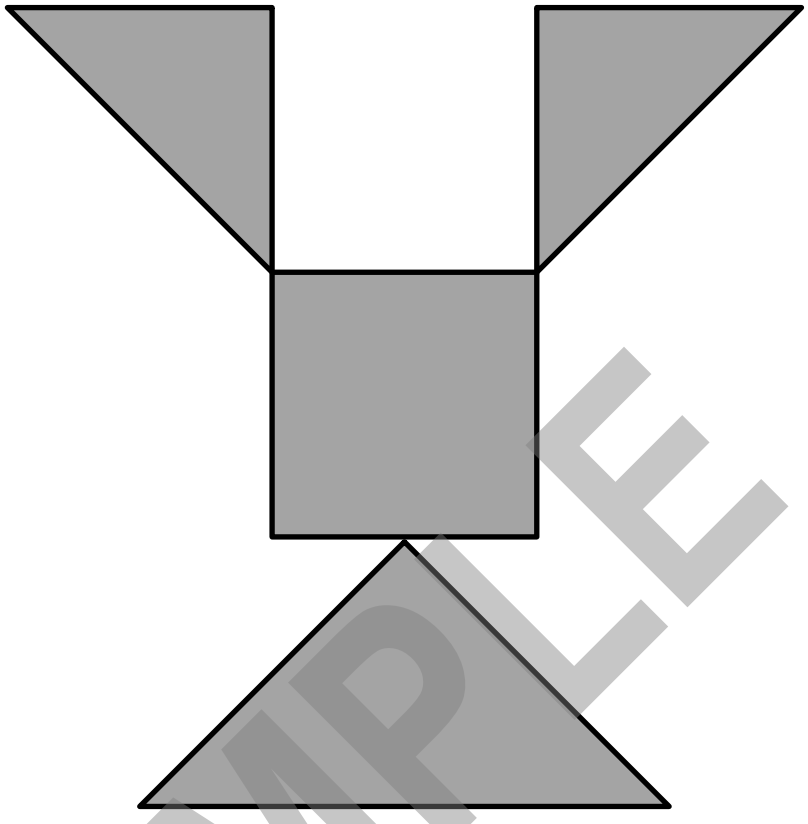
Control Panel Outline



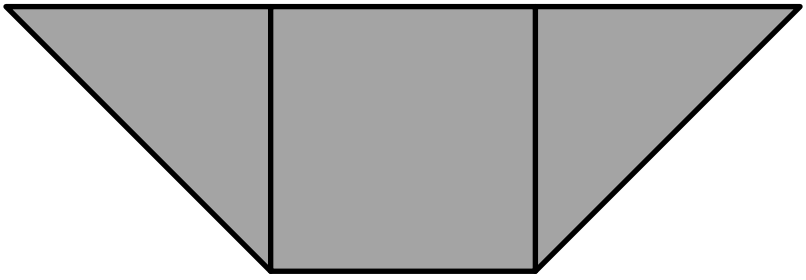
Trace the shapes when you finish the puzzle.



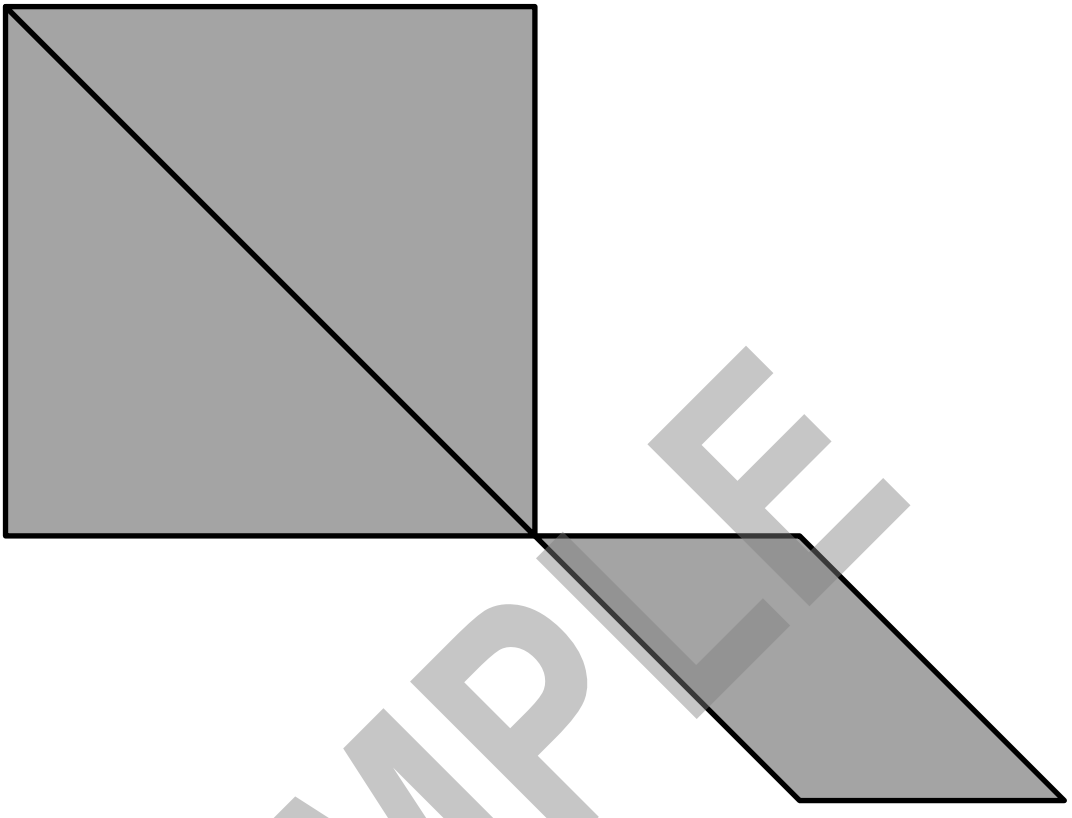
Look, Make, and Fix Space Lab 1



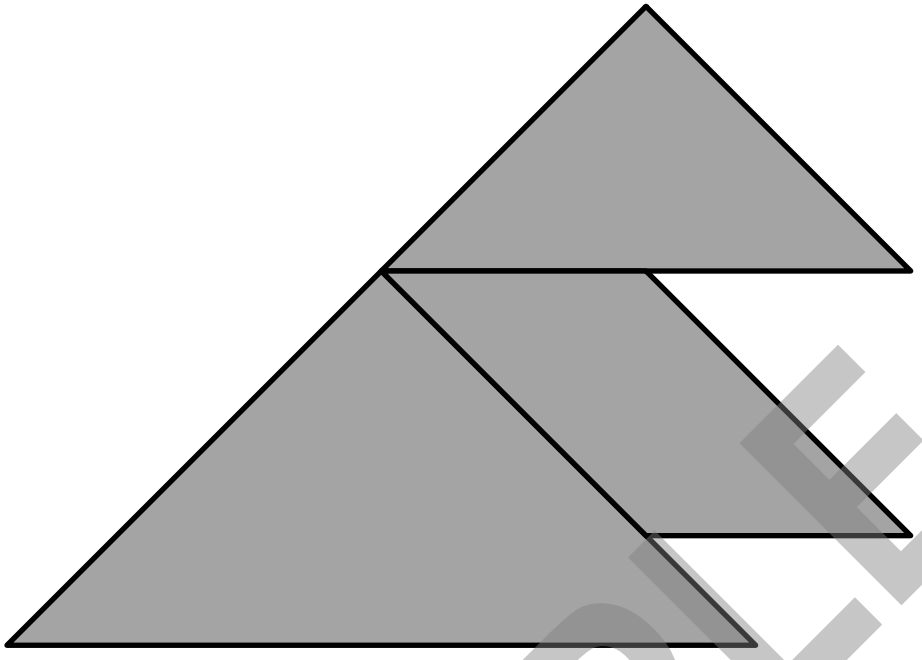
Look, Make, and Fix Space Lab 2



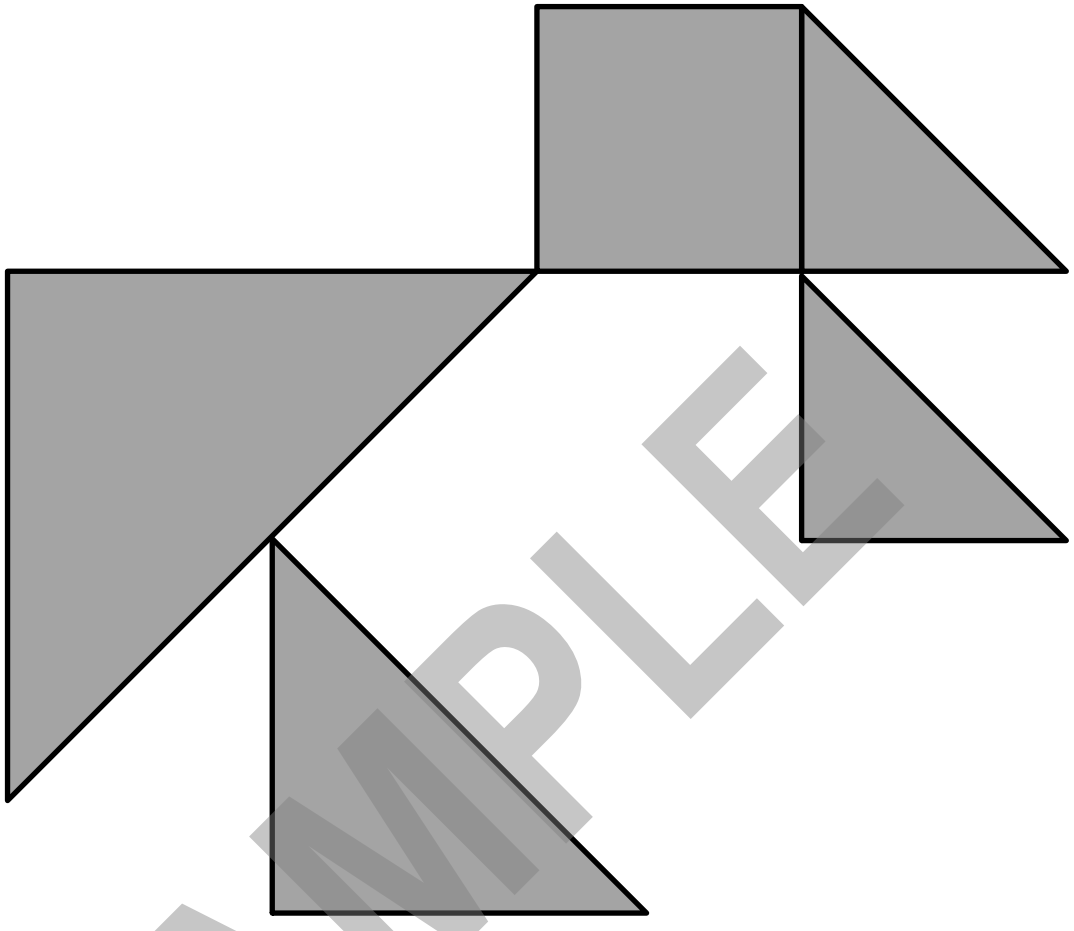
Look, Make, and Fix Space Lab 3



Look, Make, and Fix Space Lab 4



Look, Make, and Fix Space Lab 5



Lesson 3.2 Space Lab Quick Check

Student Mathematician	Puzzles Successfully Completed			Observations, including strategies used
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				
11.				
12.				
13.				
14.				
15.				
16.				
17.				
18.				
19.				
20.				

HINT CARDS

1

There are three sizes of triangles.

small

medium

large

Look, Make, and Fix

HINT CARDS

2

Shapes can be flipped and turned.

Look, Make, and Fix

A QUICK LOOK

NOTES

Chapter 3: Lesson 2

Day 1: Whole-Class Investigation

1. *Open the session with the frogonaut handshake.*
2. *Have Farley read the memo he received from Freeda.*
3. *Re-examine the box from outer space.*
4. *Have students or pairs complete the "Control Panel Puzzle."*
5. *Set the stage for the investigation.*
   - The game Look, Make, and Fix will help Farley work on replicating designs from memory.
6. *Have students look at a design and study it.*
   - Begin with three tangram pieces on the magnetic board (large triangle, square, and small triangle) and have students study the design carefully.
   - It can be helpful for students to share what they think it looks like.
7. *Have students make a design.*
   - Cover your design and have students replicate it.
8. *Have students fix their designs.*
   - Reshow your design and have students fix theirs accordingly.
9. *Briefly discuss strategies for remembering the design.*

Introduce the Space Centers for the Lesson

1. *Explain the Space Centers that will be set up for the lesson (Refer to the Space Center Guide).*
2. *Have students begin working at the Space Centers.*

Days 2 and 3: Small-Group Space Labs

1. *Open the session with the frogonaut handshake.*
2. *Review the puzzle strategies.*
3. *Play Look, Make, and Fix a number of times.*
4. *Have students complete the Look, Make, and Fix Space Lab.*
   - Students play with a partner; one is "Maker" and the other is "Fixer." Both students study the design and then turn it over.

NOTES

- The Maker recreates the design and the Fixer watches until the Maker gets stuck or needs some help. Then the Fixer may use words to help, but cannot touch the shapes.

5. *Use the "Lesson 3.2 Space Lab Quick Check" to assess student understanding.*

Whole-Class Debriefing

Have students discuss their strategies for remembering the puzzle designs.

- Question students regarding what shapes they notice and what words they can use to describe the designs and strategies.

Day 4: Think Deeply Question

In each small group:

1. *Open the session with the frogonaut handshake.*
2. *Provide background about the Think Deeply question.*
3. *Discuss and have students complete Questions 1 and 2.*
4. *Help students understand Question 3.*
   - Have students reword the question in their own words.
5. *Gather student ideas on the talk frame.*
   - Determine first what is wrong with the design, then ask students questions to help them determine how to fix it. Encourage correct use of vocabulary.
   - Refer to the What to Look for in Responses and Possible Difficulties section on pp. 231–232.
6. *Have students record their ideas and look over each other's work.*

Day 5: Chapter Check-up

Part 1

- Students should fill in the blanks either with the color word or correct color of the puzzle.
- Have students study the picture on "Look and Make" then check off that students are able to correctly recreate the picture.

Part 2

- Students need to fill in the square with their pieces, using only 1 large triangle and their other pieces. They need to trace the shapes they use.

Wrap Up

- Students may want to reflect on their unit work, look over their Journals and the letters they have written to Freeda.
- Finish planning and hold your Unit Celebration.