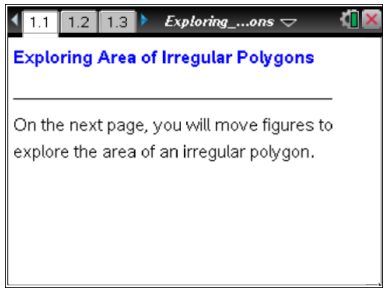
Exploring Area of Irregular Polygons

MATH NSPIRED

TEACHER NOTES

Math Objectives

- Students will recognize that the area of an irregular shape is found as the sum of the areas of smaller, familiar polygons.
- Students will find the area of irregularly shaped polygons.
- Students will decompose irregular shapes into triangles, rectangles, and parallelograms in order to determine the area of real-world objects.



Vocabulary

- polygon
- rectangle
- parallelogram
- triangle
- irregular polygon
- area
- area as a covering

About the Lesson

- This lesson involves using rectangles, parallelograms, and triangles to "fill in" the area of an irregularly shaped polygon.
- There is additional TI-Nspire file for assessment that can be used on any handheld or iPad at the conclusion of the lesson. The questions are set up for self-check which is ideal for those without the TI-Nspire Navigator System or to use as Quick Polls.
- As a result students will:
  - Visualize the concept that irregular areas can be found by determining the sum of smaller, more familiar polygons.

TI-Nspire™ Navigator™ System

- Send out the *Exploring_Area_of_Irregular_Polygons.tns* file.
- Monitor student progress using Class Capture.
- Use Live Presenter to spotlight student answers.

Activity Materials

- Compatible TI Technologies: TI-Nspire™ CX Handhelds, TI-Nspire™ Apps for iPad®, TI-Nspire™ Software

Tech Tips:

- This activity includes screen captures taken from the TI-Nspire CX handheld. It is also appropriate for use with the TI-Nspire family of products including TI-Nspire software and TI-Nspire App. Slight variations to these directions may be required if using other technologies besides the handheld.
- Watch for additional Tech Tips throughout the activity for the specific technology you are using.
- Access free tutorials at http://education.ti.com/calculators/pd/US/Online-Learning/Tutorials

Lesson Files:

Student Activity

- Exploring_Area_of_Irregular_Polygons_Student.pdf
- Exploring_Area_of_Irregular_Polygons_Student.doc

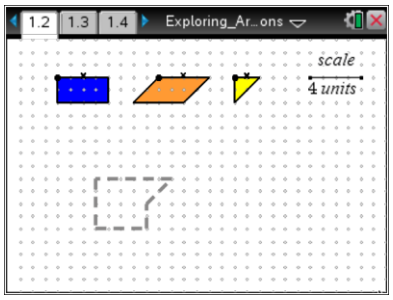
TI-Nspire document

- Exploring_Area_of_Irregular_Polygons.tns
- Exploring_Area_of_Irregular_Polygons_assessment.tns

Discussion Points and Possible Answers

Tech Tip: If students experience difficulty dragging a point, check to make sure that they have moved the cursor until it becomes a hand (☜) getting ready to grab the point. Students should press ctrl ☜ to grab the point and close the hand (☜).

Move to page 1.2.



Students are instructed to "build" the irregular polygons on the next pages and given the following guidelines:

- A copy of each figure at the top can be moved by grabbing the closed circles.
- Each figure can be rotated by grabbing the X.
- It is easier to reposition the figures if you do not overlap the closed circles from different figures.

1. What is the fewest number of figures needed to exactly cover the outlined polygon?

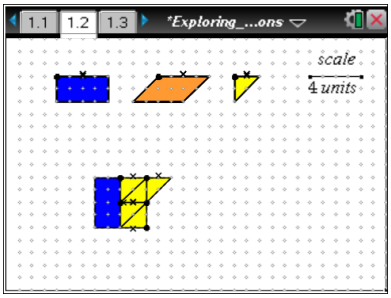
   Answer: The fewest number of figures is 3. There are several ways this can be done. Samples: 1 of each figure, 2 rectangles and 1 triangle, 2 rotated rectangles and 1 triangle. Encourage students to try different ways and then share with the class.

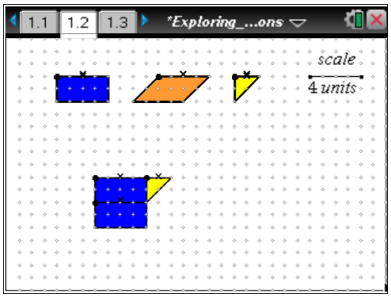
TI-Nspire Navigator Opportunity: *Class Capture*
See Note 1 at the end of this lesson.

Teacher Tip: Some students may have trouble dragging the polygons. Give them time to get comfortable with moving and rotating the shapes, and encourage them to find as many different ways as they can.

2. Can the outlined polygon be exactly covered using some combination of the rectangle and triangle figures? Make a sketch to support your answer.

Answer: Yes. Sample answers are shown below.

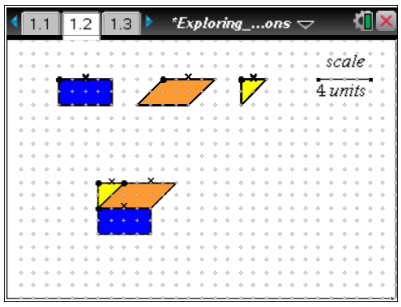




Teacher Tip: Additional answers are possible. Encourage discussion of different possibilities. Ask students to use different arrangements of polygons to find the area to see that no matter what arrangement they choose, the area will still be the same. Some students might also calculate the area by composing the figure into a rectangle and subtracting the part of the rectangle that is not in the original figure.

3. Can the outlined polygon be exactly covered using one rectangle, one triangle, and one parallelogram figure from the top? Make a sketch to support your answer.

Answer: Yes.



Teacher Tip: The area using this configuration is still the same as in question 2.

4. Jamal says that the shaded polygon can be built using only one kind of figure many times. Do you agree or disagree? Why or why not?

Answer: Yes. This can be done using 9 triangles.

TI-Nspire Navigator Opportunity: *Quick Poll*
See Note 2 at the end of this lesson.

5. If the area of the rectangle is 8 square units, then what is the area of the:

   a. parallelogram?

      Answer: The area of the parallelogram is the same as that of the rectangle, or 8 square units.

   b. triangle?

      Answer: The area of the triangle is one-fourth the area of the rectangle, or 2 square units.

   c. outlined polygon?

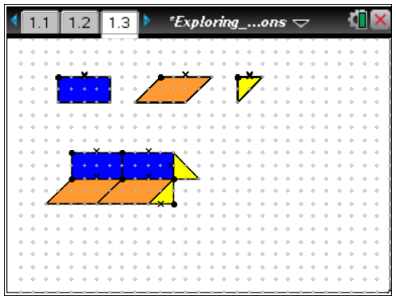
      Answer: The total area of the shaded region is 18 square units.

> **Teacher Tip:** Any combination of shapes will produce the same total area. Have students use more than one combination of shapes to demonstrate this concept.

Move to page 1.3.

6. Using each type of shape *at least once*, move shapes to exactly cover the outlined polygon. Make a sketch of the screen.

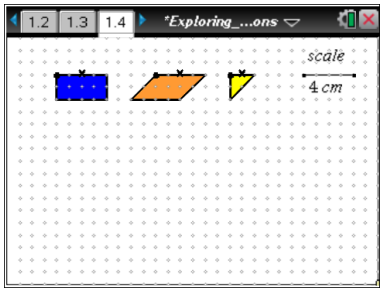
   Answer: Sample answer is shown to the right.



TI-Nspire Navigator Opportunity: *Class Capture*
See Note 3 at the end of this lesson.

> **Teacher Tip:** This can be done in a variety of ways. Encourage students to try to find more than one way to do it.

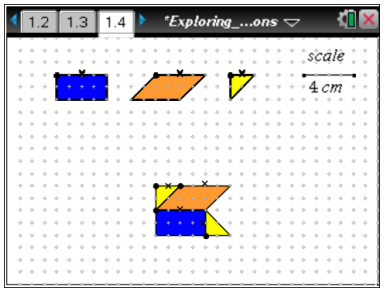
Move to page 1.4.



For Questions 7–9, use the scale that is shown on page 1.4.

7. Move the figures to "build" a polygon that has an area of 20 square centimeters. Make a sketch of your polygon.

   Answer: Sample answer is shown to the right.



   Teacher Tip: This can be done in a variety of ways. Encourage students to try to find more than one way to do it.

8. Mark said he can use the given figures to build a polygon with an area of 15 square centimeters. Maribel disagrees with him. Who is correct and why?

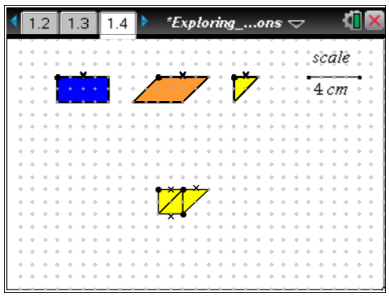
   Answer: Maribel is correct because each of the given polygons has an area that is an even integer. Since the sum of even integers must be even, these polygons could not combine to form a figure with an area of 15 square centimeters.

   Teacher Tip: Some students may think that the area of the triangle is 1 or 0.5, because it is the smallest polygon. Discuss the fact that its area is half that of a 2-by-2 square, making its area 2 square units.

TI-Nspire Navigator Opportunity: *Quick Poll*
See Note 4 at the end of this lesson.

9. Move the figures to "build" a polygon that has an area of 6 square centimeters. Make a sketch of your polygon.

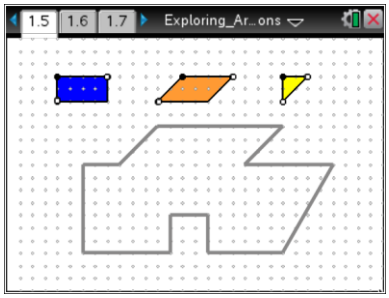
   Sample Answer: Shown here.



   Teacher Tip: While the polygon must be "built" using 3 triangles, students may arrange the three triangles in different ways.

TI-Nspire Navigator Opportunity: *Class Capture*
See Note 5 at the end of this lesson.

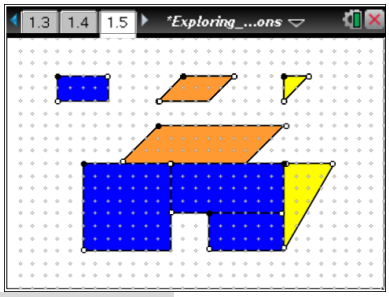
Move to page 1.5.



Guidelines:

- A copy of each figure at the top can be moved by grabbing the closed circle.
- Use the open circles to change the dimensions of the figure.

10. Use the figures at the top to exactly cover the outlined polygon shown on the screen. You may change the dimensions of the figures you use. Make a sketch of your screen.



Answer: Sample answer is shown.

Teacher Tip: This problem gives you the opportunity to emphasize the variety of possibilities and encourage students to persevere in problem solving. Then you can investigate the problem further by having students determine the area using different arrangements of figures. Students will always get the same area. You also may want to try to introduce different scale factors. First, let the distance between 2 points be 1. Then use a different scale and the corresponding area ratio to find the scaled area.

11. How can polygons such as rectangles, parallelograms, and triangles be used to help determine the area of irregular polygons? Use the figure at the right to help illustrate your answer.

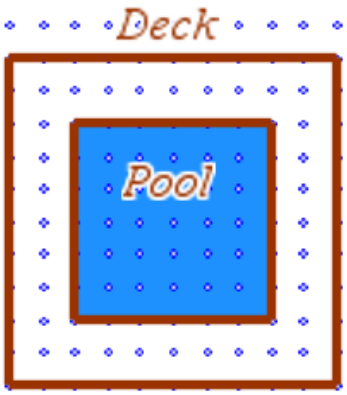
Answer: The area of an irregularly shaped polygon can be determined by dividing it into smaller polygons of known areas. An irregular polygon can be broken into smaller polygons in variety of ways, all of which comprise the same total area.

Move to pages 1.6 & 1.7.

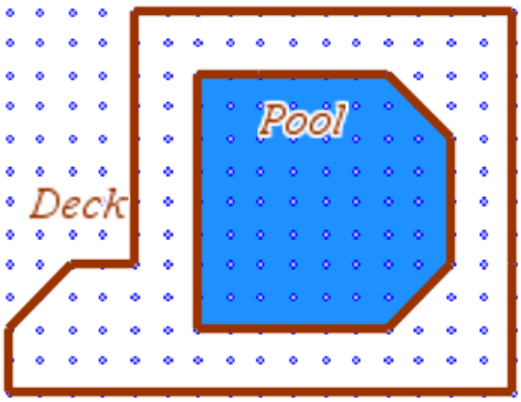
Teacher Tip: A picture of the deck and pool is provided on the student handout so that students can mark it up and explore ways to divide the area in different ways. Discuss with the students reasons why finding the area of a pool deck would be of interest in the real-world. For example, a construction crew might new to know how much material is needed to construct the deck, how much paint is needed to cover the deck, how many people could fit safely on the deck, and so forth.

12. Determine the area of the surface of the deck that surrounds the pool, showing your work below.

a.

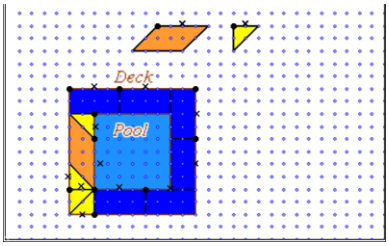


b.



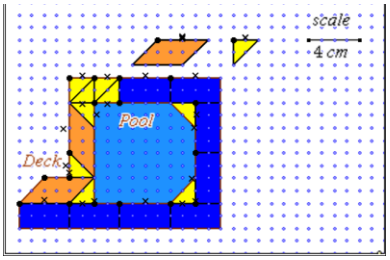
Sample Answer: Sample answer for page 1.6 is shown to the right.

The area is 8 + 8 + 8 + 8 + 8 + 8 + 2 + 2 + 2 + 8 + 2 or 7(8) + 4(2) = 64 square units.



Tech Tip: Most students may try to use only rectangles to cover the deck. Since there are only six of each shape available for students to use, they will be forced to use some combination of the shapes.

Sample Answer: Sample answer for page 1.7 is shown to the right.



The area is 98 square units. Explanations about the process used to determine the area will vary. You can have a student demonstrate how to use the Area Measurement tool to measure the area of the outer polygon and the area of the pool. Students could subtract the two measurements to verify that their calculations were correct.

Wrap Up

Upon completion of the discussion, the teacher should ensure that students understand:

- The area of an irregularly shaped polygon can be determined by dividing it into smaller polygons of known areas.
- An irregular polygon can be decomposed into smaller polygons in a variety of ways, all of which comprise the same total area.

TI-Nspire Navigator

Note 1

Questions 1 and 2, *Class Capture*:

Tell students to solve Question 1 two ways. They can drag the figures to an empty space on the screen to complete the second way. When students have completed Question 1, use Class Capture and sort the screens according to the first method used by students to cover the polygon. You may want to zoom in on screens showing the different ways. Were any additional ways shown as a second method on the screens? Repeat for Question 2.

Note 2

Questions 4, and 5, *Quick Poll*:

Use Quick Poll to gather students' answers to Questions 4 and 5.

Note 3

Questions 6 and 7, *Class Capture*:

Tell students to solve Question 6 two ways. When students have completed Question 6, use Class Capture and sort the screens according to the first method used by students to cover the polygon. You may want to zoom in on screens showing the different ways. Were any additional ways shown as a second method on the screens? Repeat for question 7.

Note 4

Question 8, *Quick Poll*:

Have students answer Question 8 using the True/False feature of Quick Poll. Before showing students the result of the poll, ask students why a student might answer true and why a student might answer false. Discuss the results.

Note 5

Questions 9 and 10, *Class Capture*:

Tell students to solve Question 9 two ways. When students have completed Question 9, use Class Capture and sort the screens according to the first method used by students to cover the polygon. You may want to zoom in on screens showing the different ways. Were any additional ways shown as a second method on the screens? How many ways are possible?

Repeat for Question 10. What is the area of the polygon?

Assessment

Use the TI-Nspire assessment document Exploring_Area_of_Irregular_Polygons_assessment.tns for Quick Polls. Teachers using the TI-Nspire Navigator can send the entire file and collect it for grading but it is advised that they first go to a Question application and change the document to Exam mode from the Teacher Tool Palette under the menu options.