All about Area

Brief Overview:

This unit explains and explores area. Students learn how to find area of a given figure by counting squares on a grid. They also create figures with a given area. More advanced exploration involves student discovery of the formula for finding area through the discussion of the relationship between area and the number of squares on adjacent sides of a rectangle. Activities include the use of manipulatives and reflective writing.

NCTM Content Standard/National Science Education Standard:

- Understand measurable attributes of objects and the units, systems, and processes of measurement
- Understand such attributes as length, area, weight, volume, and size of angle and select the appropriate type of unit for measuring each attribute

Grade/Level:

2/3

Duration/Length:

3 lessons; 60 minutes each

Student Outcomes:

- Students will define and determine area of geometric figures and pictures on a grid.
- Students will explain why different figures can have equal areas.
- Students will identify and apply the formula A=l x w to solve area problems in rectangles (3^{rd} grade). Students will use arrays and skip counting to determine area in rectangles (2^{nd} grade).

Materials and Resources:

Day 1

- For 2^{nd} grade: a 1 foot x 1 foot square (cut from construction paper or cardstock)
- Book: Bigger, Better, Best by Murphy, Stuart J.
- Small squares: 2 x 2 inch or 3 x 3 inch (post-it notes or pre-cut sheets of paper). Before the lesson measure to make sure these evenly cover the length and width of a student desk.
- Student Resource 1: concept sheet: area (plus transparency or projected copy from LCD for teacher)
- Student Resource 2: area practice sheet

- Teacher Resource 1: skill mastery checklist (use for all 3 lessons)
- 1-inch tiles

Day 2
- Student mini-whiteboards (1 per student)
- Whiteboard markers (1 per student)
- Tissues or paper towels
- Colored pencils/crayons
- Scissors (enough for all students and teacher)
- 1-inch tiles for students and for overhead projector
- Student Resource 3: Pantomimes grid
- Student Resource 4: Making a Splash directions
- Student Resource 5: Centimeter grid for pool
- Construction paper
- 3 x 5 index cards (1 per student)

Day 3
- Student Resource 6: Naming the Area (and transparency or projected image)
- 1-inch tiles for students and for overhead projector
- Table: Area of Our Names (This appears on Student Resource 6b. It can be put on chart paper, board, or projected, but students will be adding to the chart, so they need to be able to reach it and write in their names in the appropriate sections)
- Student Resource 7: Summative Assessment

Development/Procedures:

Lesson 1
Pre-Assessment

Tell students: "We are getting new tiles for our classroom floor."

- 2nd grade teachers: show a square (1 ft x 1 ft) and ask, "How do you think we can find out how many of these squares it will take to cover our classroom floor?"
- 3rd grade teachers ask: "How do you think we can measure the space we will need to cover the floor with the new tiles?" This question is more open-ended, and it will likely inspire more varied answers. (Students might respond that you can use a ruler. If this answer is given, ask: "What is a ruler used to measure?" [length]. Acknowledge that this answer is on the right track, as we do need to know length (gesture or have a student walk the length of the room), but we also need to know how wide our room is. What we are trying to find is called area. Say: "We will read a book in which two characters need to find the area of spaces, and we will explore how they make their measurements."

Launch

- Gather students on a rug/corner of the classroom.
- Display the book Bigger, Better, Best to the students.
- Read the book to the class as an introduction to exploring area.
- While reading the story, have the students count the number of pieces of paper needed to cover the windows and the floor in the pictures. Explain to students that the children in the story are finding the area of the windows and the floor.
- After reading the story, pose the following questions:
  1. What did you notice about the windows in Jeff and Jenny's room? (Students should respond that the windows have the same area even though they have different shapes.)
  2. What did Jeff and Jenny do to find the area of their rooms? (Students should respond that they covered the whole floor with newspaper and counted the total number of sheets used to find the area.)
     - Point out that the children in the story use paper of the same size when comparing the area of the two windows, and then use sheets of the same newspaper to find the area of the two bedrooms.
     - Pose the following question: Thinking about the story, what do you think area is? (Guide students to define area as the number of square units that covers a flat space.)
     - Tell students they will learn all about area in the next three days.
     - Dismiss the students back to their desks.

Teacher Facilitation/Student Application

- Pose the following question: How do you think we would find the area of our desktop?
- Choose volunteers to share their strategy with the class, but be careful not to tell students whether their strategy will work or not.
- Explain to students they will now have the opportunity to find the area of a desk using post-its. Remind students to think about how the children in Bigger, Better, Best found the area of their room.
- Organize students into groups of three and give a pad of post-its to each group.
- Instruct students to work together on the task of finding the area of the desk, but give each student a specific job. Partner 1 is the Reporter (they share their strategy with the class). Partner 2 is the Recorder (they write down the total area on an unused post-it). Partner 3 is the Facilitator (they help the group come to an agreement for the area of the desk).
- Allow students time to determine the area of the desk.
- Once all groups have finished and recorded their strategies and answers, gather students' attention and ask, "What is area?" Students will likely identify that it is the space inside a region or a flat shape.
- Have the Reporter for each group share their group's strategy for determining the area of the desktop. How are the strategies similar/different? Some students may have used array-like multiplication to ascertain their answers. Reinforce that all the strategies led to the correct answer. In 3rd grade,

students will hopefully arrive at the formula Area = length x width. If they did not discover this formula through their exploration, prompt the class by asking, "What did you notice about the relationship between the area of this figure and the number of squares across the top and up the side of your desk?" At this point they will likely arrive at the formula A = l x w. You could also link this to describing the array on their desks.

- Discuss how the area formula is used to find the area of a rectangle. Students who do not yet know multiplication, or who are confused by the formula should be encouraged to continue to count square units or skip count arrays as they have been doing.
- Distribute and project the concept sheet (Student Resource 1). Read the formal definition for area, including the information about how to find area. (2^{nd} graders may skip the last bullet that explains how to use the area formula). Answers can be found on Teacher Resource 3.
- Model several examples with the class, numbering the shaded squares as she/he counts. After completing several examples together, invite students to continue working on the example problems independently while you circulate and assess work and reteach individuals as needed.
- Once everyone finishes, call on students to put their answers on the projector, showing their work. Others may check their work with the answers as each one is displayed. Informally assess understanding by having students give a show of hands to indicate if they got all correct, just missed one, etc. Ask students who missed a problem to share with the class why they missed it (miscounted, forgot to show work, etc.) Answer any questions about finding area at this time.
- Next, distribute Student Resource 2 and display a copy on the overhead for the students to see. Point out that this sheet includes more practice problems as well as some critical thinking questions. Students continue to independently practice while you differentiate as students work (See differentiation section below).

Embedded Assessment

- Student Resource 2: Practice Area. This sheet enables you to glean student understanding of finding area. It also requires students to write their own definition for area, which makes clear the level of their understanding of the concept at this point. Answers can be found on Teacher Resource 4.
- Monitor students as they work (use skill mastery checklist: Teacher Resource 1, which will be used throughout the unit).

Reteaching/Extension

- Advanced 3^{rd} graders: Invite students who are adept at multiplication to look at the problems on the area practice worksheet (Student Resource 2). Ask students to decide which could use the formula A = l x w to solve. Why can you use it on these and not others? Have the students use the formula while you check their work and understanding.

- Advanced 2nd graders: Work in a small group with these students to develop strategies for determining the area of rectangles in a faster way (skip counting the arrays).
- Reteach: With a small group or select students, use 1-inch square tiles to create figures that match those on the worksheets. Students may count the tiles, and then compare them to those on their worksheets to have a more tactile way to determine area. Also, demonstrate counting and labeling on the worksheet so that students can eventually move away from the tiles as they gain confidence with this skill.
- Technology integration: Invite students to visit the following link on the web in order to have more practice with determining area of a given figure. http://www.shodor.org/interactivate/activities/AreaExplorer/

Lesson 2

Pre-Assessment

- Distribute mini dry erase boards, dry erase markers, and tissues to all students.
- Tell students you will display figures created with 1-inch tiles and that they should determine the area of each figure using whatever strategy they choose. Direct them to write their answers on their dry erase boards.
- Display a rectangle on the overhead with an area of 12 square units.
- Have students show their boards all at once and look around the room to identify correct answers on their classmates' dry eraseboards. (A correct answer MUST have square units written.) Ask "Why can't you just write 12 and have a correct answer?" Students must explain how with measurement you must always note what units you used to measure.
- Invite a student to the overhead to explain his/her strategy for arriving at the correct answer (counting each square unit, counting arrays, or using the formula). Emphasize that all of these strategies are correct since this is a rectangle.
- Repeat the process with two other figures: one should not be a rectangle so that you can ask the class, "Why can you only use the counting strategy to determine the area of this figure?" Students should use their knowledge of multiplication to explain that you must have equal groups to multiply or skip count.

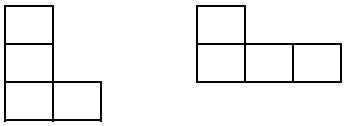
Launch

Pose the question: Can two different figures have the same area? If so, can you give you an example? Use the strategy think/pair/share for this question.

Teacher Facilitation/Student Application

- Guide students to look at the overhead projector.
- Using four tiles, model for students how to make a figure with an area of 4 square units. Point out that the tiles must touch on at least one side (not at the corners).

- Have students predict how many other figures they can make with an area of 4 square units by rearranging the tiles.
- Distribute a bin of colored tiles in the middle of each table group in the classroom.
- Have students experiment with this to discover how many different figures they can create. Choose volunteers to come up to the overhead to make the different figures with an area of 4 square units. When students make a figure that has already been displayed, but it is just transformed, ask the class, "Is this a different figure, or does anyone sees another figure that is like this one?" Invite a student to demonstrate manipulating the shape by sliding, flipping, or turning it. This will demonstrate that the figure does not change, but rather just changes position). Tell the class that a transformed figure is still the same figure, just moved, so it cannot be counted as a unique figure. For example, the two figures here are the same—they have just been transformed.



- Continue this process until all possible unique figures (4 total) with an area of 4 square units have been created on the overhead for all students to see.
- Using Teacher Resource 2, model for students how to trace (with a crayon) and cut out one of the figures (created on the overhead) with an area of 4 square units.
- Distribute Student Resource 3 (1 inch grid paper), scissors and crayons to each student.
- Explain to students they will now have the opportunity to make figures with an area of 5 square units. Direct students to work together in pairs (or small groups) to transfer the figures they make onto grid paper and cut them out. Circulate to make sure students are transferring their figures from tiles to the grid paper correctly. Remind students to transform (slide, flip, turn) to make sure that they are not cutting duplicate figures and that all their creations are unique.
- Once all groups have had time to create as many different figures as possible, gather students' attention. Call on one group at a time to choose one of the figures they cut out from grid paper and tape it to the board.
- Direct students to look at the board where the figures have been placed.
- Discuss the figures with the students. Ask: "Are any of the figures the same?" "How can we find out if a figure that looks the same as another one has already been displayed?" Have students manipulate the figures so that the class can see how they slide, flip, or turn them.
- Help the students in identifying that there are 12 figures with an area of 5 square units.
- Ask: "How can the areas be the same if these figures all look so different?" Students should refer to the definition of area to answer this. Area is the space

inside a figure that is covered. Therefore, the figure can look really different, but still cover the same amount of space.

- Distribute Student Resource 4 and 5 to each student. (This is the Making a Splash worksheet.)
- Go over directions for Student Resource 4 and answer any additional questions students may have about the activity.
- Allow students time to create their pool designs. Assist as they count, mark off, and cut their designs. They may glue their pool to construction paper and decorate it once they have cut it out.

Embedded Assessment

- Monitor students as they work (using skill mastery checklist: Teacher Resource 1).
- At the conclusion of the lesson, give a 3 x 5 index card or "exit ticket" to each student.
- Display these directions on the board or project them: "Using an example from class today, explain how two figures with different shapes can have an equal area." Students should work independently without notes. They should be encouraged to use pictures and labels in their explanation.
- Collect the completed cards.

Reteaching/Extension

- **Advanced:**
  1. Pantomimes puzzles (Teacher Resource 2).
  2. Have students explain why there are more unique figures that can be created with 5 square tiles than 4. Have them predict how many could be made with 6 tiles, and explore and draw conclusions.
- **Reteach:** Work with small groups of students to find unique shapes with just 4 square units. Have them count and cut each of the figures they create.

Lesson 3

Pre-Assessment/Launch

- Tell students you are going to flash images on the overhead, and as soon as they identify the image they should raise their hand.
- Flash on the overhead an L made from 1-inch tiles.
- Call on a student to identify the image (letter L)
- Keep flashing different letters with increasing difficulty: K, A, V, etc. You can increase the speed as students start to realize that all of the images are letters of our alphabet.
- Ask, "What did the images all have in common?" They are letters. Ask: "Can we measure the area of each letter we created?" Yes. Have students think-pair-share to discuss.
- Distribute tiles and have students experiment with making letters and counting the area.

Teacher Facilitation/Student Application

- Distribute Student Resource 6 a-b to each student and project it in order to read with the class. This sheet is to be used as a guide and as a place to record work throughout the lesson.
- Begin at the top with the letter example. Review the first section, then guide the students to the second section of the sheet, where they use tiles to create the letters in their first names. Go over the prediction part of the worksheet together and discuss—"Why do you think _____'s name would have the greatest area?" (Students will likely associate a long name with a larger area, but may not yet realize that some letters have a small area: I, for example).
- Direct students to the activity below where they use the grids to shade in their first names (There are two rows in case names are long).
- Read directions for the After-Activity while students follow along on their worksheets.
- Direct students to look at the table that they will be creating as they find the area of their names. Display a copy of the table on the board or overhead projector.
- Students work independently on the activity and the questions in the After-Activity. Circulate to assist students as they shade letters, calculate area, and answer questions.
- Discuss the table and whether predictions were true. "What did you notice about the areas of letters?" "Did the length of the names matter?" Explain.

Embedded Assessment

- Informal: Class discussions, student questions and independent work
- Formal: Student Resource 7: Summative Assessment (Answer key: Teacher Resource 5 a-b)
- Monitor students as they work (use skill mastery checklist: Teacher Resource 1).

Reteaching/Extension

- Advanced: Give students graph paper, and tell them to find the area for all letters of our alphabet. Invite them to create their own questions about their findings (e.g. which letter has the greatest area? Which letter combinations give you an area of 15, etc.)?
- Reteach: Work closely with students to make sure they use their tiles to create letters, and then transfer their letters to the grids on the worksheets. If needed, as a first step use scrap paper to write letters, then try to create them with the tiles (for a more visual experience).

Summative Assessment:

Distribute Student Resource 7 (Summative Assessment) to each student. Go over directions for Student Resource 7 and answer any additional questions students may have about the assessment. Allow students time to work on Student Resource 7 independently.

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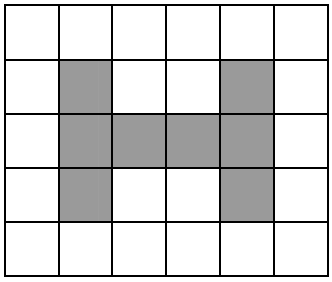
CONCEPT: AREA

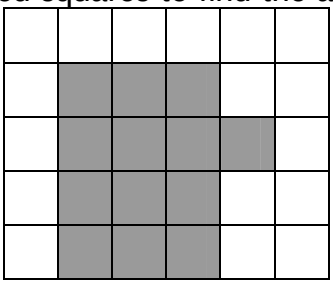
- Area is the number of square units needed to cover the space inside of a figure.
- Area is measured in square units.
- To find area, count the number of square units that have been covered.
- Another way to find the area of a rectangle is to multiply the length times the width. (Remember measuring the area of your desktop!) Formula: A = l x w

EXAMPLES

Directions: Number the shaded squares to find the area.



Area: _____ sq units



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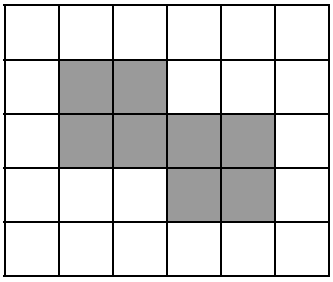

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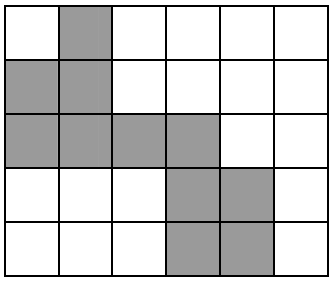

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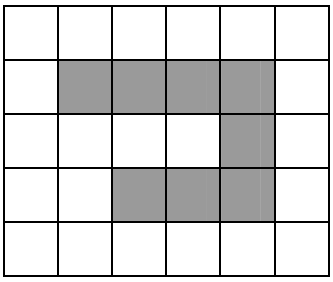

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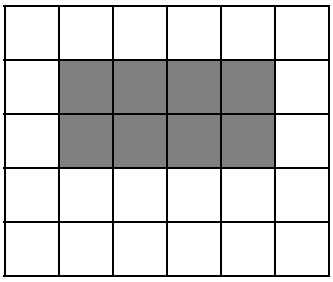
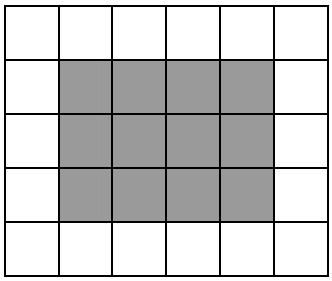


Area: _____ sq units

Challenge: Circle the figures above with the same area. What makes these figures alike? How are they different? Explain.

PRACTICE: AREA

Directions: Number the shaded squares (OR use the formula A= l x w for rectangles) to find the area.



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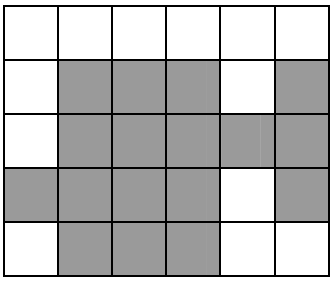

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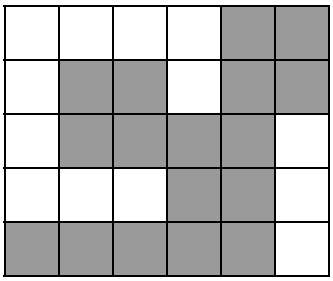

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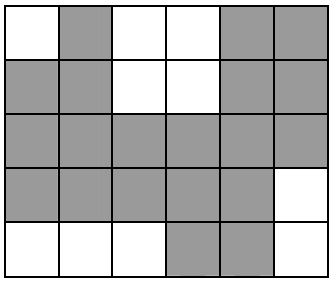

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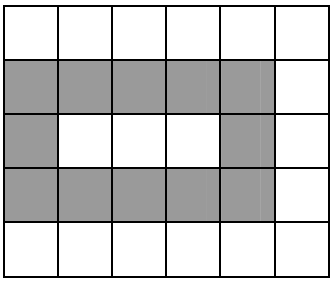

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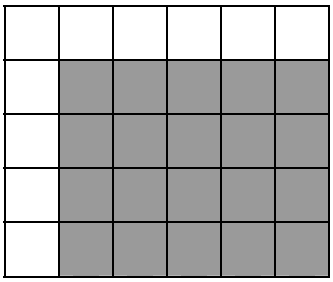

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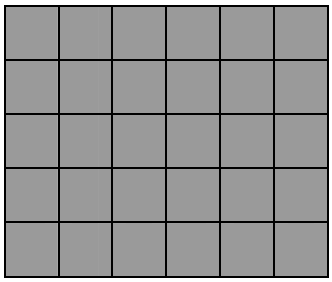

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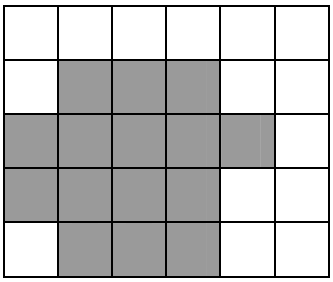

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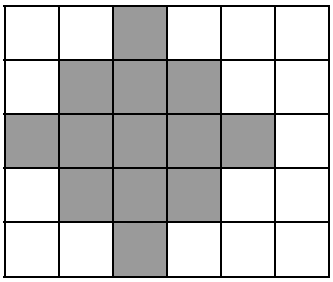
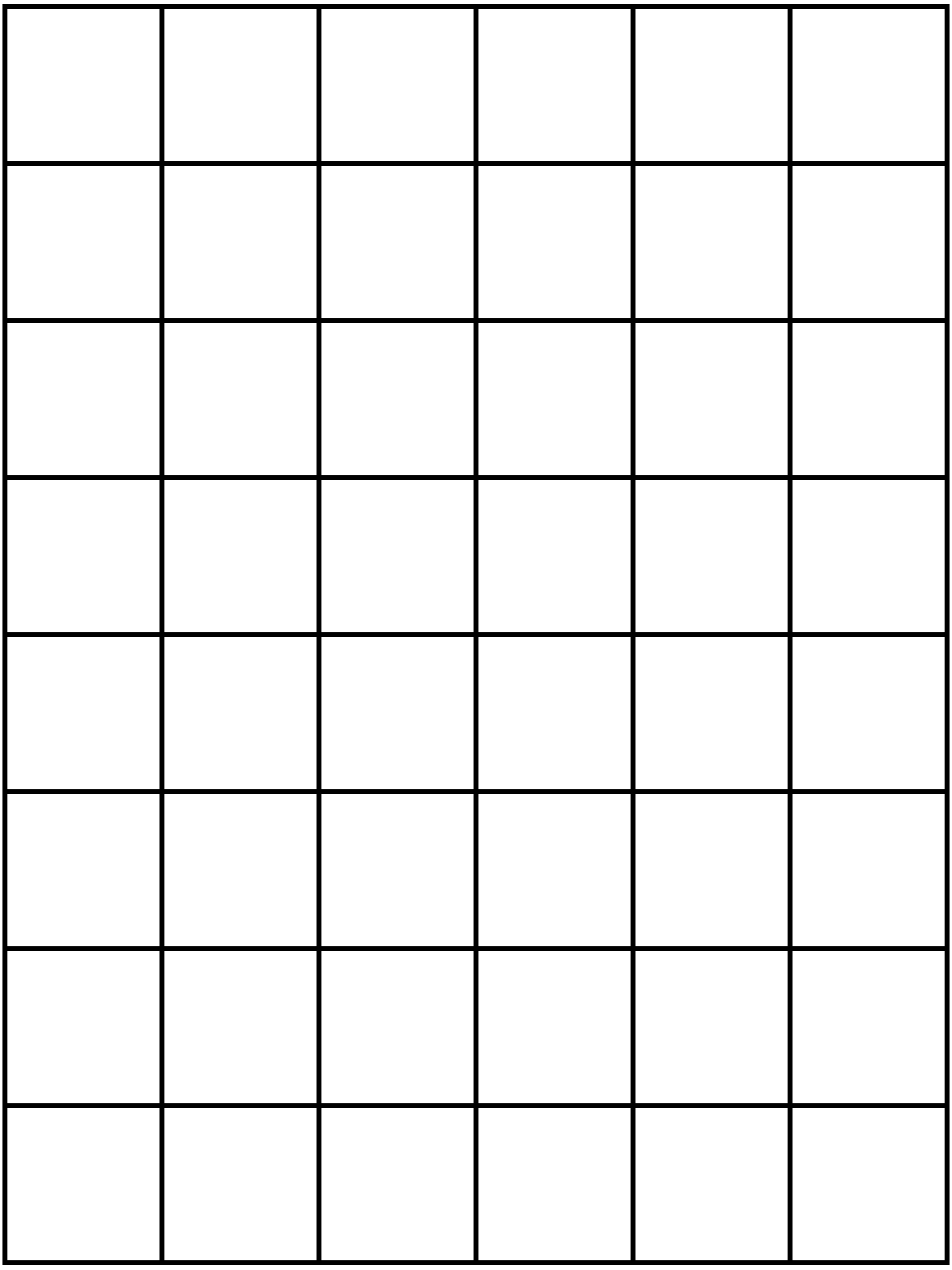


Area: _____ sq units

Area is:

Why can't you use the formula A = l x w for some figures?

Pantomimes Grid

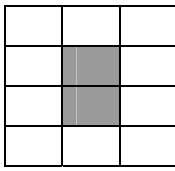


AREA: MAKING A SPLASH!

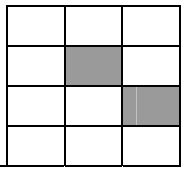
Directions: You are excited because your parents just announced that you will be getting a pool for your backyard! You even get to help with the design. On the grid paper you get (Student Resource 3), design a pool in any shape you want. There are just 2 rules. First, the pool must be exactly 100 square units. Second, the squares must touch side by side (not at the corners).

Example:

Yes



No



Once you have finished marking off your pool you may cut it out of your grid paper, paste it onto construction paper, and decorate it as it fits into your backyard.

TIPS

On a scrap of paper, sketch the shape of the pool you would like to try to create on your grid. Remember that your edges must be straight lines with corners that meet in order to fit in your grid.

On the grid, use a pencil to lightly number your squares as you begin to picture the shape of the pool you design.

Remember that you may need to increase or decrease the size of your pool as you put it on the grid.

AFTER-ACTIVITY

Use what you know about area to explain why you chose to design your pool as you did.

_____

_____

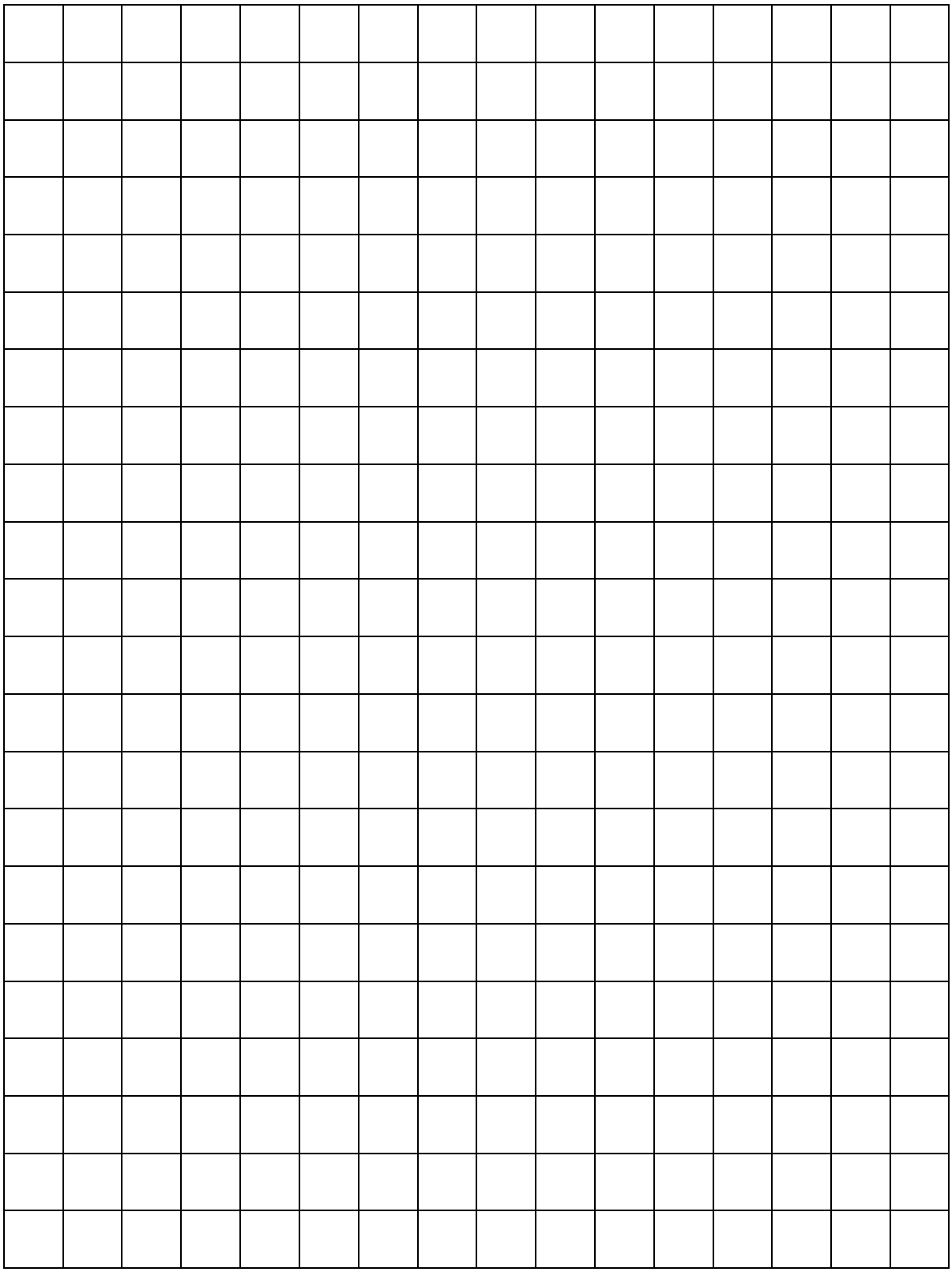
_____

What strategies did you use to find the area of your pool design?

_____

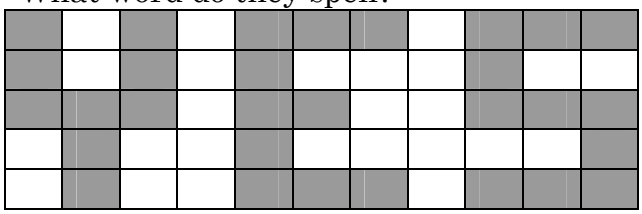
_____

_____



NAMING THE AREA

Each letter of our alphabet can be put on a grid. Below are some letters. What word do they spell?



__9__sq units ____ sq units ____ sq units

What is the total area of the word "yes"? _____ sq units

How did you find your answer? _____

-Use inch tiles to make the first capital letter of your first name. What is the area? _____ sq units

-Continue using tiles to make the rest of the letters in your first name (using capital letters).

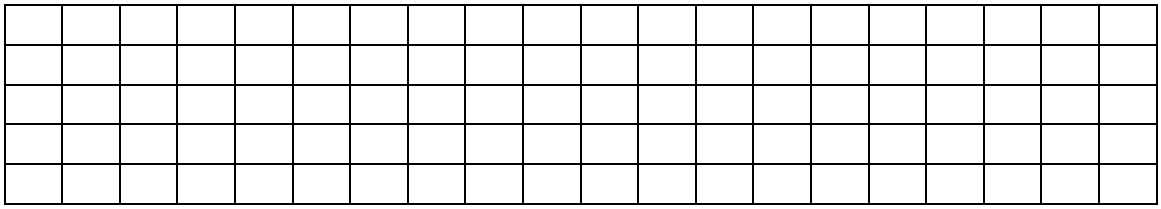
-**Make a prediction:** Think of the names of students in our classroom. Whose name do you think will have the greatest area? _____

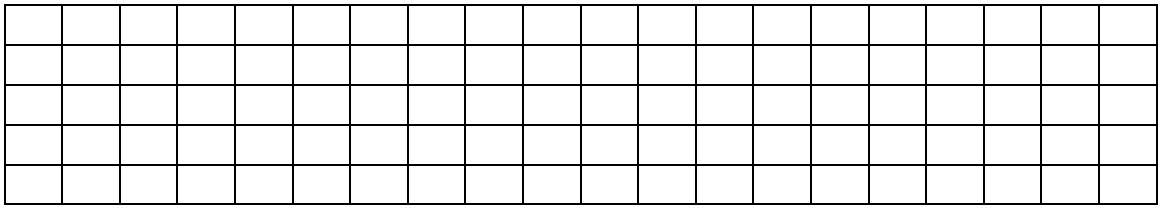
-Explain your answer. _____

_____

ACTIVITY

Using the grids below (refer to tiles), shade each letter of your first name. Skip a column between each letter. You may use your crayons or colored pencils if you choose. When you have finished, answer the questions in the After-Activity.





AFTER-ACTIVITY

1. What is the area of your name? _____ square units

2. Which letter in your name has the greatest area? _____ Which letter has the least area? _____

3. Using the table on the board, write your name by its area. For example, if your name is Sara, it has an area of 46 sq units, so it would be in the 40-50 row.

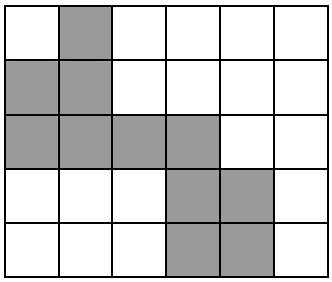
Area of Our Names

Area in square units	Names of Students
< 30	
30-40	
40-50	Sara
50-60	
60-70	
70-80	
> 80	

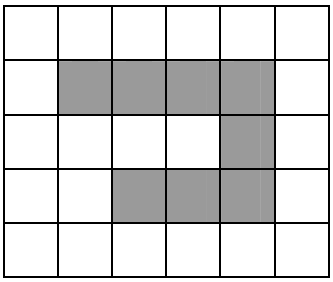
SUMMATIVE ASSESSMENT (Total points = 15)

Show all work for each question.

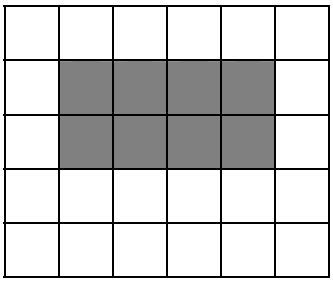
1. What is the area of the shaded region? (1 point each)



Area: _____ sq units



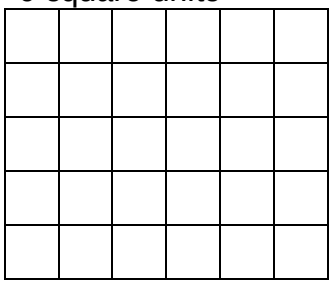
Area: _____ sq units



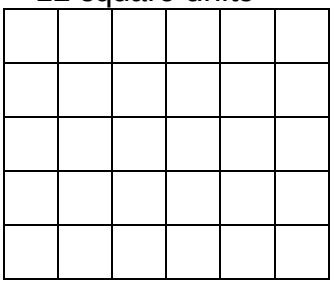
Area: _____ sq units

2. Draw a figure with the following area. (1 point each)

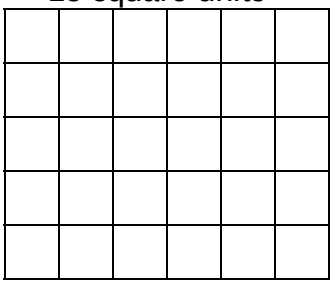
9 square units



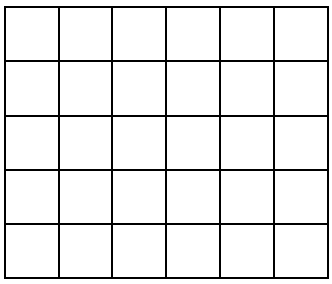
12 square units

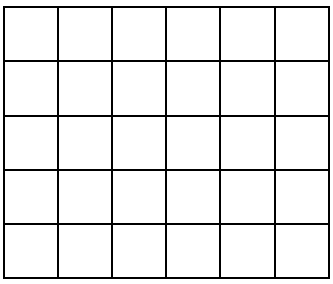


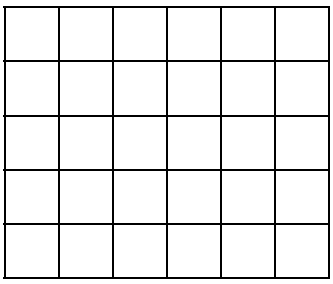
15 square units



3. In the grids below draw 3 different figures with an area of 6 square units. (1 point each)







3a. Explain why different figures can have equal areas. You may use words and/or pictures in your explanation. (1 point)

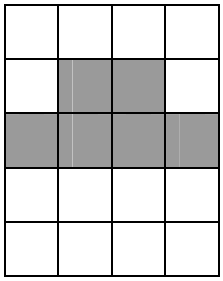
_____

_____

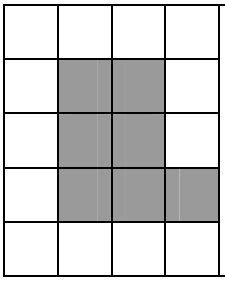
4. Multiple Choice (2 points)

Which figure has the greatest area? (circle the figure)

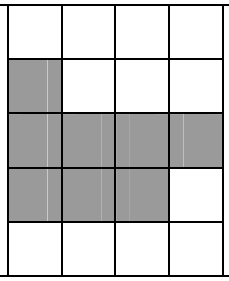
A



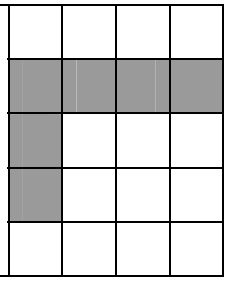
B



C



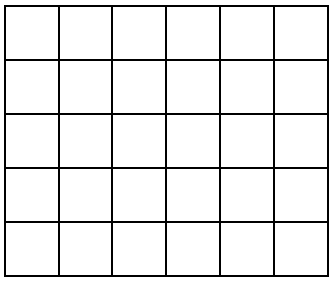
D



5. BCR (3 points)

Part A (1 point)

On the grid below, draw a figure with an area of 8 square units.



Part B (2 points)

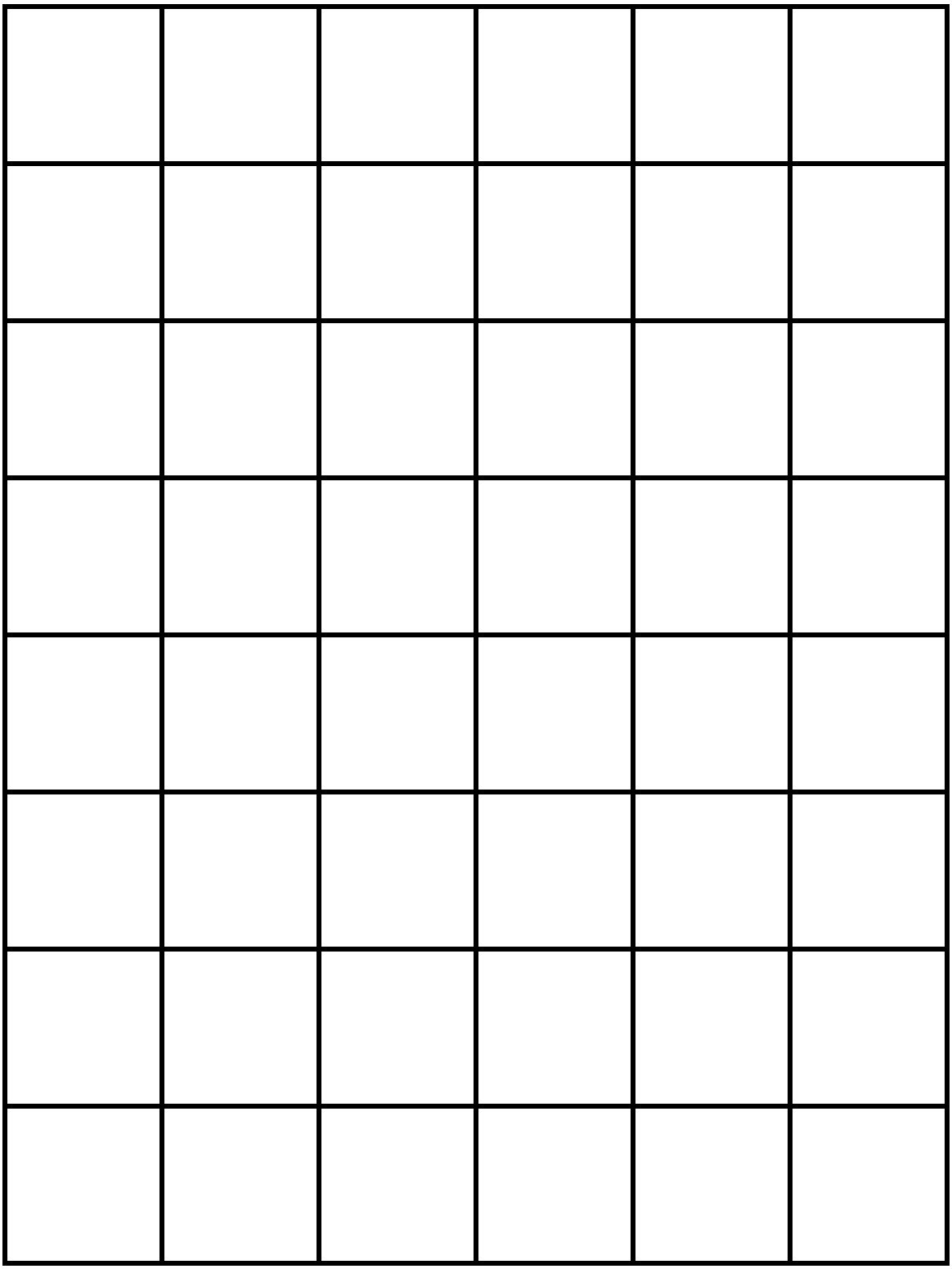
Use what you know about area to explain how you found your answer. Use words, numbers, and/or symbols in your explanation.

_____
_____
_____
_____
_____
_____
_____
_____
_____
_____

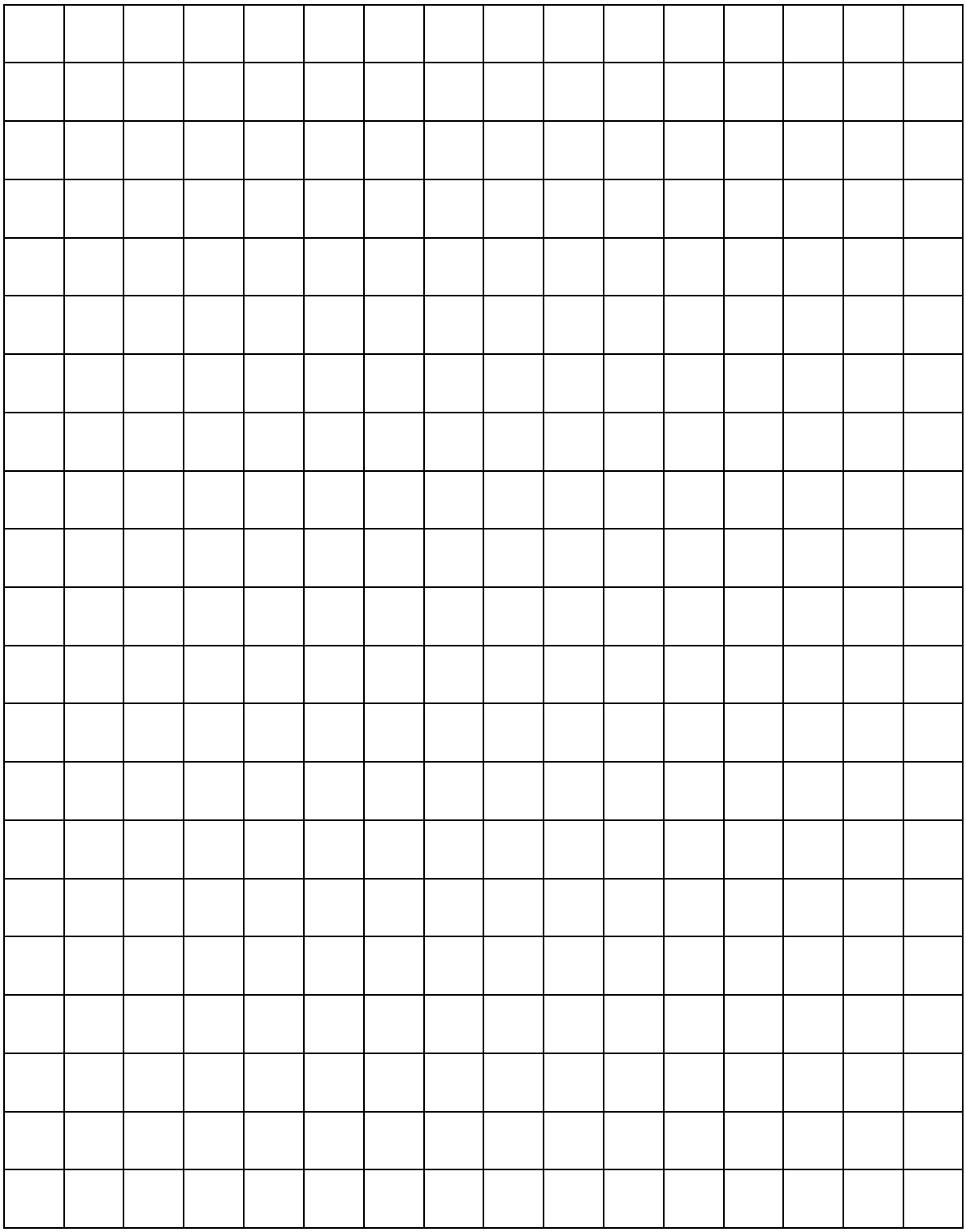
Skill Mastery Checklist (use throughout all 3 days of unit)

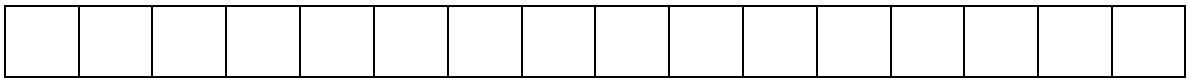
Student Name	Able to count square units in a figure	Able to make figures with given square units	Understands figures with same area can be different shapes	Applies formula for calculating area of a rectangle

Pantomimes Grid



Model for Making A Splash



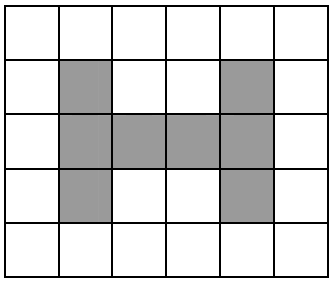


CONCEPT: AREA (ANSWER KEY)

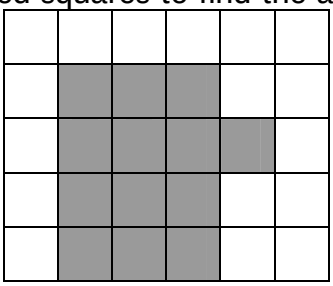
- Area is the number of square units needed to cover the space inside of a figure.
- Area is measured in square units.
- To find area, count the number of square units that have been covered.
- Another way to find the area of a rectangle is to multiply the length times the width. (Remember measuring the area of your desktop!) Formula: A = l x w

EXAMPLES

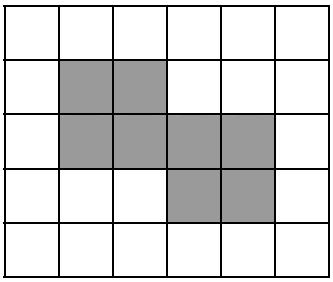
Directions: Number the shaded squares to find the area.



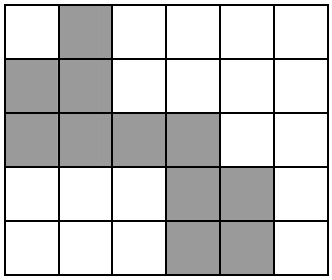
Area: 8 sq units



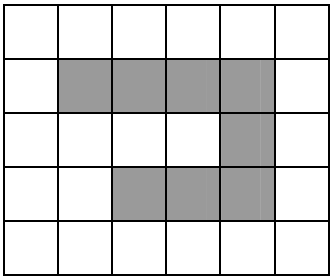
Area: 13 sq units



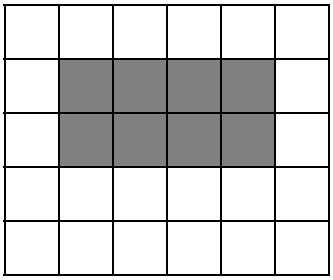
Area: 8 sq units



Area: 11 sq units



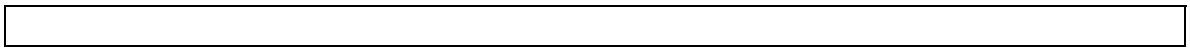
Area: 8 sq units



Area: 8 sq units

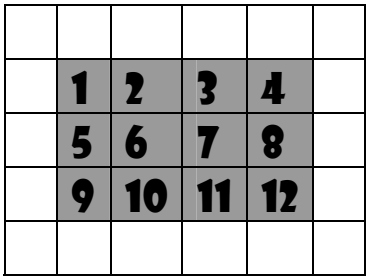
Challenge: Circle the figures above with the same area. What makes these figures alike? How are they different? Explain.

(sample answer) Students should have circled the figures with an area of 8 square units. These figures are all alike because they have the same area. These figures are different because they do not have the same shape.

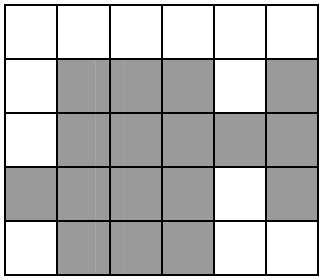


PRACTICE: AREA (ANSWER KEY)

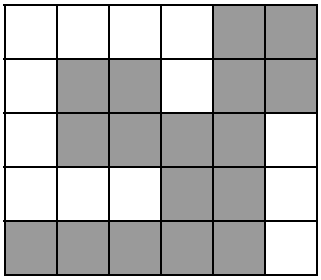
Directions: Number the shaded squares (OR use the formula A= l x w for rectangles) to find the area.



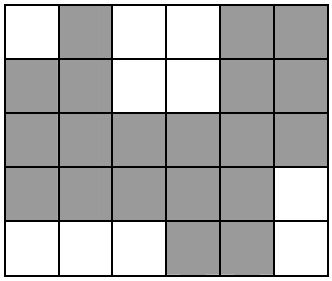
Area: 12 sq units



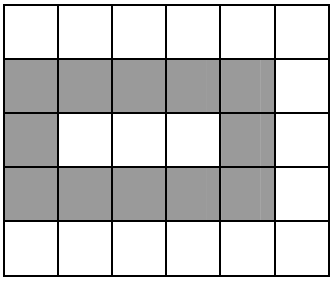
Area: 17 sq units



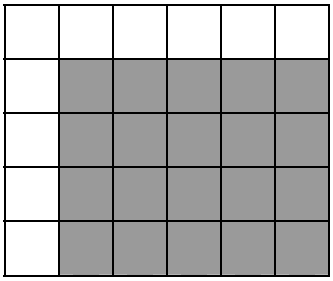
Area: 17 sq units



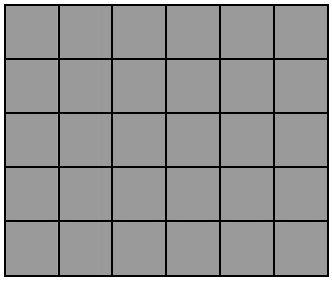
Area: 20 sq units



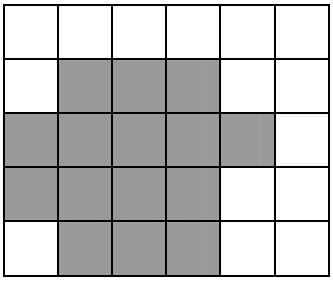
Area: 12 sq units



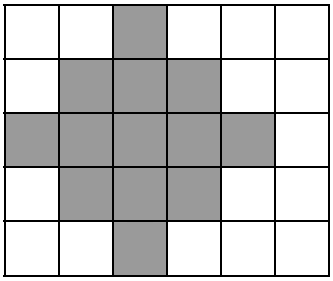
Area: 20 sq units



Area: 30 sq units



Area: 15 sq units



Area: 13 sq units

Area is: **(sample answer)** the number of square units needed to cover the space inside a figure.

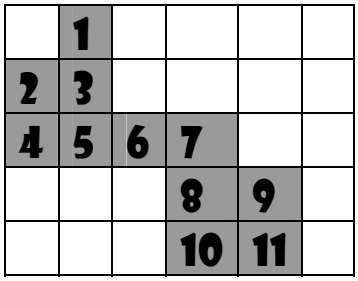
Why can't you use the formula A = l x w for some figures?

(sample answer) You cannot use the formula A = l x w for some figures because a figure must be a rectangle to calculate l x w. You can only multiply groups that are equal, which you have in a rectangle on a grid.

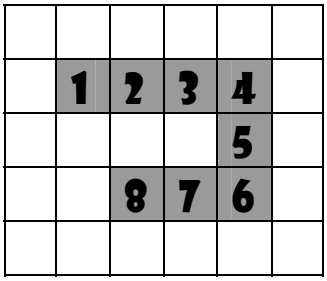
SUMMATIVE ASSESSMENT ANSWER KEY (Total points = 15)

Show all work for each question.

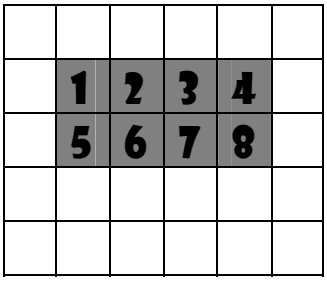
1. What is the area of the shaded region? (1 point each)



Area: 11 sq units



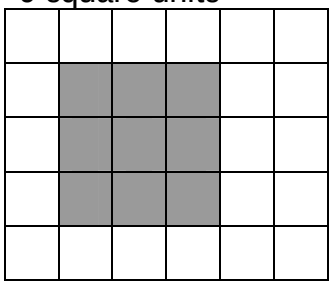
Area: 8 sq units



Area: 8 sq units

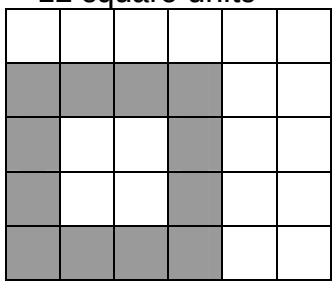
2. Draw a figure with the following area. (1 point each)

9 square units



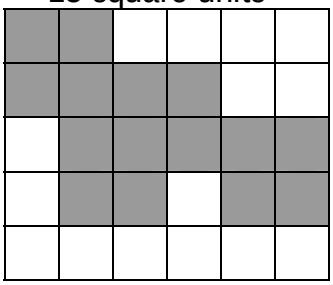
(sample answer)

12 square units



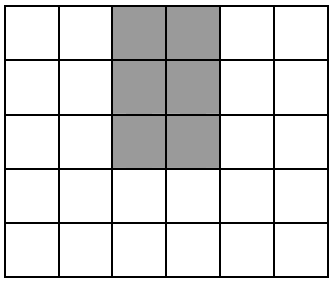
(sample answer)

15 square units

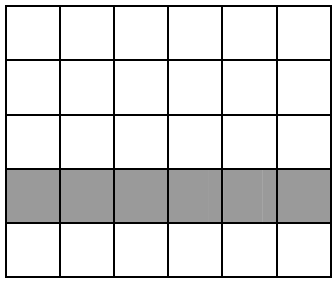


(sample answer)

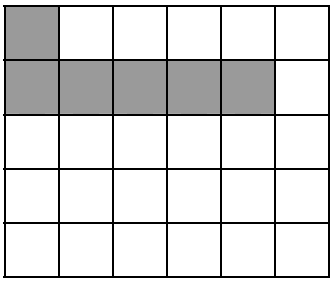
3. In the grids below draw 3 different figures with an area of 6 square units. (1 point each)



(sample answer)



(sample answer)



(sample answer)

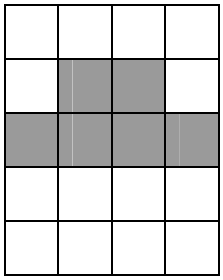
3a. Explain why different figures can have equal areas. You may use words and/or pictures in your explanation. (1 point)

(Sample answer)
Area means the number of square units needed to cover the space inside a figure, so figures with the same area can be different shapes.

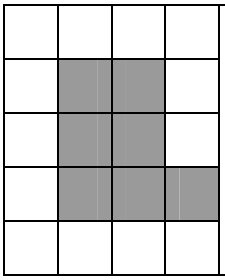
4. Multiple Choice (2 points)

Which figure has the greatest area? (circle the figure) Answer = c

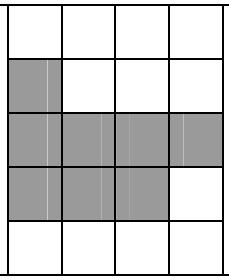
A



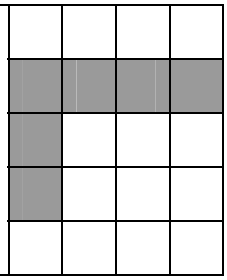
B



C

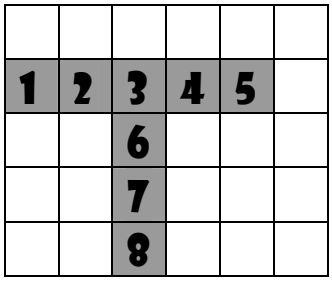


D



5. BCR (3 points)

Part A (1 point)
On the grid below, draw a figure with an area of 8 square units.



(sample answer)

Part B (2 points)

Use what you know about area to explain how you found your answer. Use words, numbers, and/or symbols in your explanation.

(sample answer)
Area is the space inside a figure. My answer is correct because I created a figure with 8 square units shaded, according to the directions. To measure area, count the square units that have been shaded.