SCAFFOLDING TASK: Polygon Capture

Adapted from NCTM Illuminations

The purpose of this task is to motivate students to examine relationships among geometric properties. In this activity, students must choose figures according to a pair of properties, players go beyond simple recognition to an analysis of the properties and how they interrelate.

STANDARDS FOR MATHEMATICAL CONTENT

MCC5.G.3 Understanding that attributes belonging to a category of two-dimensional figures also belong to all subcategories.

STANDARDS FOR MATHEMATICAL PRACTICE

SMP 1.Make sense of problems and persevere in solving them.
SMP 2. Reason abstractly and quantitatively.
SMP 6. Attend to precision.
SMP 7. Look for and make use of structure.

BACKGROUND KNOWLEDGE

The students will need to know the meaning of parallel, perpendicular, quadrilateral, acute, obtuse, and right.

COMMON MISCONCEPTIONS

Students think that when describing geometric shapes and placing them in subcategories, the last category is the only classification that can be used.

ESSENTIAL QUESTIONS

- How can I classify and understand relationships among 2D figures using their attributes?
- How many ways can I classify polygons?
- What are the different attributes of polygons that help me classify them into groups?
- What strategy will you use to capture the most polygons?

MATERIALS

- Polygon Capture Game Rules
- Polygon Capture Game Cards, **(Copied onto cardstock)**
- Polygon Capture Game Polygons, **(Copied onto cardstock)**

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GROUPING

Pairs/small group task/Introduction whole group

TASK DESCRIPTION, DEVELOPMENT AND DISCUSSION

Comments: The purpose of this task is to motivate students to examine relationships among geometric properties. According to Van Heile, the students move from recognition or description to analysis. When asked to describe geometric figures, students rarely mention more than one property or describe how two properties are related. In this activity, by having to choose figures according to a pair of properties, players go beyond simple recognition to an analysis of the properties and how they interrelate.

TASK

Prior to beginning the game, assess the students' familiarity with the vocabulary used in this game by engaging students in a class discussion in which they find examples, define, and/or illustrate the geometric terms.

1. Distribute copies of Polygon Capture Game Rules, Polygon Capture Game Cards, and Polygon Capture Game Polygons to each pair of students.

2. BEFORE CUTTING: The students should label each game card on the back to designate it as an "angle" or "side" card. The first eight game cards, or the top sheet, should be labeled "A" for angle property; the last eight game cards, or the bottom sheet, should be labeled "S" for side property. After labeling the game cards, the students may cut out the polygons and all game cards.

3. Basic Rules: Have the students read the rules on the Polygon Capture Game Rules sheet. Teachers have found it helpful to begin by playing the game together. Teacher vs class. For the first game, remove the Steal Card to simplify the game.

To introduce the game as a whole-class activity, lay all twenty polygons in the center of the overhead projector. Students may lay out their shapes and follow along. An introductory game observed in one of the classroom proceeded as follows.

1. The teacher draws the cards, *All angles have the same measure* and *All sides have the same measure*. She takes figures D, G, Q, and S, placing them in her pile and out of play.

2. Students then pick the cards *At least two angles are acute* and *It is a quadrilateral*. They choose figures I, J, K, M, N, O, and R.

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3. On her second turn, the teacher picks the cards *There is at least one right angle* and *No sides are parallel*. She chooses figures A and C and then asks students to find a figure that she could have taken but forgot. One student points out that figure H has a right angle and no parallel sides. Other students are not sure that this polygon has a right angle, which leads to a discussion of how they might check.

4. The students then proceed to take two new cards.

*When no polygons remain in play that matches the two cards chosen, the player may turn over one additional card-either an angle or a side card. This move calls for some planning and analysis to determine whether an angle card or a side card is most likely to be useful in capturing the most polygons. If the player still cannot capture any polygons, the play moves to the opponent. When all cards in a deck are used up before the end of the game, they are reshuffled. Play continues until two or fewer polygons remain. **The player with the most polygons is the winner**.

WILD CARD: When the "Wild Card" is selected, the player may name whatever side property he or she wishes; it need not be one of the properties listed on the cards. Again, a good strategy to capture the largest number of polygons requires an analysis of the figures that are still in play.

STEAL CARD: When the "Steal Card" comes up, a card from the deck is not drawn. Instead, the player has the opportunity to capture some of the opponent's polygons. The person who has chosen the Steal Card names two properties (one side and one angle) and "steals" the polygons with those properties from the opponent. The students may select their own properties, not necessarily those on the game cards. If the opponent has no polygons yet, the Steal Card is put back in the deck and a new card chosen.

NOTES: The various strategies that the students use will be interesting. Some students go through the figures one at a time, using a trial and error method. Some students perform two sorts; they find the polygons that match the first card and then the second. Others may mentally visualize the polygons that are possible.

FORMATIVE ASSESSMENT QUESTIONS

- How did decide which card to play?
- How did you decide which property to select?
- How did you sort your cards?
- How can you capture the most cards?

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DIFFERENTIATION

Extension

- Some teachers have found that coordinating two properties is initially too difficult for their students and have simplified the game by placing all cards into a single pile. For this simpler version only one card is turned over, and students choose all polygons with that property. It is probably best to remove the WILD CARD and the STEAL CARD. The other rules are the same.
- The polygons figures on the Polygon Capture Game Polygons sheet can also be used for various sorting games and activities. For example, students may work in pairs, with one student separating the shapes into groups based on some rule or set of rules, and the other student trying to decide the rules.
- More polygons can be added by the students or teacher. These might include figures that are more complex to capture, such as a kite or nonconvex hexagon. Nonpolygons, such as figures with curves, can be added to the basic deck.

Intervention

- Use the polygon figures on the Polygon Capture Game Polygon sheet to review geometry vocabulary prior to playing the game.
- The Polygon Capture game cards can also be used to generate figures. As in the game, students turn over two cards. Instead of capturing polygons, they use a garboard or dot paper to make a figure that has the two properties. Rather than a game, this is simply an activity to help students learn to coordinate the features of a polygon.

TECHNOLOGY CONNECTION

- http://www.crickweb.co.uk/ks2numeracy-shape-and-weight.html#quad Play the Polygon Capture game
- http://www.nctm.org/standards/content.aspx?id=25040 This interactive activity explores geometric relationships and make and test conjectures.
- http://illuminations.nctm.org/LessonDetail.aspx?ID=L350In this lesson, from Illuminations, students use dynamic software to examine the properties of rectangles and parallelograms and then identify what distinguishes a rectangle from a more general parallelogram. Using spatial relationships, they examine the properties of two- and three-dimensional shapes. The lesson links to a virtual manipulative that allows students to compare rectangles and parallelograms.

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Polygon Capture: RULES OF THE GAME

Preparation

Before playing the game, cut out the cards on the Polygon Capture Game Cards sheet. Mark the back of the top eight cards with "A" for angle. Mark the back of the bottom eight cards with "S" for side. Cut out the polygons on the Polygon Capture Game Polygons sheet. Place the twenty polygons in the center of the playing area. Put the cards in two decks: *angle* cards and *side* cards.

Basic Play

1. Player 1 turns over one card from the angle deck and then one card from the side deck. All polygons that match *both* these properties may be captured. Captured polygons are removed from play.
2. If player 1 has missed any figures, player 2 may now capture them.
3. Player 2 chooses a card from each deck and tries to capture polygons.

If no polygons can be captured with the cards chosen, the player may choose one more card from either deck. If no polygons can then be captured, that turn is over. A player may challenge the opponent's capture. If the piece was incorrectly chosen, it is put back in play in the center. Play until two or fewer polygons remain. If you run out of cards, reshuffle the deck. The player with the most polygons wins.

Wild Card

If the Wild Card comes up, you may choose any side property. For example, if you have chosen *All angles are right angles and* the Wild Card, you may say, "All opposite sides are the same length" and capture all rectangles.

Steal Card

If you select the Steal Card, do not turn over a second card. This card allows you to steal polygons from your opponent. Without selecting another card, pick two properties, one for sides and one for angles, that will allow you to steal as many polygons from your opponent as possible. Make up these properties on your own. If your opponent has no cards to steal, put the Steal Card back in the angle deck and choose two new cards.

Example

Player 1 turns over the cards *All angles have the same measure* and *It is a quadrilateral.* Player 1 captures shapes D, E, and G.
Player 2 may now capture shape T, since it was missed by player 1.
Player 2 now turns over two cards.

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Polygon Capture Game Cards (Copy on Cardstock)

All angles are right angles. (Angle)	At least one angle is obtuse. (Angle)	No angle is a right angle. (Angle)	At least one angle is less than 90 degrees. (Angle)
At least one angle is a right angle. (Angle)	At least two angles are acute. (Angle)	All angles have the same measure. (Angle)	**<u>Steal Card</u>**: Select a pair of properties. Steal all those polygons from your opponent.

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Polygon Capture Game Cards (Copy on Cardstock)

No pairs of sides are parallel. (Sides)	All sides are of equal length. (Sides)	Only one pair of sides is parallel. (Sides)	At least one pair of sides is perpendicular. (Sides)
All pairs of opposite sides are parallel. (Sides)	It is a quadrilateral. (Sides)	All pairs of opposite sides have equal length. (Sides)	WILD CARD: Pick your own side property. (Sides)

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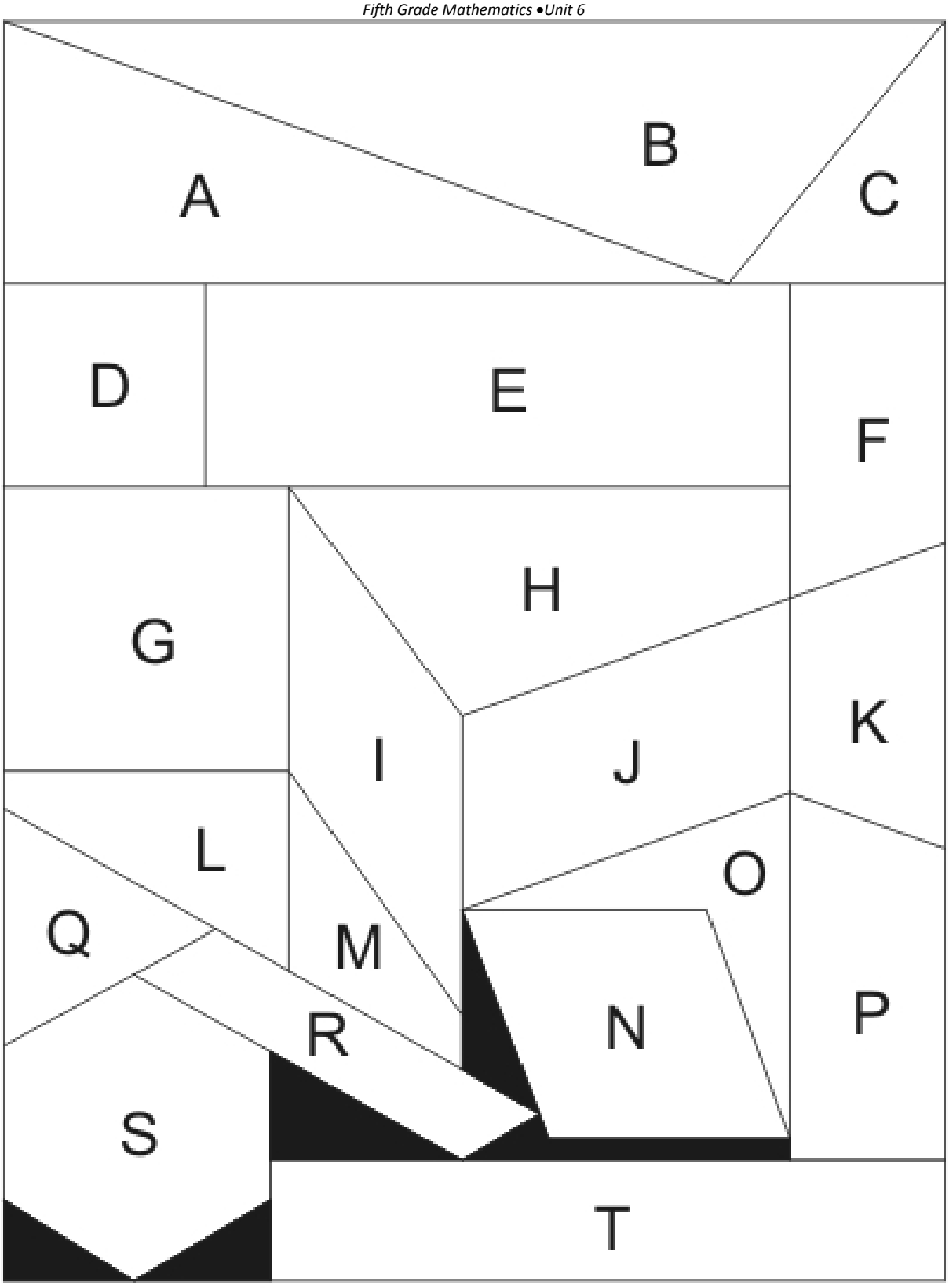

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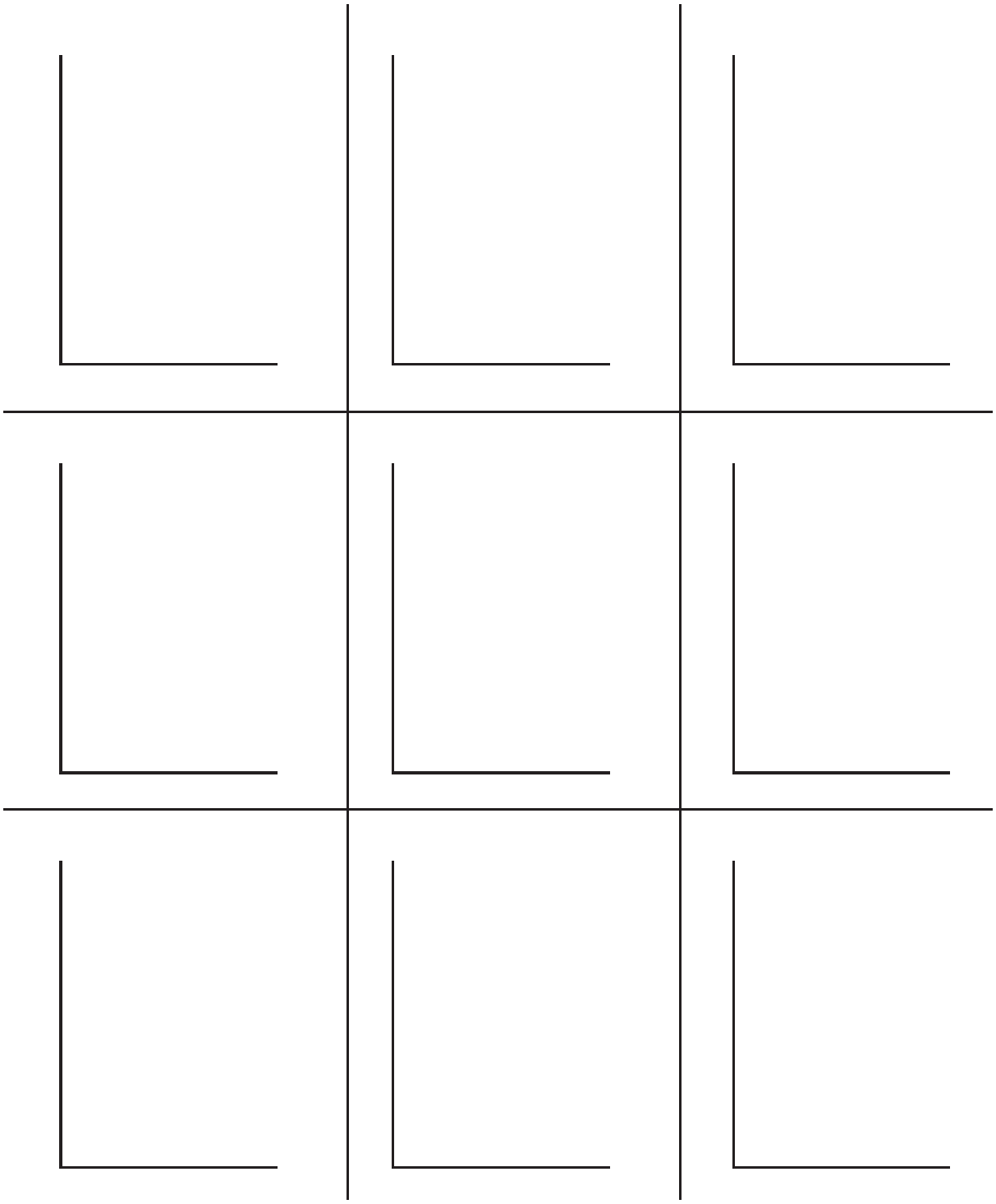

This resource may be used with a variety of tasks as a guide for students. Copy onto cardstock and laminate for students as a guide to determine right, obtuse, and acute angles. (From Academy handbook)

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