About the Mathematics

The Pentagon Problem asks students to create a new pentagon from a given one, keeping the area the same. The *The_Pentagon_Problem.tns* document was created in response to poor student performance on a 2005 National Assessment of Educational Progress (NAEP) eighth grade test item.

The document provides a simple, virtual "geoboard" that allows students to manipulate the polygon displayed on a unit grid. The grid squares provide a visual means of finding area.

With the .tns file, students can use the concrete picture to help solve the problem and to check their answers to the problem using different methods. They can also use the document to justify conclusions about area, to communicate conclusions to others, and to distinguish correct reasoning from that which is flawed.

Math Objectives

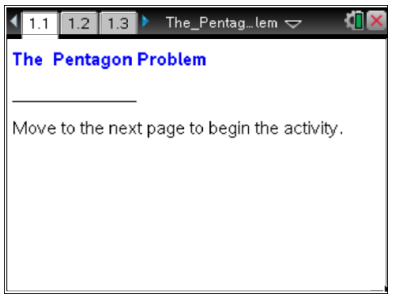
- Students will use the document to find several non-congruent pentagons having the same area as a given pentagon.
- Students will solve real-world and mathematical problems involving area, volume, and surface area of two- and three-dimensional objects composed of triangles, quadrilaterals, polygons, cubes, and right prisms (CCSS Geometry, Grade 7).
- Students will make sense of problems and persevere in solving them (CCSS MP).
- Students will construct viable arguments and critique the reasoning of others (CCSS MP).
- Students will reason abstractly and quantitatively (CCSS MP).
- Students will look for and make use of structure (CCSS MP).

TI-Nspire™ Navigator™

- Send and collect a file.
- Use Class Capture to monitor student work.
- Use Live Presenter to let students demonstrate their work.

Activity Materials

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



Tech Tips:

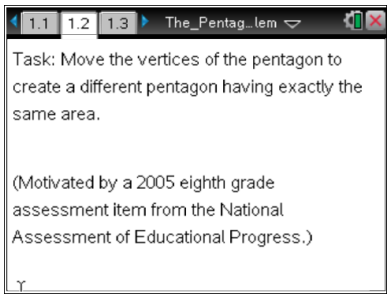
- This activity includes screen captures taken from the TI-Nspire CX handheld. It is also appropriate for use with the TI-Nspire family of products including TI-Nspire software and TI-Nspire App. Slight variations to these directions given within may be required if using other technologies besides the 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:

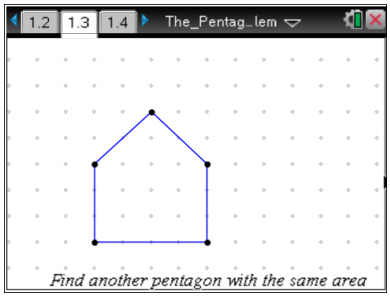
- The_Pentagon_Problem.tns

Using the Document

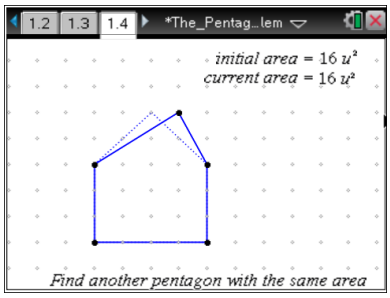
Page 1.2 describes the task: create a different (meaning not congruent) pentagon containing the same area as the given pentagon.



Page 1.3 provides a dynamic picture of a pentagon on a square grid. Students can move the vertices to create a new polygon. The grid squares become useful in determining the area of the polygon.



Page 1.4 adds area calculations for checking student solutions.



Tech Tip: To move a point, press on it once. This brings up a menu of options. Select the item you want to move and press Done. The point is now ready to move.

Discussion Possibilities

There are many possible correct answers (and many possible incorrect ones as well). A mathematically-productive classroom discussion can be centered on considering various student solutions, strategies, and approaches.

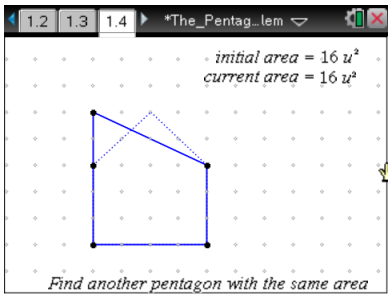
TI-Nspire Navigator Opportunity: *Class Capture and Live Presenter*
See Notes 1 and 2 at the end of this lesson.

Examples

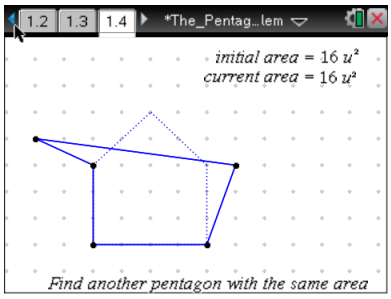
Here are six possible student solutions (A-F). Which are correct? Which are incorrect? And why?

Spur discussion by asking individual students to elaborate on the strategy each used to find a solution (use of a formula? A "compensation" method—i.e., imagining subtracting part of the original and "pasting" it into a new position?).

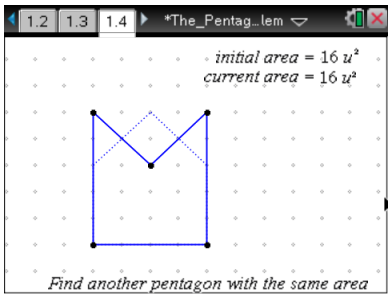
A.



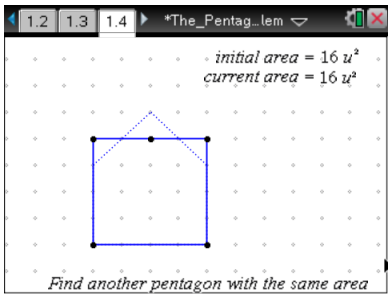
B.



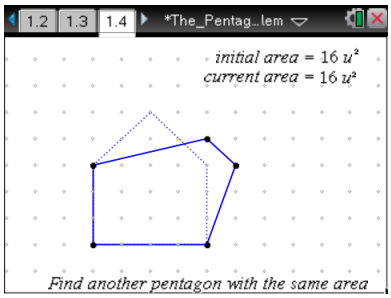
C.



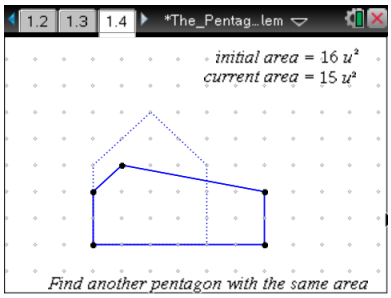
D.



E.



F.



Answers

A. **Incorrect**: It is not a pentagon, although it has the correct area.

B. **Correct**: Students might have used a compensation strategy where the rectangular part remains constant and the triangular section has been divided in half. They then place one triangle on the upper left and the other triangle off the right side of the rectangle to create a new pentagon.

C. **Correct**: Although it is concave, it is still a pentagon.

D. **Incorrect**: It is not a pentagon. Some might argue that the presence of the point indicates is it made up of five segments and thus should be considered a pentagon.

E. **Correct**: One way of looking at it is Area=15-1.5+2.5=16. Rectangle 3x5 minus the triangle at the right side plus the area of the top triangle.

F. **Incorrect**: Area is 15. (rectangle 6x2) + (triangle (1/2 of 6x1) = 15.

TI-Nspire Navigator

Note 1 Class Capture

Use Class Capture to share student solutions anonymously and to afford students the opportunity to critique and evaluate each other's reasoning.

The possible student solutions above might be typical of the ones that would be on a Class Capture of student work. Discussion should focus on how students might have strategized and whether the solutions are in fact correct.

Note 2 Live Presenter

Using *Live Presenter* gives a student control over TI-Nspire Navigator's display to show how they moved vertices in creating a new pentagon and to explain their reasoning for doing so.