Performance Based Learning and Assessment Task

Tiling

I. ASSESSMENT TASK OVERVIEW & PURPOSE:
This task is designed to develop skills in calculating areas in connection with tessellating tiles to cover an area, and develop criteria for judging the aesthetics of the tessellated pattern.

II. UNIT AUTHOR:
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III. COURSE:
Geometry

IV. CONTENT STRAND:
Geometry: Polygons and Circles

V. OBJECTIVES:
The learner will be able to…

- Apply properties of polygons to determine which tile shapes will tessellate different areas.
- Apply properties of polygons to determine the cost to tessellate the specified area.
- Apply properties of polygons to determine the amount of wasted material.

VI. REFERENCE/RESOURCE MATERIALS:

- SOL formula sheet - VDOE
- Larson, R. (2003) Geometry. Boston, MA: McDougal Littell
- Graph paper
- Scissors
- Pattern blocks
- Classroom set of graphing calculators
- Technology (if available and if needed): Promethean Board, document camera, eBeam, computer with ActivInspire or Geometer's Sketchpad, projector

VII. PRIMARY ASSESSMENT STRATEGIES:
Students will use the assessment list as a tool for self-assessment on several criteria including mathematical accuracy, quality of explanations, and neatness. The teacher will use the assessment list as a rubric to assess student work. The same rubric is intended for use with both the main task and the extension questions.

VIII. EVALUATION CRITERIA:
The assessment list/rubric and a benchmark of exemplary work for the activity are included in this packet.

IX. INSTRUCTIONAL TIME:
Two 90-minute class periods.

Tiling

Strand
Geometry - Polygons and Circles

Mathematical Objectives
The learner will be able to…

- Apply properties of polygons to determine which tile shapes will tessellate different areas.
- Apply properties of polygons to determine the cost to tessellate the specified area.
- Apply properties of polygons to determine the amount of wasted material.

Related SOL
- G.9 (verify characteristics of quadrilaterals and use properties of quadrilaterals to solve real-world problems)
- G.10 (solve real-world problems involving angles of polygons)

NCTM Standards
- Analyze properties and determine attributes of two- and three- dimensional objects
- Apply and adapt a variety of appropriate strategies to solve problems
- Communicate mathematical thinking coherently and clearly to peers, teachers, and others

Additional Objectives for Student Learning:
- Economics and Personal Finance SOLs
  EPF.10c (describing the steps in making a purchase decision)
  EPF.10f (develop consumer skills by demonstrating comparison-shopping skills)
- Visual Art SOLs
  6.19 (explain the means by which works of art evoke personal sensory, emotional, and aesthetic responses)
  7.19 (describe personal responses to visual qualities of works of art)
  8.21 (describe and justify personal responses to visual qualities in works of art)
  AI.20 (describe aesthetic qualities found in works of art)
  AI.23 (use personal criteria when making visual aesthetic judgments)
  AII.24 (describe personal responses to aesthetic qualities found in works of art and design)
- Computer Technology SOLs
  C/T 6-12.2b (use content-specific tools, software, and simulations to complete projects)

Materials/Resources
- SOL formula sheet - VDOE
- Larson, R. (2003) Geometry. Boston, MA: McDougal Littell
- Graph paper
- Scissors
- Pattern Blocks
- Classroom set of graphing calculators
- Technology (if available and if needed): Promethean Board, document camera, eBeam, computer with ActivInspire or Geometer's Sketchpad, projector

Assumption of Prior Knowledge

- This activity assumes students are already familiar with the properties of various polygons including equilateral triangles, squares, rectangles, and regular hexagons. They should understand the concept of area and be able to find the areas of each of these shapes. Students may or may not be familiar with tessellations prior to completing this activity; it may be used either as an introduction to or as an application of tessellations.
- Students should immediately recognize that the activity involves the concept of area. When determining the number of tiles needed to cover the space, students may discover that while the square and rectangular tiles will cover the space perfectly, the triangular and hexagonal tiles will not (hence the leftover "waste"). They may be confused about this initially, but eventually they will be able to see why it is so by creating a picture or just thinking about the shapes and sizes of the various tiles compared with the shape and size of the room. This should lead them to the conclusion that the number of tiles for the triangles and hexagons must be rounded up. Students may have difficulty calculating the "waste" but will hopefully realize it is simply the amount of leftover unused tile and that it can be calculated by (area of one tile*number of tiles) - (area of room). This formula is based on the assumption that all end-cuts can be used somewhere else in the pattern.
- This activity is built around the real-world application of tiling a floor in a home or building. While applying and practicing mathematical concepts and skills, students get a glimpse of the questions they would need to answer if they were performing the task in real life. Students who are interested in art/design or construction/contracting may be particularly interested in this activity.

Introduction: Setting Up the Mathematical Task

- In this task/activity, the student will investigate methods to tile a specific area with a choice of tile shapes and sizes, then adapting to other situations the students will generate their own list of questions to obtain the information to help find a solution.
- The pre-activity will be given to the students right as they enter the room. Introduce the task by explaining that they will be figuring how to tile the 10ft x 10ft using the given shapes (equilateral triangle, square, rectangle, regular hexagon). When the bell rings they are to break into small groups (2-3) and 'Think-Pair-Share' about what they did to get their answer. The teacher will ask for volunteers to show their work and explain how they got their answer.
- The teacher will ask if an area can be tiled using just one type of tile. They will 'Think-Pair-Share' how it can be done. If yes, go to asking about what shapes could they use. If no, show examples like floor, walls, ceiling, and graph paper. They will share their findings.
- The teacher will give the students the task handout. It contains the different areas and the information for the different kinds of tiles. The teacher tells them they have to use at least 2 shapes as a combination this time.
- The teacher will ask the groups to write down the list of questions that will help them create a method (algorithm) to have all of the information that they need to tile the area. Next they share what they think is important information. The class decides what information they need. All choices are defended.
- The teacher tells them that they are to add any other they need to figure out the cost to tile the whole area and to calculate what amount of material will be left over. They will share their methods. They start the task. The teacher walks around to observe and offer assistance but not by giving the answer but by asking questions.

- At the specified time, the student will put away their materials, clean their areas, and make sure everything is correct. They will turn in their work if they are finished or complete this for homework. Hand them an exit slip (attached) to complete before the bell rings. The students will turn in their exit slip.

Student Exploration

Individual Work: The students will work on the pre-activity.
Small Group Work: The students will talk about how they solved the pre-activity with their partner. The students will talk about how they decided which tile(s) can be used.
Whole Class Sharing/Discussion: They will share their findings.
Individual work/Small Group Work: The teacher will introduce the task by asking the students to write down the questions they need to ask to get the information that they need to find a method to solve the problem and their solution for their task. All answers must be justified and discussed. The teacher will ask how you can figure out the cost and what you do with any extra material that is left over. They must explain and support why they used this strategy. If they are stuck/struggling they can ask their group or ask the teacher.
Individual Work: At the specified time they will turn in their work, put back their materials, clean their area, and double check that everyone has done their job. Lastly, they will complete an exit slip before the bell rings.

Student/Teacher Actions:

- Students should draw in shapes to divide the area of the pre-activity. Some students might struggle, and if so, the teacher can guide them by asking questions to understand what type of shapes they could use to divide the area.
- The students should explore by trying out different groups of shapes to divide the area. The teacher will monitor student's actions.
- In their groups, they should be sharing their thoughts about how to do the task. The teacher will monitor student's actions.
- The whole class will discuss what methods worked the best.
- They will work on figuring what information is needed to solve the cost and leftover issue. The teacher will monitor student's actions.
- The group will discuss what and why they did what they did. The teacher will monitor student's actions.
- The students will work on the task. The teacher will monitor student's actions.
- The students will put materials back and clean their area.

Monitoring Student Responses

- Students will communicate with their group members during the activity. They will be required to explain their thinking as they answer the questions on the activity sheet.
- The teacher will rotate amongst the groups to be sure each group is on the correct path. If a student or group is having difficulties, the teacher can ask questions to help clarify the material. If the teacher notices that multiple groups are having trouble with the same thing, he/she may bring the class together to discuss the issue. Either the teacher can provide some guidance, or he/she can call on a student who understands it to explain his/her thinking to the class.
- Groups who finish the main task early will be asked to continue to the extension questions. These require students to work with the same concepts but on a deeper level.
- When all groups have completed the activity, the teacher will bring the class together to discuss their results. An emphasis will be placed on the different strategies students used to solve the

problems. Student volunteers from each group will be given the opportunity to share their group's strategy with the class.
- Each student will summarize his/her new learning by completing an exit slip.

Assessment List and Benchmarks

See attached assessment list and benchmarks.

Tiling Task

You are given the task of choosing tile to cover the floor of a 10 ft. by 10 ft. room. The tiles come in the shapes of equilateral triangles, squares, rectangles, and regular hexagons. Listed below are the available tiles and the price per tile:

Triangles	Squares	Rectangles	Hexagons
6-in. equilateral - $3.80/tile	6-in. - $4.63/tile	3 in. x 6 in. - $2.31/tile	4-in. regular - $10.00/tile
12-in. equilateral - $16.00/tile	12-in. - $32.00/tile	4 in. x 8 in. - $6.00/tile	6-in. regular - $22.00/tile

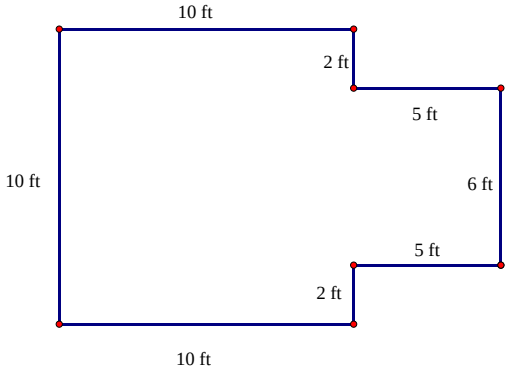
Note: Prices were calculated from information obtained from https://www.fireclaytile.com/tile/sizes/

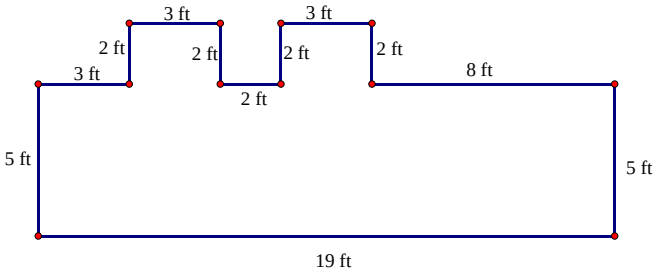
1. Using a combination of different shapes (at least two), determine the cost to cover the floor of the room and the amount of waste (leftover unused tile). Show all calculations and sketches to explain your answers. To help with the explanation, list all of the questions you are asking, the answers you found, and any assumptions you made.
2. Which of the different floor designs that you have looked at do you think people would like on their floor? Explain why you feel they would like or dislike certain designs.

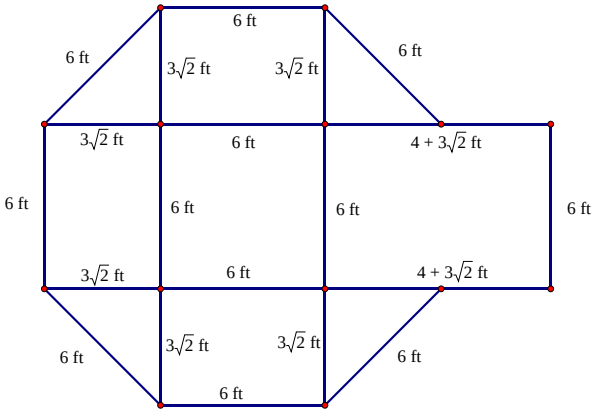
Extensions:

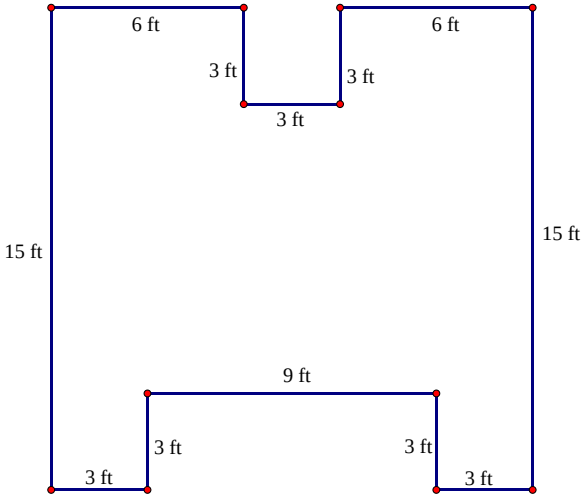
1. Using the tile shapes and prices above, determine the cost and amount of waste for rooms that are not square as shown on the attached page. Show all calculations and sketches to explain your answers. Again your explanation should list all of the questions you are asking, the answers you found, and any assumptions you made.
2. Try using the combination of different shapes for the rooms that are not square. Does this make it easier or harder to tessellate the plane of the floor?

Additional Rooms









Tiling Task Assessment List

		Earned Assessment	
	Point Value	Self	Teacher
Student shows calculations	4		
Student identifies the cost of tile	4		
Student identifies amount of waste	4		
Student provides explanations, including questions and answers	4		
Student describes and explains the aesthetics of the patterns	4		
Student's work is neat and presentable	4		
Student provides pictures of tessellations	4		

Tiling Task Rubric

	0	2	4	Score
Student shows calculations	Student shows no calculations, or all calculations are incorrect	Student either shows all calculations with some incorrect or shows some calculations with all correct	Student shows correct calculations for all parts of the problem	___/4
Student identifies the cost of tile	Student does not identify the cost	Student identifies cost, but it is incorrect	Student correctly identifies the cost tile	___/4
Student identifies amount of waste	Student does not identify amount of waste	Student identifies amount of waste, but it is incorrect	Student correctly identifies amount of waste	___/4
Student provides explanations, including questions and answers	Student provides no explanations, or all explanations are incorrect	Student provides some explanations, or explanations are incomplete	Student provides thorough explanations of all answers, including questions asked and answers found	___/4
Student describes and explains the aesthetics of the patterns	Student provides no description or explanation, or all are incorrect	Student provides some description or explanation, or description or explanations are incomplete	Student provides thorough description or explanations of all answers, including questions in task	___/4
Student's work is neat and presentable	Student's work lacks neatness	Student's work needs improvement	Student's work is neat and presentable	___/4
Student provides pictures of tessellations	Student provides no pictures of tessellations	Student provides partially correct tessellations	Student provides correct tessellations	___/4

Tiling Pre-Activity

You are given the task of choosing tile to cover the floor of a 10 ft. by 10 ft. room. The tiles come in the shapes of equilateral triangles, squares, rectangles, and regular hexagons. Listed below are the available tiles:

Triangles	Squares	Rectangles	Hexagons
6-in. equilateral	6-in.	3 in. x 6 in.	4-in. regular
12-in. equilateral	12-in.	4 in. x 8 in.	6-in. regular

1. Using the single type of tile assigned to your group, determine the number of tiles needed to cover the floor. Show all calculations and sketches to explain your answers. To help with the explanation, list all of the questions you are asking, the answers you found, and any assumptions you made.

2. After viewing the other group's sketches, discuss which of the patterns you find to be the most visually pleasing. What else could be done with the floor tiles to add to their aesthetics?

Exit Slip

You obtain a summer job helping to remodel a home. You are given the task of laying new floors. List at least three things you must take into account before ordering the materials. Explain why each of these is important.

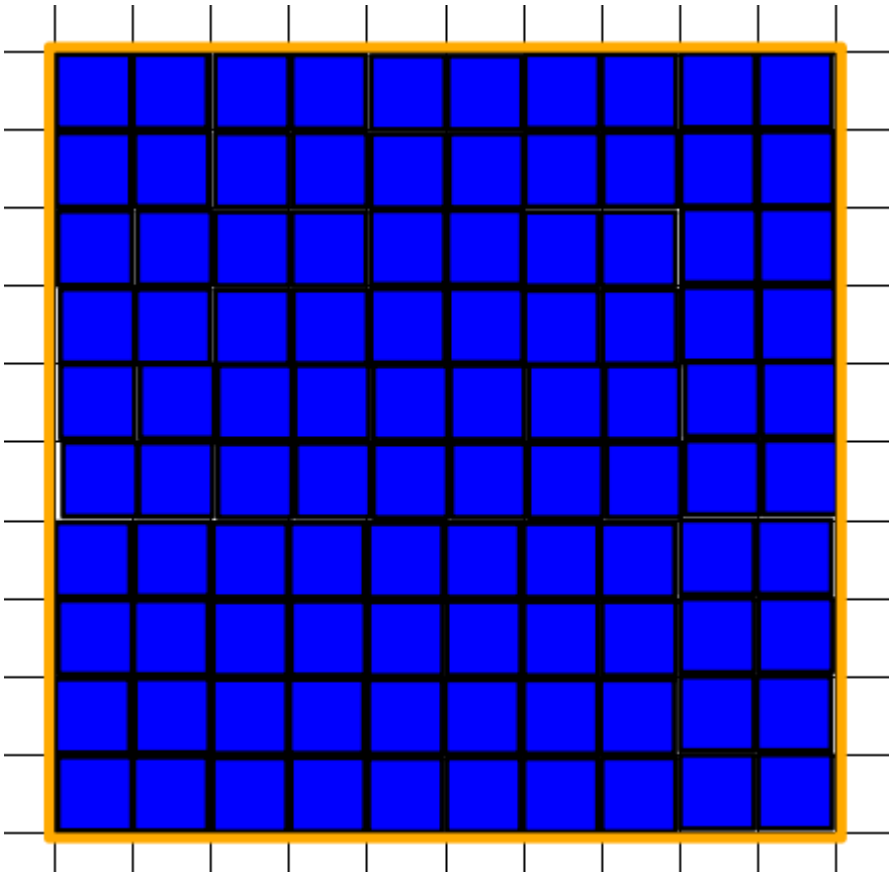
Tiling Pre-Activity
Benchmark

You are given the task of choosing tile to cover the floor of a 10 ft. by 10 ft. room. The tiles come in the shapes of equilateral triangles, squares, rectangles, and regular hexagons. Listed below are the available tiles:

Triangles	Squares	Rectangles	Hexagons
6-in. equilateral	6-in.	3 in. x 6 in.	4-in. regular
12-in. equilateral	12-in.	4 in. x 8 in.	6-in. regular

1. Using the single type of tile assigned to your group, determine the number of tiles needed to cover the floor. Show all calculations and sketches to explain your answers. To help with the explanation, list all of the questions you are asking, the answers you found, and any assumptions you made.

Below are sample answers using two of the shapes – the 12-inch square and the 12-inch triangle.

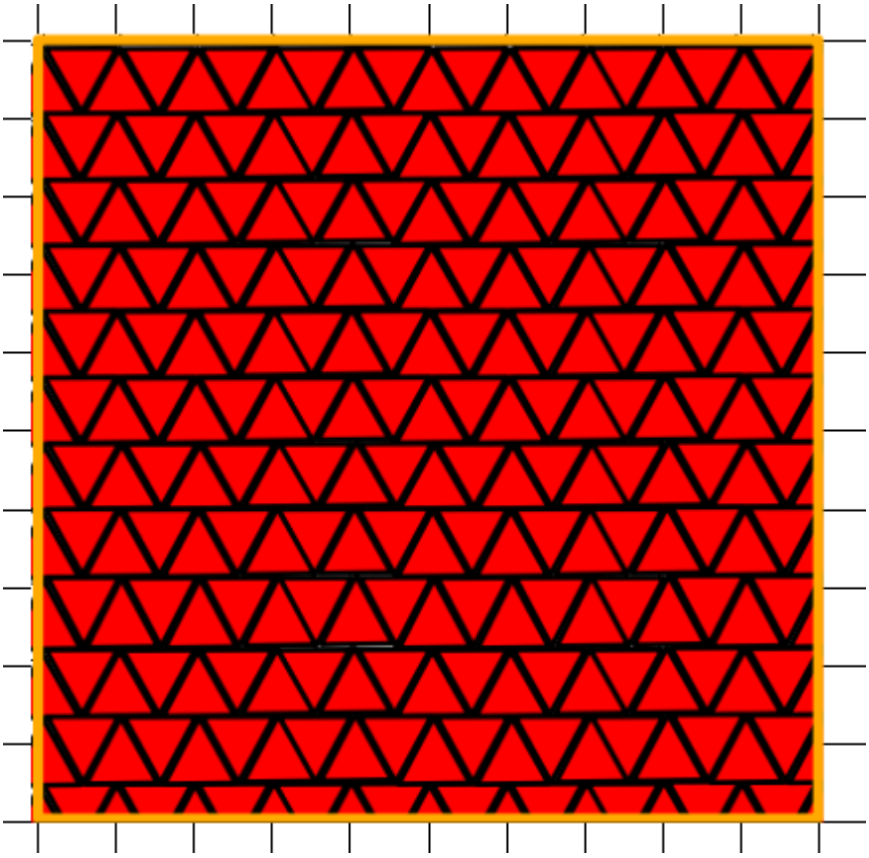


Dimensions of room (in.): 120 in. by 120 in.

Area of room (in.^{2}): 120(120) = 14,400 in.^{2}

Area of each tile (in.^{2}): 12(12) = 144 in.^{2}

Number of tiles: 14,400/144 = 100 tiles



Dimensions of room (in.): 120 in. by 120 in.

Area of room (in.^{2}): 120(120) = 14,400 in.^{2}

Area of each tile (in.^{2}): $\frac{1}{2}(12)\left(6\sqrt{3}\right) = 36\sqrt{3} \approx 62.4$ in.^{2}

Number of tiles: $\frac{14{,}400}{36\sqrt{3}} = \frac{400\sqrt{3}}{3} \approx 230.9$ tiles → Round up to 231

The following are possible questions students might ask along with their answers:

- What calculation is related to "covering" a floor? Area
- What are the dimensions of the 10 ft by 10 ft room in inches? 120 in. by 120 in.
- What is the area of the room in square inches? 14400 in.^{2}
- How do you find the number of tiles? Divide the area of the room by the area of an individual tile. What if your answer is not a whole number? Round up to the next whole number.
- How do you find the area of an equilateral triangle? $A = \frac{s^2\sqrt{3}}{4}$ A square? $A = s^2$ A rectangle? $A = lw$ A regular hexagon? $A = \frac{3s^2\sqrt{3}}{2}$

2. After viewing the other group's sketches, discuss which of the patterns you find to be the most visually pleasing. What else could be done with the floor tiles to add to their aesthetics?

The hexagons were the most interesting of the shapes. To add to the aesthetics, we could combine different shapes together in the pattern or use different colors of tiles to create other patterns.

Tiling Task Benchmark

1. Using a combination of different shapes (at least two), determine the cost to cover the floor of the room and the amount of waste (leftover unused tile). Show all calculations and sketches to explain your answers. To help with the explanation, list all of the questions you are asking, the answers you found, and any assumptions you made.
2. Which of the different floor designs that you have looked at do you think people would like on their floor? Explain why you feel they would like or dislike certain designs.

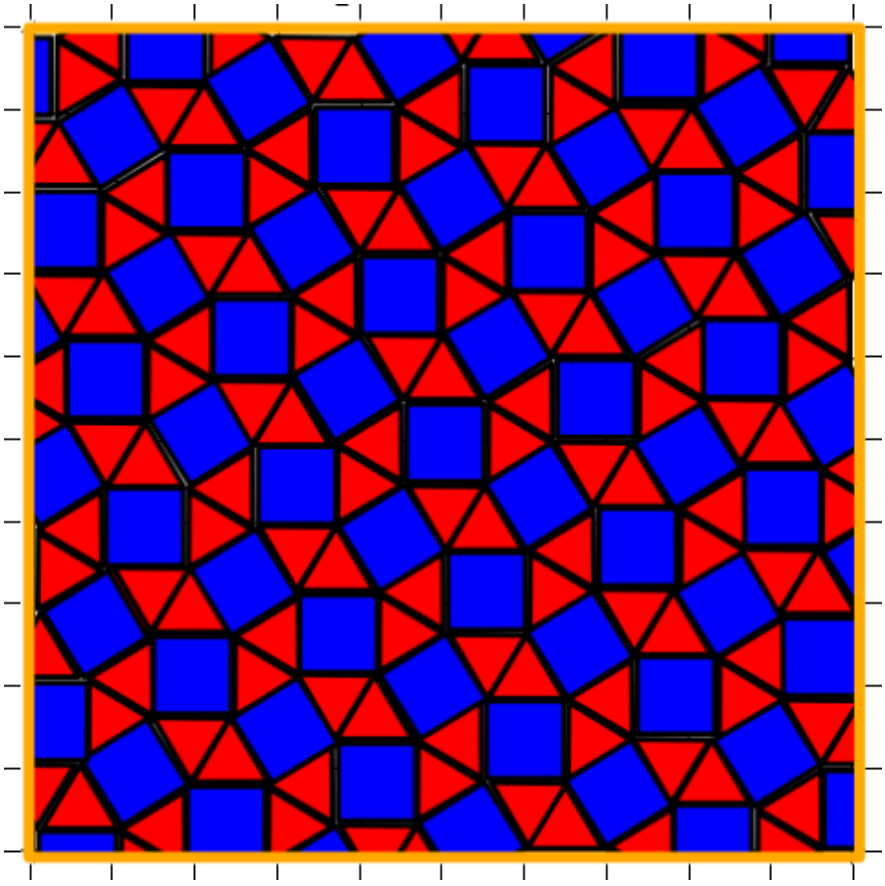
Here are possible examples of questions the students would be writing and the questions they would be asking (student work in red and answers in blue)

The 12" square and 12" triangle would allow me to cover the floor at a cost ($3680) and waste (1066 square inches). To approach this problem, I found the area of each tile and created my pattern. I found the combined area of the tile combo and I divided this area of two new tiles into the area floor to find the number of tiles needed. I then multiplied the number of each type tile by its price per tile to obtain the cost for each type of tile. I added these two costs to get the total cost to tile the floor. To find the waste, I multiplied the area of each type of tile by the number of that kind tile. I did the same for the other type of tile. I added these two areas and subtracted the area of the room. Here is a list of questions I asked along with their answers:

- What calculation is related to "covering" a floor? Area
- What are the dimensions of the 10 ft by 10 ft room in inches? 120 in. by 120 in.
- What is the area of the room in square inches? 14400 $in.^2$
- How do you find the number of tiles? Divide the area of the room by the area of one combo tile [1] What if your answer is not a whole number? Round up to the next whole number.
- Assumption 1: If a tile is cut the leftover area will always fit the remaining area to be covered.
- How do you find total cost? Multiply the number of tiles for each type by their price per tile and add them.
- How do you find the area of an equilateral triangle? $A = \frac{s^2\sqrt{3}}{4}$ A square? $A = s^2$ A rectangle? $A = lw$ A regular hexagon? $A = \frac{3s^2\sqrt{3}}{2}$
- How do you calculate waste? Multiply the area of each tile type by the number of tiles. Do this for the other kind of tile. Add the two areas and subtract the area of the room.
- Which of the patterns do you find to be the most visually pleasing? I thought my square triangle combo was pretty cool looking.
- What else could be done with the floor tiles to add to their aesthetics? We could color the tiles to create other patterns.

Examples of sketches and detailed calculations for the task:

10x10 Room using 12" Squares & 12" Triangles
Arrangement #1



Material, Coverage, and Cost

Material:

48 – Whole 12” Square Tiles; 20 - Partial 12” Square Tiles made from 10 whole tiles
103 – Whole 12” Triangle Tiles; 22 – Partial 12” Triangle Tiles made from 11 whole tiles
Total: $48 + 10 = 58$ - 12” Square Tiles and $103 + 11 = 114$ - 12” Triangle Tiles

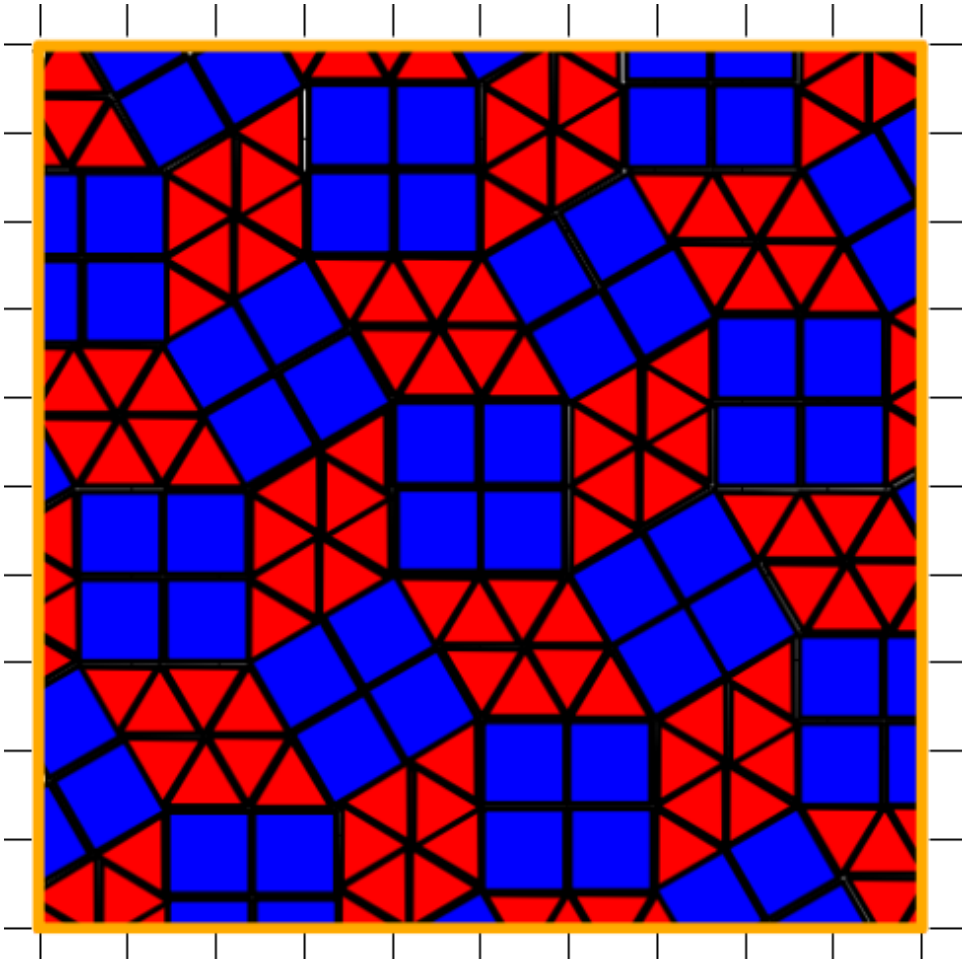
Coverage:

Tiles: $58 * 144in^2 + 114 * 62.4in^2 = 15466in^2$
Room Area: $120in * 120in = 14400in^2$
Waste: $15466in^2 - 14400in^2 = 1066in^2$

Cost:

58 - 12” Square Tiles & 114 Triangle Tiles: $58tiles * \$32/tile + 114tiles * \$16/tile = \$3680$

10x10 Room using 12" Squares & 12" Triangles
Arrangement #2



Material, Coverage, and Cost

Material:

46 – Whole 12” Square Tiles; 22 - Partial 12” Square Tiles made from 11 whole tiles

103 – Whole 12” Triangle Tiles; 29 – Partial 12” Triangle Tiles made from 15 whole tiles

Total: $46 + 11 = 57$ - 12” Square Tiles and $103 + 15 = 118$ - 12” Triangle Tiles

Coverage:

Tiles: $57 * 144in^2 + 118 * 62.4in^2 = 15571in^2$

Room Area: $120in * 120in = 14400in^2$

Waste: $15571in^2 - 14400in^2 = 11171in^2$

Cost:

57 - 12” Square Tiles & 118 Triangle Tiles: $57tiles * \$32/tile + 118tiles * \$16/tile = \$3712$

Tiling Task Extension Benchmark

1. Using a combination of the shapes (at least two) and prices above, repeat the first task but this time use rooms that are not square or rectangular in shape, but instead they are a combination of polygons. Pick at least 2 shapes to tile the area. Show all calculations and sketches to explain your answers. To help with the explanation, list all of the questions you are asking, the answers you found, and any assumptions you made.

a) Determine the cost to cover the floor.

b) Determine the amount of waste (leftover unused tile).

Below are the images of the Excel spreadsheets used to do the calculations for each single tile:

room 1	area dim ft		area dim in		
	130		18720		
square					
	side (in)	Area	# Tiles	Price/Tile	Total Cost
	6	36	520.00	$4.63	$2,407.60
	12	144	130.00	$32.00	$4,160.00
rectangle					
width	length	Area	# Tiles	Price/Tile	Total Cost
3	6	18	1,040.00	$2.31	$2,402.40
4	8	32	585.00	$6.00	$3,510.00
	eq triangle				
	side	Area	# Tiles (rounded up)	Price/Tile	Total Cost
	6	31.18	601.00	1.59	955.59
	12	124.71	151.00	3.80	573.80
	hexagon				
	side (in)	Area	# Tiles (rounded up)	Price/Tile	Total Cost
	4	83.14	226.00	$1.84	$415.84
	6	187.06	101.00	$6.93	$699.93

room 2	area dim ft		area dim in		
	107		15408		
square					
	side (in)	Area	# Tiles	Price/Tile	Total Cost
	6	36	428.00	$4.63	$1,981.64
	12	144	107.00	$32.00	$3,424.00
rectangle					
width	length	Area	# Tiles	Price/Tile	Total Cost
3	6	18	856.00	$2.31	$1,977.36
4	8	32	482.00	$6.00	$2,892.00
	eq triangle				
	side	Area	# Tiles (rounded up)	Price/Tile	Total Cost
	6	31.18	495.00	1.59	787.05
	12	124.71	124.00	3.80	471.20
	hexagon				
	side (in)	Area	# Tiles (rounded up)	Price/Tile	Total Cost
	4	83.14	186.00	$1.84	$342.24
	6	187.06	83.00	$6.93	$575.19

room 3	area dim ft		area dim in		
	198		28512		
square					
	side (in)	Area	# Tiles	Price/Tile	Total Cost
	6	36	792.00	$4.63	$3,666.96
	12	144	198.00	$32.00	$6,336.00
rectangle					
width	length	Area	# Tiles	Price/Tile	Total Cost
3	6	18	1,584.00	$2.31	$3,659.04
4	8	32	891.00	$6.00	$5,346.00
	eq triangle				
	side	Area	# Tiles (rounded up)	Price/Tile	Total Cost
	6	31.18	915.00	1.59	1,454.85
	12	124.71	229.00	3.80	870.20
	hexagon				
	side (in)	Area	# Tiles (rounded up)	Price/Tile	Total Cost
	4	83.14	343.00	$1.84	$631.12
	6	187.06	153.00	$6.93	$1,060.29

room 4	area dim ft		area dim in		
	189		27216		
square					
	side (in)	Area	# Tiles	Price/Tile	Total Cost
	6	36	756.00	$4.63	$3,500.28
	12	144	189.00	$32.00	$6,048.00
rectangle					
width	length	Area	# Tiles	Price/Tile	Total Cost
3	6	18	1,512.00	$2.31	$3,492.72
4	8	32	851.00	$6.00	$5,106.00
	eq triangle				
	side	Area	# Tiles (rounded up)	Price/Tile	Total Cost
	6	31.18	873.00	1.59	1,388.07
	12	124.71	219.00	3.80	832.20
	hexagon				
	side (in)	Area	# Tiles (rounded up)	Price/Tile	Total Cost
	4	83.14	328.00	$1.84	$603.52
	6	187.06	146.00	$6.93	$1,011.78

Exit Slip
Benchmark

You obtain a summer job helping to remodel a home. You are given the task of laying new floors. List at least three things you must take into account before ordering the materials. Explain why each of these is important.

1. You need to think about which tile shapes will tessellate (and be pleasing to the eye). If you choose ones that do not tessellate, you will have gaps between tiles.

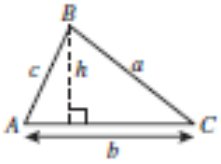
2. You need to find the area of the room you want to tile. This will allow you to determine how many tiles you will need to cover the floor.

3. You need to take into account the cost. If you are working under a certain budget, the number of tiles multiplied by the cost of each tile must be less than or equal to the amount you have to spend.

Resources

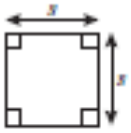
Geometry Formula Sheet
2009 *Mathematics Standards of Learning*

Geometric Formulas



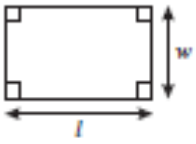
$A = \frac{1}{2}bh$

$A = \frac{1}{2}ab \sin C$



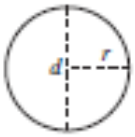
$p = 4s$

$A = s^2$



$p = 2l + 2w$

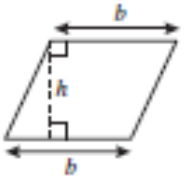
$A = lw$



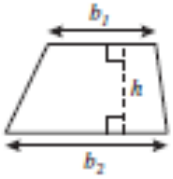
$C = 2\pi r$

$C = \pi d$

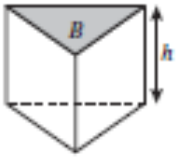
$A = \pi r^2$



$A = bh$



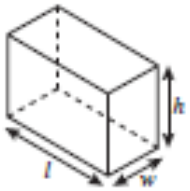
$A = \frac{1}{2}h(b_1 + b_2)$



$V = Bh$

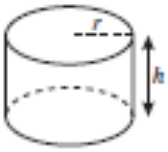
$L.A. = hp$

$S.A. = hp + 2B$



$V = lwh$

$S.A. = 2lw + 2lh + 2wh$



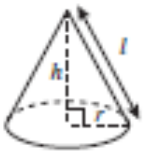
$V = \pi r^2 h$

$L.A. = 2\pi rh$

$S.A. = 2\pi r^2 + 2\pi rh$

$V = \frac{4}{3}\pi r^3$

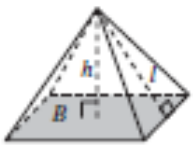
$S.A. = 4\pi r^2$



$V = \frac{1}{3}\pi r^2 h$

$L.A. = \pi rl$

$S.A. = \pi r^2 + \pi rl$



$V = \frac{1}{3}Bh$

$L.A. = \frac{1}{2}lp$

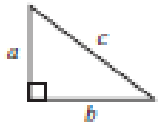
$S.A. = \frac{1}{2}lp + B$

Abbreviations

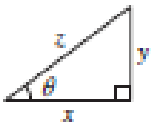
Area	A
Area of Base	B
Circumference	C
Lateral Area	$L.A.$
Perimeter	p
Surface Area	$S.A.$
Volume	V

Geometry Formula Sheet
2009 *Mathematics Standards of Learning*

Geometric Formulas



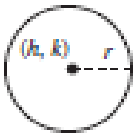
$a^2 + b^2 = c^2$



$\text{Sin}\,\theta = \frac{y}{z}$

$\text{Cos}\,\theta = \frac{x}{z}$

$\text{Tan}\,\theta = \frac{y}{x}$



$(x-h)^2 + (y-k)^2 = r^2$

Pi

$\pi \approx 3.14$

$\pi \approx \frac{22}{7}$

Quadratic Formula:

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}, \text{ where } ax^2 + bx + c = 0 \text{ and } a \neq 0$$

Geometric Symbols

Example	Meaning
$m\angle A$	measure of angle A
AB	length of line segment AB
$\overrightarrow{AB}$	ray AB
	right angle
$\overline{AB} \parallel \overline{CD}$	Line AB is parallel to line CD.
$\overline{AB} \perp \overline{CD}$	Line segment AB is perpendicular to line segment CD.
$\angle A \cong \angle B$	Angle A is congruent to angle B.
$\triangle ABC \sim \triangle DEF$	Triangle ABC is similar to triangle DEF.
	Similarly marked segments are congruent.
	Similarly marked angles are congruent.