Performance Based Learning and Assessment Task

Activity/Task Title

I. ASSESSMENT TASK OVERVIEW & PURPOSE:
Students will apply their geometric knowledge of circles, polygons, area and surface area to create a miniature golf course hole.

II. UNIT AUTHOR:
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III. COURSE:
Geometry

IV. CONTENT STRAND:
- **Polygons and Circles**
- **Triangles**
- **Three Dimensional Figures**

V. OBJECTIVES:
The learner will be able to use their knowledge of circles, polygons, area, surface area and measurement to:
- **Design a "putt-putt" golf course hole using geometric shapes**
- **Create a scale drawing of their design**
- **Create a 3-D scale model of their design**
- **Calculate the cost of materials needed to build the hole**
- **Calculate the area that will need to be covered in artificial grass.**

VI. REFERENCE/RESOURCE MATERIALS:
- **Internet resources**
- **Geometry Textbook**
- **Calculator, compass, graph paper, ruler**

VII. PRIMARY ASSESSMENT STRATEGIES:
Students will be assessed on the following:
- Accuracy of scale drawing and use of geometric figures in drawing
- Calculations for area and surface area is shown accurately and completely
- Presentation to class is clear and understandable with correct geometric terminology

VIII. EVALUATION CRITERIA:

- **Scaled drawing rubric (35%)**
- **Scaled model rubric (35%)**
- **Presentation rubric (30%)**

IX. INSTRUCTIONAL TIME:

- **Two to three ninety minute class periods**
- **Or five to six 50 minute class periods**

"Putt-Putt" For The Geometry of It!

Geometry Strand

- Polygons and Circles
- Triangles
- Three Dimensional Figures

Mathematical Goals and Objective(s)

The learner will be able to:

- Accurately measure dimensions
- Convert measurements using scale factor
- Create an accurate scaled drawing
- Apply knowledge of circles, polygons, scale factor, area, and surface area

Related SOL

- G.8 (The student will solve real-world problems involving triangles by using the Pythagorean Theorem and its converse, properties of special right triangles, and right angle trigonometry.)
- G.9 (The student will verify characteristics of quadrilaterals and use properties of quadrilaterals to solve real-world problems.)
- G.11 (The student will use angles, arcs, chords, tangents, and secants to a) investigate, verify, and apply properties of circles; b) solve real-world problems involving properties of circles; and c) find arc lengths and areas of sectors in circles.)
- G.13 (The student will use the formulas for surface area and volume of three-dimensional objects to solve real-world problems)
- G14 (The student will use similar geometric objects in two- or three-dimensions to a) compare ratios between side lengths, perimeters, areas, and volumes; b) determine how changes in one or more dimensions of an object affect area and/or volume of the object; c) determine how changes in area and/or volume of an object affect one or more dimensions of the object; and d) solve real-world problems about similar geometric objects)

Additional Objectives for Student Learning

The student will learn through investigation about the angle of incidence and reflection by bouncing the golf ball off of various barriers.

Physics SOL:

- PH.4 (The student will investigate and understand how applications of physics affect the world.)

NCTM Standards

- use, with increasing confidence, problem-solving approaches to investigate and understand mathematical content
- apply integrated mathematical problem-solving strategies to solve problems from within and outside mathematics
- recognize and formulate problems from situations within and outside mathematics
- apply the process of mathematical modeling to real-world problem situations
- understand and use ratios and proportions to represent quantitative relationships
- use trigonometric relationships to determine lengths and angle measures
- make decisions about units and scales that are appropriate for problem situations involving measurement
- understand, select, and use units of appropriate size and type to measure angles, perimeter, area, surface area, and volume
- represent problem situations with geometric models and apply properties of figures
- classify figures in terms of congruence and similarity and apply these relationships
- understand relations and functions and select, convert flexibly among, and use various representations for them
- apply and adapt a variety of appropriate strategies to solve problems
- communicate mathematical thinking coherently and clearly to peers, teachers, and others

Materials/Resources

- VDOE Geometry formula sheet
- Geometry Textbook
- Calculator
- Graph paper
- Internet
- Straight edge, compass, lumber, cardboard, fabric, hot glue guns, scissors, paint, and other materials for the model that students may come up with.
- Golf ball or Table Tennis ball

Assumption of Prior Knowledge

- Students should have prior knowledge of fractions and proportions
- Students should have prior knowledge of geometric shapes, how to use geometric formulas for area, perimeter, volume and surface area. They should also have prior knowledge of using a scale and creating a scale drawing.
- A typical student should be operating at a high level to succeed with this task.
- Students may find creating the scale drawing more difficult than building the actual "putt-putt" hole. Measuring and creating the scale may be a challenge.

Introduction: Setting Up the Mathematical Task

How many of you have ever played "putt-putt" golf? The City Manager is thinking about building a miniature golf course in one of the public parks. He is asking for a design of the new miniature golf course. His vision is to have a miniature golf course that includes various geometric shapes. The City Manager wants to get the residents' input about the golf course. He is asking that groups of residents design one hole each for the golf course and submit it to his office. He is also asking the designers to develop a name for the new golf course. At the May City Council meeting, the designs of each hole will be presented to the City Council for approval. The creators of the design that are chosen will have their name placed on a plaque at the entrance to the miniature golf course.

In this task, you are one group of city residents. You will design one hole for the new miniature golf course. Your "putt-putt" hole must be between 90 to 120 square feet at full scale. You must include at least five geometrical shapes in your design from at least three different categories.

Category 1- Triangles

Category 2- Circles

Category 3- Quadrilaterals

Category 4- Regular Polygons with more than 4 sides.

Category 5- Solids

For the first part of the project, your group will design a scale drawing of a "putt-putt" golf course hole. In addition to the model, you must include your scale, a list of materials needed to complete the construction, and an estimated building cost (for the full size construction). You will show all accurate calculations used in creating your scale and estimating the cost. While the course should be challenging, you should be able to demonstrate to the class how one might be able to make a hole in one. Class time allotted: (90 minutes)

For the second part of this project, you will build a scale model of the "putt-putt" hole. This model can be built using cardboard, foam board, and other materials you find. It should be at least one meter in length. Be creative and think about real world objects that you can use. This might include Pringles cans, Basketballs, wrapping paper tubes, etc. Make sure your model is aesthetically pleasing. Take the time to decorate it and make it look like a fun place to play. You may use a plastic cup for the ball to land. Use books to elevate your model so the cup will have room below the surface. Class time allotted: (120 minutes)

Finally, your group will present the model and design to the class. Class time allotted: (60 minutes)

There will be analysis questions that you will answer at the end of the project. These are to help you summarize how you created your "putt-putt" golf course hole. It also will require that you apply other mathematical or geometrical concepts to the design of your course.

(As an extension of this project for differentiated learning , you can have students build a life size replica of the golf course hole)

Student Exploration

Small Group Work

- Students will work in groups of 2 or 3 to design their scale model plan of their golf course hole.
- Students will also calculate the area of their design and figure out the estimated constructional cost of the hole.
- The small group work for this task will be to decide which design to make a scale drawing and constructed "putt-putt" hole groups will then answer the analysis questions at the end.

Whole Class Sharing/Discussion

- As an introduction to the lesson, the teacher will show a video on what a "putt-putt" golf course looks like and how to make a hole in one. Some Youtube videos of "putt-putt" courses are www.youtube.com/watch?v=KLz4syGdoaU, (begin at 1:18)
- Each group will present their scale drawing to the class. The students will present the reasons why they have selected their design and the estimated cost of the project.
- The class will then vote on which holes should be used in the golf course.
- As an alternative to each group building a model the instructor could have each group present their scaled drawing to the class. The class could then vote on which holes they will construct.

Student/Teacher Actions:

- Students will research possible designs for their "putt-putt" golf course hole. This will include measurements, materials needed. Drawings should be done in pencil only. They are to include a scale and how it was created.

- Students will determine the construction cost of materials with a projected total building cost. Students will need to determine the surface area of their hole in order to calculate the amount of material needed for the project. Students can go to the following websites to research the prices of construction costs. (www.lowes.com/Building-Supplies, www.homedepot.com) Students can also visit their local hardware store to find prices of materials. Students will need to calculate the measurement of each geometric shape and the length and width of their hole. They will then need to find the area of the entire hole and subtract the area that is not to be covered with the artificial turf.

- The teacher will present the task and outline all requirements. The teacher will present examples of possible scale drawings with calculations of estimated costs. They will assist in any mathematical or geometrical calculations. They will provide deadlines for individual parts of the task.

- The teacher will present the task and outline all requirements. They will assist in any mathematical or geometrical calculations. They will provide deadlines for individual parts of the task (i.e. model, construction cost with list of materials, rough draft for presentation, and summary questions at the

end). The instructor will also assist with guiding the students in the construction of the models (how to use a glue gun, cutting difficult material, safety concerns, etc.)

- To help students with calculating construction costs, the teacher may provide the following table to help students figure actual construction costs: These costs come from the www.lowes.com website.

Material	Amount Needed	Cost per unit	Total Cost
Artificial Turf	_____sq ft	.78/sq ft	$
2 x 10 x 16 pressure treated lumber	_____# of pieces	20.57	$
2 x 4 x 12 pressure treated lumber	_____# of pieces	6.37	$
Decking screws	_____ lb box	31.48	$
Construction Adhesive	_____tubes	2.48	$
TOTAL COST			$

Monitoring Student Responses

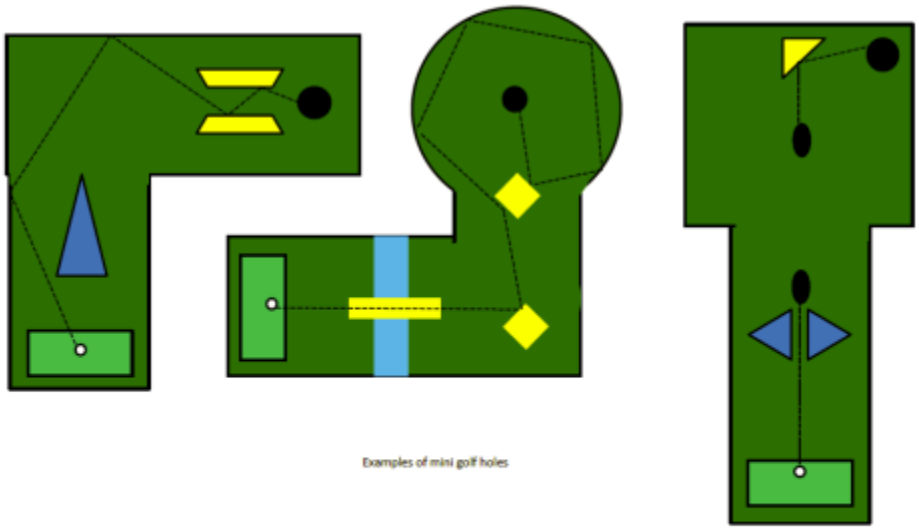
- Students should be able to communicate effectively in small groups to overcome challenges. The teacher should not intervene unless it is apparent that a specific strategy or idea is extremely unrealistic and time consuming. The teacher should be prepared to give hints on ideas and strategies, but the majority of the problems or ideas should be largely student generated.

- After each group presents their design and model, questions will be allowed from their peers. After all questions from students have been answered, the teacher will guide a small discussion highlighting the positives from that groups' work as well as any difficulties that might make their design impractical with real world (i.e. Did the group incorporate all the requirements for their hole? Did they use the required number of geometric shapes? Did they use the correct formula for finding the surface area of their hole?, Would this hole be practical on a "putt-putt" golf course?, etc)

- If a particular group has moved at a faster than expected pace, an extension might be to create the hole multipurpose. For instance, the teacher could ask "Where is an alternative place for the cup to go on this hole that would be more challenging to play?

Assessment List and Benchmarks

- Self-Assessment Rubric for scaled model and drawing
- Self-Assessment rubric for materials and building cost
- All calculations clearly shown for scale, converting measurements to scale, and building costs
- Final summary and extension questions
- Teacher's grading rubric for scale drawing and calculation of estimated costs



Examples of mini golf holes

Student Self-Assessment Rubric for scaled model or drawing

Scale Model Rubric Name _____

Criteria	4	3	2	1	Score
Use of Scale Factor	Scale factor used correctly for all calculations.	Scale factor used correctly for most of the calculations.	Scale factor used correctly for some of the calculations.	Scale factor not used.	
Mathematical Calculations	All calculations are accurate, work is shown and answers provided.	Most calculations are accurate, work is shown and answers provided.	Some calculations are accurate, work is shown and answers provided.	No calculations are accurate, work is not shown and/or answers are not provided.	
Model built to scale	All measurements in the scale drawing match the calculated measurements.	Most measurements in the scale drawing match the calculated measurements.	Some measurements in the scale drawing match the calculated measurements.	No measurements in the scale drawing match the calculated measurements.	
Quality of work	Creative, neat and well laid out model. While not full scale, the ball is able to roll around fall in hole. Model is at least 1 meter in length and is a similar shape to the scaled drawing.	Well-built and effort is evident. However, one of the criteria for the build is missing.	Effort is there, however, two of the criteria for the build is missing.	Effort is questionable and multiple criteria is missing.	
Aesthetics and creativity	Creativity was demonstrated by the use of real world objects in the build. In addition to the selection of materials, effort and pride in the project were shown in the decoration of the model.	Model lacks a real world object, but was still decorated creatively.	Model lacks decoration but includes a real world object.	Neither a real world object nor decoration was used in the model.	

TOTAL SCORE(Out of 20) _____

Presentation Rubric **Names _____**

Criteria	4	3	2	1	Score
Attention to Audience	**Engaged audience and held their attention throughout with creative articulation, enthusiasm, and clearly focused presentation**	**Engaged audience and held their attention most of the time by remaining on topic and presenting with enthusiasm**	**Little attempt to engage audience**	**Did not attempt to engage audience**	
Math Content	**Connections to geometry were thoroughly clear and accurate. Many relevant points made**	**Connections to geometry were clear and accurate**	**Connections to geometry were somewhat unclear and inaccurate**	**Connections to geometry were unclear and inaccurate**	
Creativity	**Exceptional originality of presented material and interpretation**	**Some apparent originality displayed through use of original interpretation of presented materials**	**Material presented with little interpretation or originality**	**Delivery is repetitive with little or no variety in presentation**	
Function and Use of Visual Aide	**Excellent visual aide highlighting topic presented**	**Good visual aide related directly and appropriately to content**	**Some visual aspect of presentation but lacking in connection to content or not meaningful**	**No visual aide or limited use of one**	
Elocution	**Student uses a clear voice and correct precise pronunciation of terms so that all audience members can hear presentation**	**Student's voice is clear. Pronounces most words correctly. Most audience members can hear presentation.**	**Student's voice is low. Incorrectly pronounces terms. Audience members have difficulty hearing presentation.**	**Student mumbles, incorrectly pronounces terms, and speaks too quietly for majority of audience to hear presentation.**	

Student Names _____ **Presentation Grade** _____

Topic (Description of "Putt-Putt" Golf Course Hole) _____

Analysis, Reflection, and Extension

1. What were the most challenging aspects of this project for you and why?

_____

_____

_____

_____

2. What skills did this project help you develop?

_____

_____

_____

_____

3 If you did this project again, what might you do differently and why?

_____

_____

_____

_____

4. Describe or illustrate with a drawing two paths in which you could get a hole in one on your putt putt golf course hole? (Be sure to provide details…illustration with calculations.)

_____

_____

_____

_____

Teacher's grading rubric for scale drawing and calculation of estimated costs

Group members: _____

Activity	4	3	2	1	Score
Use of 3 geometric figures	Use 3 figures	Used only 2 figures	Used only 1 figure	No geometric figures	
Scale factor	Drawn to scale, No errors	Drawn to scale, minor errors	Not drawn to scale Minor errors in scale	Not drawn to scale Major errors in scale	
Mathematical calculations	Surface Area, constructional costs mathematically correct	Surface Area, constructional costs mathematically correct with few errors	Surface Area, constructional costs mathematically correct with some errors	Surface Area, constructional costs mathematically incorrect	
Creativity of drawing	Design was innovative and creative and complex	Design was innovative and creative with some complexity	Design was innovative and creative and simple	Design was simple with no imagination used	
Neatness of drawing	Used pencil, clear and precise drawing	Used pencil, clear drawing with some erasures	Used pencil, drawing is not clear	Did not use pencil, drawing is unrecognizable	
Power point or visual of key points of presentation	Presentation was exciting, presented all aspects of project, power point was colorful and no errors Used correct mathematical terminology	Presentation engaged audience presented all aspects of project, power point was colorful and had a few errors Used correct mathematical terminology	Presentation bored audience presented all aspects of project, power point was colorful and had a few errors Used correct mathematical terminology	Presentation lacked excitement, audience was not engaged, not colorful and had many errors Did not use correct mathematical terminology	

Scale Drawing and Presentation Score _____

1. Strengths of group scale design and model

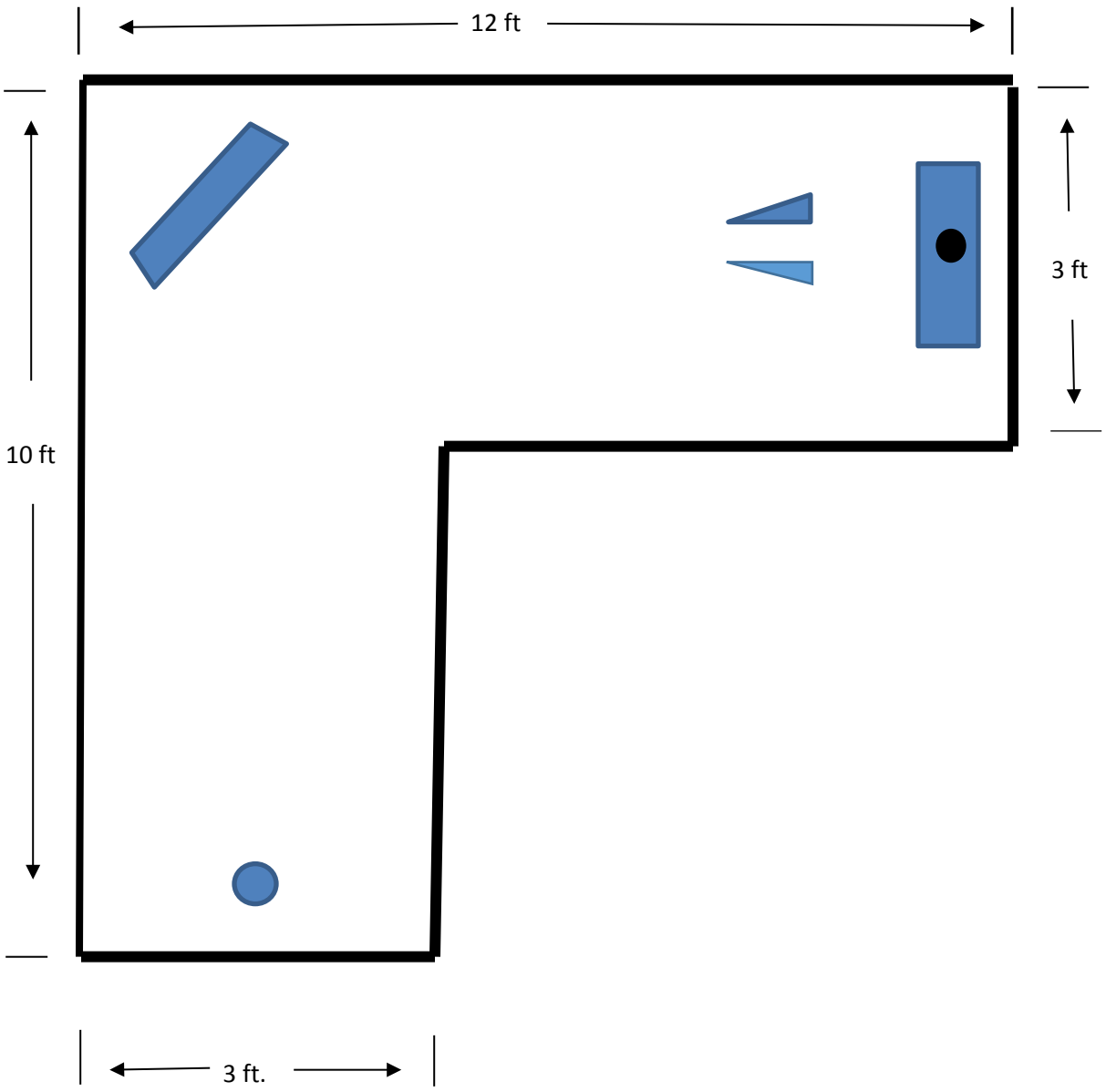
2. Areas of growth of group scale design and model

3. Strengths of groups mathematical understanding of geometric concepts

4. Areas of growth of groups mathematical understanding of geometric concepts

5. Creativity of the Presentation

Example 1 of Scale Drawing



Construction Costs

Perimeter = 44 ft

Area = 57 sq/ft

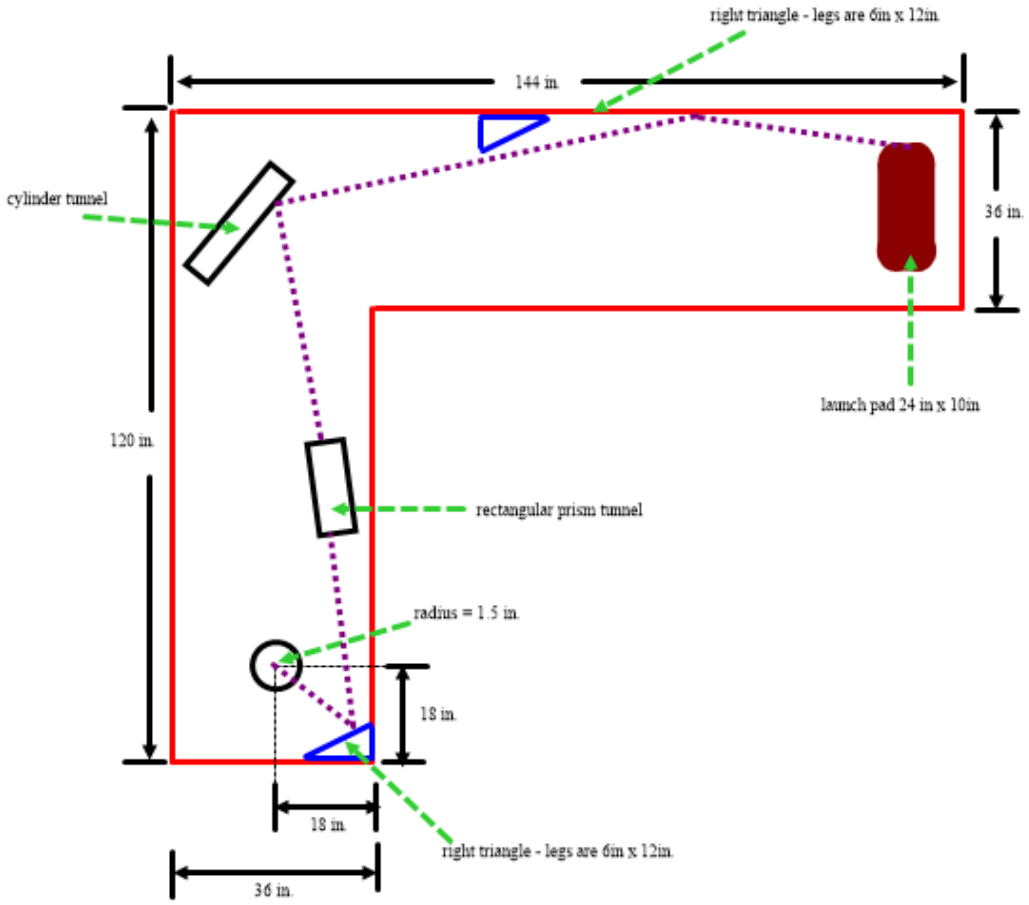
Perimeter calculations: 3ft. + 10 ft. + 12 ft. + 3 ft. + 9 ft. + 7 ft. = 44 ft.

Area Calculations: Area was calculated by dividing the course into two rectangles. One rectangle was 3 ft. by 10 ft. which gave an area of 30 sq/ft and the other was 9 ft. by 3 ft. which gave an area of 27 ft. This gave a total of 57 sq/ft.

All construction costs were calculated from: http://www.lowes.com/

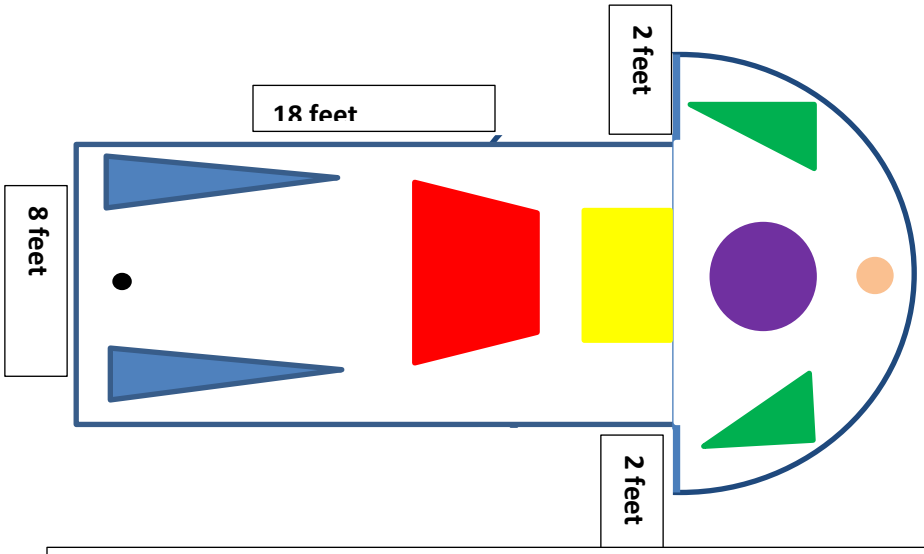
Material	Amount Needed	Cost per unit	Total Cost
Artificial Turf	57 sq ft	.78/sq ft	$44.46
2 x 10 x 16 pressure treated lumber	3	20.57	$61.71
2 x 4 x 12 pressure treated lumber	5	6.37	$31.85
Decking screws	5 lb box	31.48	$31.38
Construction Adhesive	3 tubes	2.48	$7.44
TOTAL COST			$176.84

Using the above scale model, students can create a 3 dimensional scale model of the “putt-putt” hole.



Video link for putt putt project: https://youtu.be/NIbfNfO13SY

Example 2 of Scale Drawing



The main portion of the "putt-putt" golf hole is made up of a rectangle and a semi-circle. The surface area of the main shape is:

Rectangle = (length)(width) = (18 feet)(8 feet) = 144 ft ^{2}

The Semi-circle = $\frac{1}{2}(\pi)(\text{radius})^2 = \frac{1}{2}(\pi)(6)^2$ = 56.55 ft^2

Total area of both main shapes is 200.55 ft^2

Since there are 7 geometric shapes inside the "putt-putt" hole, we will need to subtract the area of each shape from the total area. The geometric shapes have the following area:

Two blue equilateral triangles = $2(\frac{1}{2})$ (base)(height) = $2(\frac{1}{2})$ (3 ft)(8 feet) = 24 ft^2

Red Trapezoid = $(\frac{1}{2})$ (base_1 + base_2)(height) = $(\frac{1}{2})$ (6 feet + 4 feet)(3 feet) = 15 ft^2

Yellow Rectangle = (length)(width) = (4 feet)(3 feet) = 12 ft^2

Purple Circle = $\pi(radius)^2 = \pi(2\ feet)^2$ = 12.57 ft^2

2 Green Right Triangles = $2(\frac{1}{2})$ (base)(height) = $2(\frac{1}{2})$ (2 feet)(4 feet) = 8 ft^2

Total surface area of the geometric shapes = 71.57 ft^2

We need to take the surface area of the two main shapes and subtract the surface area of the geometric shapes in order to get the total surface area. Therefore the total surface area will be 128.98 ft^2

The perimeter of the main "putt-putt" hole is found by finding the perimeter of the rectangle and the perimeter or circumference of the semi-circle. The perimeter of the rectangle is found by adding up the three exterior sides of the rectangle. Therefore the three exterior sides are 8 feet + 18 feet + 18 feet = 44 feet. The semi-circle has a circumference of $\frac{1}{2}(2\pi)$(radius) = 18.84 feet. We also need to remember that there are two exterior sides of the semi-circle that are 2 feet in length. Therefore the total perimeter of the "putt-putt" hole is 44 feet + 18.84 feet + 4 feet = 66.85 feet.

Construction Costs: Using the Lowes.com website

Material	Amount Needed	Cost per unit	Total Cost
Artificial Turf	72 sq ft	.78/sq ft	$56.16
2 x 10 x 16 pressure treated lumber	2	20.57	$41.14
2 x 4 x 12 pressure treated lumber	6	6.37	$38.22
Decking screws	5 lb box	31.48	$31.38
Construction Adhesive	3 tubes	2.48	$7.44
TOTAL COST			$174.34