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GEOMETRY LESSON
When Will I Ever Use It? Putt-Putt Golf

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Overview

Concepts: Geometry, Shapes in two- and three-dimensions, Lines, Angles, Mathematical Reasoning, Communication

Skills: Identify the properties of three dimensional interaction, scale, and design for life-sized putt-putt golf.

Vocabulary: *3-D net* (flattened model that, when folded, creates a three dimensional shape); *cube, pentagonal, pyramid, face, vertex, vertices.*

Grade Level(s): 9, 10, 11, 12.

Duration/Length: 150 to 200 minutes (e.g., three to four 50-minute periods).

Prior Knowledge: measuring using a ruler and protractor, scaling measurements, attributes of line segments and shapes on flat and non-flat surfaces in 2 and 3-dimensions.

California Common Core State Standards:
CCSS.MATH.CONTENT.HSG.MG.A.1: Using geometric shapes, measures, and properties to describe objects.
CCSS.MATH.CONTENT.HSG.MG.A.3: Applying geometric methods to solve design problems.

Materials: Cardboard, tape, scissors, safety compasses, rulers, printer paper, golf balls, putting sticks, cups, markers, printouts of nets for 3-D shapes.

Preparation: Pre-cut pieces of cardboard in order to model assembling a putting hole. At least one pre-made putting hole to demonstrate how the golf course will work.

Background: The real world is math. Often times, mathematics transpires in places we do not consider and can take for granted. Looking back, many people can recall memories of attending an amusement park. Playing putt-putt or miniature golf is a focal point of such a venue. Why? Because it is fun! It is challenging! There is an attraction of striking a ball through a miniature obstacle course that entices people to play. However, does anyone ever think of the work behind creating such an alluring obstacle course? What kind of design and engineering goes into building these collections of blockades and barriers? Think about all the geometry that might be used in creating a putting hole. First and foremost, angles come to mind. The more challenging putting holes are typically accompanied by angles, which range from acute to obtuse. In addition to these angles, putting holes are complemented by lines. The lines serve the purpose of guiding the ball in the desired path. Next, we begin to think

about the bumpers: those treacherous and conniving bumpers that are implemented only to obstruct our passageways to success. Bumpers come in all shapes and forms. So, what three-dimensional shapes can someone put into their golf course to make it more appealing? Upon gathering our thoughts, we begin to recognize the mathematical principles that surround a common activity such as putt-putt. Through remembrance, understanding, analysis, and creation we will be able to construct a golf course?a golf course brought about by math into the real world.

Description

This project should take place after the students have knowledge of the different types of lines, angles, and three-dimensional shapes along with all of their properties. This project is intended to serve as a class project that encompasses all of their knowledge together.

Teacher Activities	**Student Activities**
Step 1 (10 – 15 minutes) Launch. To begin, the teacher displays examples to the students ranging from basic courses to elaborate constructions. The purpose is to show the students what they will create by the end of the lesson	The students observe the examples and begin to brainstorm their ideas. They should get an idea of what they like from the examples and think of ways that they can personalize their own putting hole.
Step 2 (8 – 10 minutes) Hands-on with a model. The teacher exhibits a model of a putting-hole for class interaction. This serves as a hook to get the students engaged in the lesson by sparking their interest in the project.	The students interact with the putting-hole model(s) and analyze construction. This way, the students get a first-hand experience of how their own putting hole might need to function. In addition, students observe how many attempts it takes them to score. So, they will be able to assess some of the challenges that occur and build on the experience.
Step 3 (15 minutes) Guidelines and materials. The teacher gives students the requirements for their putting holes. Each putting hole model must: (1) incorporate a minimum of 4 different shapes, (2) use at least one pair of lines (parallel, perpendicular, intersecting). The teacher hands out the printouts of the nets to the students (see page 40). These nets will serve as outlines so that students can create their shapes out of cardboard. As such, the students will have an opportunity to see the different shapes that they can make so that they can decide on what works best for their own putting hole.	After seeing requirements for the project, students are placed in groups of 3 to 4. Each group creates a "blueprint" of their contribution to the putt-putt golf course. They brainstorm the construction of their putting holes, implement their desired level of creativity, and display to the teacher that they have met all necessary requirements before construction begins. Supply groups with printer paper, rulers, and safety compasses to create their single putting hole blueprint. Each group finishes their design blueprint and shows to the teacher before starting to build the actual putt-putt hole. This will ensure that the students are on the right path.
Step 4 (90 – 120 minutes) Construction. Students work with their groups to create parts and assemble the putting holes. The teacher will supply the students with cardboard, scissors, tape, rulers, safety compasses, and cups. The students should be supplied with a long piece of cardboard to serve as the base of their putting hole. This will make their putting hole moveable and they will be able to use it on any surface such as grass, dirt, or cement. Supply students with additional cardboard to create three-dimensional shapes and any walls or bumpers that they may want to include. Also, it is important to note that the cups are intended to	Groups should troubleshoot their putting holes along the way so that they can find any imperfections that need to be fixed and make any necessary modifications. The cup must be positioned so that it allows players to remove the ball after they have scored. The teacher will have a few golf balls and putting sticks available for the students to test their work. The teacher will provide the students with assistance if needed.

serve as the target of putting but are not limited to the one requirement (e.g., a cup on its side may serve as a bumper if the ball comes from one direction but as the hole if the ball comes from another direction).	
Step 5 (30 – 40 minutes) The whole course. The class assembles all of the holes together to create a large course that includes everyone's putting holes. Pairs of students play through the course (pairs start two holes apart). Let students know about the assignment (see below) so they can make notes on easiest, most challenging, and most creative putting holes as they play. The students should be supplied with their own putting stick and golf ball (if possible).	At the end of the lesson, after interacting with all the putting holes, the students will write a short paper (see below). For doing this, the students will have to go to each hole, analyze it, and remark on each other's constructions.

Assignment/Reflection Paper: Each student writes an analysis describing which hole seemed easiest and why, which seemed hardest and why, and which seemed most creative and in what way. They must refer to data collected during Step 5 but may also include other experience. The purpose of the reflection is for students to draw conclusions and support their claims through cited evidence.

Extension: Depending on the grade level, the sheer number of requirements will vary. For example, 12th grade students will have to complete more requirements in order to make their golf courses more elaborate and rigorous whereas 9th grade students will have to implement the basic requirements. Furthermore, the teacher may require the students to calculate the volume of their three-dimensional shapes to optimize the space of their golf course. Another suggestion is to have the students calculate the average amount of tries to complete the hole. This can extend to a statistical approach as well. Depending on the amount of empirical evidence collected in Step 5, the students may be able to calculate the odds of making a hole-in-one.

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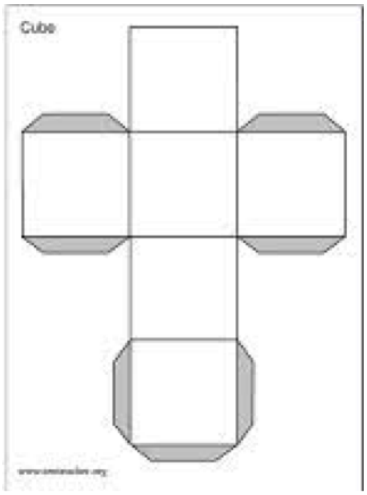
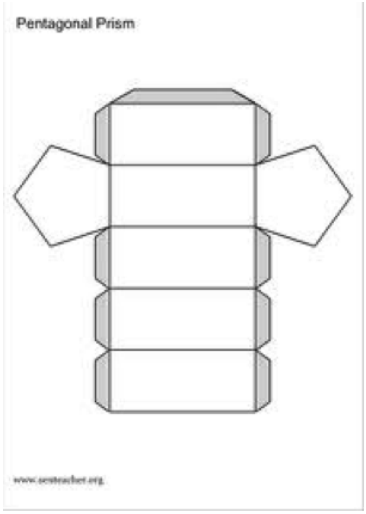
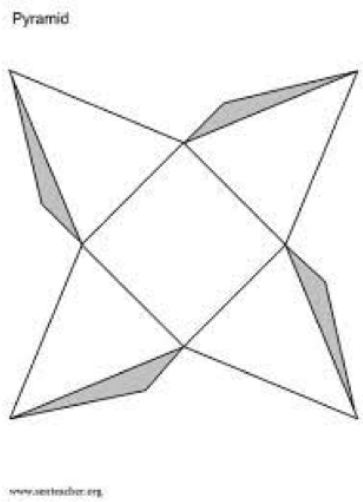
Sample Nets for Putt-Putt Golf Hole Shapes







Two More Examples

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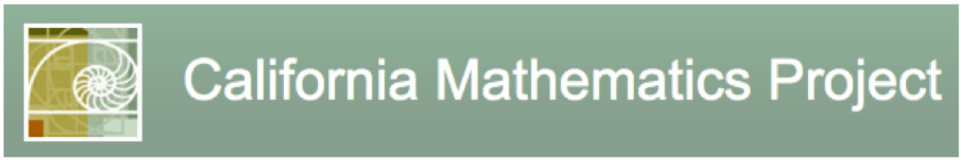
California State University, Stanislaus

One University Circle

Turlock, CA 95382



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