# Project-Based Learning

## Hole in One

**High School**

**Geometry**

UT DALLAS
The University of Texas at Dallas

# Hole in One

## High School

## Geometry

### Overview

A miniature golf course company is hiring interns for the season based upon the best design of an individual hole within an 18-hole course.
Students will explore transformations and geometric relationships by engaging in constructions.
Students will demonstrate their understanding by communicating accountable content through a design of a mini golf hole.

### Guiding Questions

How do you explain a figure transformation?
How do you complete a figure transformation?
What geometric patterns are evident in the patterns of parallel lines cut by a transversal, criteria for triangle congruence, special segments of triangles, diagonals of quadrilaterals, and interior and exterior angles?
What geometric relationships can be explained using congruent segments, congruent angles, angle bisectors, and perpendicular bisectors?
How do you demonstrate that a conjecture is false?

## Table of Contents

# PBL Project Guide

## Timeframe

This project will take approximately fourteen 50-minute class periods.

## Step-by-Step Overview

- Introduce Launch Video.
- Introduce Entry Document.
- Facilitate Know/Need to Know activity.
- Students engage in an exploration activity.
- Groups brainstorm initial design products and assign roles/responsibilities.
- Groups alternate between facilitated content experiences and design time.
- During design time, groups integrate new content into design and re-evaluate product(s).
- Groups finalize product(s) and presentation.
- Groups present according to project guidelines.
- Content Debrief.
- Summative Assessment.

# PBL Resources

## Project Resources

- Launch Video: https://youtu.be/_oQAjtXz-Vc
- Entry Document text
- Anticipated Knows/Need to Knows
- Strategies/considerations for implementation

## Resources to Assemble/Prepare

You will need to prepare the following resource(s) ahead of time:

- Format Entry Document to local context
- Select local businesses for marketing aspect of project and for presentation panel
- Verify access to technology links
- Sample authentic products similar to project expectations
- Select Launch Video
- Informational resources about geometric transformations and relationships

# Entry Event Guide

## Launch Video

Mini Masters - Crazy Golf: https://youtu.be/_oQAjtXz-Vc

Purpose: Engages students and introduces the topic of miniature golf. Use video to solicit student responses to the following question: *How do players work around the obstacles and features of miniature golf?* Post student responses.

## Entry Document

Format: *Call for Applications* from a miniature golf company. Edit document to include a miniature golf company of choice, a city name where it is located, and the upcoming season and year for the internship. Include logistics, such as submission dates and presentation requirements.

## Entry Event Guide *continued*

### Entry Document

[MINIATURE GOLF COMPANY LOGO]

[YEAR & SEASON] INTERNSHIPS: OPEN CALL FOR APPLICATIONS

[MINIATURE GOLF COMPANY] is seeking interns to join our team in the [CITY] branch of our company for this season. Candidates must demonstrate an interest in miniature golf and other related fields.

Ideal candidates have strong communication skills, mathematics skills, and an ability to challenge players in the game of mini golf.

Interested? In order to determine a candidate's love of the game and interest in our company, please prepare the application requirements below by [DUE DATE].

## Entry Event Guide *continued*

### Entry Document

**Application Requirements:**

Prepare a design and a theme for an individual hole for an 18-hole mini golf course

Include one scale drawing of the design with obstacles and features and its scale

Include one scale drawing for our engineers to approve

In this scale drawing, label the acute, obtuse, right, complementary, supplementary, congruent, adjacent, and vertical angles and linear pairs

In this scale drawing, construct a logical and geometrical path of a hole-in-one shot

Prepare a description of the incoming and outgoing angles of a given shot

Prepare a maximum 5-minute persuasive presentation for our team at the [CITY] location that showcases your design

**General Considerations:**

Please consider the fact that our golf course receives players of all abilities so the design of your individual hole should be winnable via a hole-in-one but not so easy that a single shot can land a golf ball in the hole. Make sure that a sequence of bounces off of straight walls is required to get the shot in one swing.

## What do we KNOW about the project?

### Content

- Application includes a design of a mini golf hole
- Application includes a general scale drawing with a scale
- Application includes a second scale drawing with individual angles and pairs denoted
- Second scale drawing has to show the path of a hole-in-one by means of logic and geometry
- Application includes a description of incoming and outgoing angles

### Product

- [MINIATURE GOLF COMPANY] has an open call for internship applicants
- Applications include a design and theme for a golf hole in a 18-hole course
- Design must be hard enough that a sequence of bounces is required to get a hole-in-one
- Design must be easy enough that a hole-in-one is an option
- Submissions are to be accompanied with a maximum 5-minute persuasive presentation with the purpose of showcasing the design
- Submissions and presentations are due on [DUE DATE]

Additional responses will vary

## What do we NEED to know about the project?

### Content

- What is a scale drawing and how do I create one?
- What are acute, obtuse, right, complementary, supplementary, congruent, adjacent, and vertical angles and linear pairs?
- How do these items relate to golf?
- How do you measure an angle?
- How do you use geometry to determine the path of a hole-in-one?
- How does a series of bounces allow for a hole-in-one to occur?
- What are incoming and outgoing angles?
- How do incoming and outgoing angles relate to golf?

### Product

- What are some examples of themes for mini golf?
- What applications can I use to create a scale drawing?
- What are examples of easy and hard miniature golf holes?
- What type of presentation can I prepare?

Additional responses will vary

## Additional Information

This PBL alternates content and design time so that students are consistently revising their products. This document is a framework for teachers to use. Teachers may manipulate it to fit the needs of their students and classroom. This is an example of how a teacher might organize this PBL to meet those needs.

Content Workshop #1 – Figure transformations
Design Time #1 (Individual) – Decide on theme and revise initial design of golf hole to include multiple options via transformations

Content Workshop #2 – Constructions of different angles and linear pairs
Design Time #2 (Individual) – Measure and identify angles in the multiple design options

Content Workshop #3 – Constructions of parallel lines cut by a transversal and other geometric figures
Design Time #3 (Individual) – Describe and model the hole-in-one shot

Content Workshop #4 – Constructions of angle bisectors and other geometric figures
Design Time #4 (Group) – Revise design to account for validity of geometrical and logical path of hole-in-one shot

Content Workshop #5 – Proving a conjecture is false
Design Time #4 (Group) – Determine a final design based on counterexample of unequal incoming and outgoing angles; finish deliverables

# Implementation Guide

## Websites

Ensuring Mathematical Success for All:

http://www.nctm.org/PtA/

Angle Information:

http://www.regentsprep.org/regents/math/geometry/gp5/langles.htm

HoodaMath Mini Golf:

http://www.hoodamath.com/mobile/games/minigolf.html

## Technology Resources

GeoGebra:

https://www.geogebra.org/

## Teaching Strategies/Considerations

Consider the guiding questions for the project when selecting content workshops. A combination of practice and hands-on activities should be included.

Have students develop an understanding of the basics of angles and measurement with a protractor before beginning.

Direct students to use paper for constructions and scale drawings until the revisions are minimal and a more polished solution is ready for conversion to a technology-based scale drawing.

Consider having students use math notebooks or journals to meet the project expectations of design process and to record the iterations of the design. Have them record notes from content workshops.

## Assessment/Presentation

### Final Group Product

- Mini golf hole design submission that meets requirements
- Maximum 5-minute persuasive presentation about the design

### Rubric

- Students will use the entry document as a real world rubric to meet expectations of the project.

### Individual

- Individual assignments as they pertain to each content workshop
- Journal entries documenting what the individual has contributed to the golf hole design
- Record of design process and revisions made over the course of design, assessed throughout the project
- Summative assessment

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# Project-Based Learning

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