Project-Based Learning

Roller Coaster Ride

High School

Algebra I

UT DALLAS
The University of Texas at Dallas

Roller Coaster Ride

High School

Algebra I

Overview

A local amusement park is requesting proposals for the theme and design of a new roller coaster.
Students will explore quadratic equations within a real world context.
Students will demonstrate their understanding by communicating accountable content through a submission of a design.

Guiding Questions

What is a quadratic function and how do you express it algebraically and graphically?

What are key attributes of a graphed quadratic function?

How do you transform a quadratic function, algebraically and graphically?

How do you write a quadratic function that fits given data reasonably?

How do you use a self-generated quadratic function from data provided to estimate solutions and make predictions?

What are domain and range and why are they important?

How does domain and range apply to a quadratic function?

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PBL Project Guide

Timeframe

This project will take approximately twelve 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.

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PBL Resources

Project Resources

- Launch Video: https://youtu.be/V-KEkQFuUKU

- 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 linear functions

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Entry Event Guide

Launch Video

Hilarious! Daredevil Grandma Rides Roller Coaster for the First Time: https://youtu.be/V-KEkQFuUKU

Purpose: Engages students and introduces the topic of roller coasters. Use video to solicit student responses to the following question: *What characteristics of the roller coaster ride likely caused the grandma to have such a good time?* Post student responses.

Entry Document

Format: *Call for Proposals* from an Amusement Park. Edit document to include a local amusement park name. Include logistics, such as submission dates and presentation requirements.

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Entry Event Guide *continued*

Entry Document

[AMUSEMENT PARK LOGO]
Request for Proposals (RFP)
[CURRENT DATE]

SOLICITING PUBLIC BODY:

[AMUSEMENT PARK NAME]

[AMUSEMENT PARK ADDRESS]

PURPOSE AND BACKGROUND:

[AMUSEMENT PARK] has seen a steady increase in attendance over the past five years. In order to accommodate the growing number of visitors, the park management team has purchased additional land and will be adding new rides in this area. One roller coaster will be added as the main feature of this area. The park management team, in an effort to garner public support of this new venture, is asking the public for submissions for the theme of this new area and the design of the roller coaster.

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Entry Event Guide *continued*

Entry Document

PROPOSAL REQUIREMENTS

The theme for the park must be aligned to the family-friendly environment of [AMUSEMENT PARK]. The design for a smooth roller coaster must include at least six hills (parabolic curves) of varying heights and widths. Boundaries for each hill (curve) must be specified. Please submit and present the theme and an electronic model of your smooth roller coaster design during a maximum 5-minute technology-based presentation on [DUE DATE].

Additional consideration will be given to especially creative designs that include more than hills.

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What do we KNOW about the project?

Content

- Roller coaster must be smooth

- Roller coaster must have at least six hills (parabolic curves)

- Hills must have varying heights and widths

- Boundaries for each hill (curve) must be specified

Product

- [AMUSEMENT PARK] is requesting proposals for roller coaster design

- Proposal includes a family-friendly theme and an electronic model of the roller coaster

- Submissions are to be accompanied with a 5-minute technology-based presentation about the roller coaster and theme

- Submissions and presentations are due on [DUE DATE]

Additional responses will vary

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What do we NEED to know about the project?

Content

- What does it mean for a roller coaster to be smooth?

- How do you make sure a hill is smooth?

- How do you design a roller coaster so that it has hills?

- What is a parabolic curve?

- How do you account for varying heights and widths?

- What is a boundary to a curve?

- How do you specify a boundary for a curve?

Product

- What is the criteria for a family-friendly theme?

- How do you create an electronic model for a roller coaster?

- What applications can you use to create a technology-based presentation?

Additional responses will vary

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Additional Information

Content

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 - Quadratic functions and parabolic curves
Design Time #1 (Individual) - Describe theme and begin initial design

Content Workshop #2 - Key attributes of a quadratic function
Design Time #2 (Individual) - Revise design by noting key attributes and modifying for reasonableness of roller coaster ride at an amusement park

Content Workshop #3 - Transforming a quadratic function
Design Time #3 (Individual) - Revise design by writing applicable functions for the different parabolic curves

Content Workshop #4 - Domain and range
Design Time #4 (Individual) - Revise design to include boundaries for each of the individual curves

Content Workshop #5 - Estimating and writing a graphed quadratic function
Design Time #5 (Group) - Determine a final roller coaster from each member's design and determine a piecewise function of all functions with domain and range noted; finish deliverables

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Implementation Guide

Websites

Ensuring Mathematical Success for All:

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

Desmos Calculator:

https://www.desmos.com/calculator

Quadratic Equations:

https://www.khanacademy.org/math/algebra/quadratics

Roller Coaster Ride Builder:

http://dep.disney.go.com/sodi_app/index.html?st=2

Visual Resources: Consider having images of different roller coasters posted in case students are not familiar.

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 linear functions before beginning their initial roller coaster design.

Students can complete the electronic model in whatever application they are comfortable using. Desmos calculator has been included above. It is user-friendly and has a help feature that shows how users how to restrict a function or add a slider for a value. This will allow students to make multiple revisions to their design in real time. Additionally, they can add multiple functions and sliders onto the same view.

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

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Assessment/Presentation

Final Group Product

- Roller coaster proposal submission that meets requirements

- Maximum 5-minute presentation about the theme and model of the roller coaster

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 roller coaster proposal

- Record of roller coaster design process and revisions made over the course of design, assessed throughout the project

- Summative assessment

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