PBL UNIT- Rollercoasters

Subjects: Math and Science

Grade Level: 7th

Projected Duration: 3 weeks (15 school days)

Overview and Purpose:

The purpose of this unit is to integrate Math and Science to create a fun, engaging, and educational unit that is based around a problem or project of designing a roller coaster for Dollywood. Here are the basics you should know:

* Students will work in groups and have assigned roles within the group, which means that each person is needed to complete the project!
* Students will keep track of their personal contributions to the group by completing an effort log each day
* There will be group grades and individual grades- These activities will be specified
* We will be covering a lot of Math and Science topics during this unit. Students will be expected to participate and attend class regularly
* The final grade for this unit is a model and presentation of that model to the class
* The groups will design a smaller model first on paper and then build a model
* You will have time each day at the end of class to work in your groups- this time needs to be used effectively

Topics to be Covered:

Here are the topics and standards that we will be covering in Math and Science, as well as our 21st Century Life skills, which all prepare us to succeed

**Common Core State Standards (CCSS) assessed:**
Source: [www.tncore.org](http://www.tncore.org)

**Math:**
 **CCSS.Math.Content.7.RP.A.1** Compute unit rates associated with ratios of fractions, including ratios of lengths, areas and other quantities measured in like or different units.
**CCSS.Math.Content.7.RP.A.2** Recognize and represent proportional relationships between quantities.
**CCSS.Math.Content.7.RP.A.3** Use proportional relationships to solve multistep ratio and percent problems
**CCSS.Math.Content.7.NS.A.3** Solve real-world and mathematical problems involving the four operations with rational numbers.
**CCSS.Math.Content.7.EE.B.3** Solve multi-step real-life and mathematical problems posed with positive and negative rational numbers in any form (whole numbers, fractions, and decimals), using tools strategically. Apply properties of operations to calculate with numbers in any form; convert between forms as appropriate; and assess the reasonableness of answers using mental computation and estimation strategies.
**CCSS.Math.Content.7.EE.B.4** Use variables to represent quantities in a real-world or mathematical problem, and construct simple equations and inequalities to solve problems by reasoning about the quantities.
**CCSS.Math.Content.7.G.A.1** Solve problems involving scale drawings of geometric figures, including computing actual lengths and areas from a scale drawing and reproducing a scale drawing at a different scale.
**CCSS.Math.Content.7.G.A.2** Draw (freehand, with ruler and protractor, and with technology) geometric shapes with given conditions. Focus on constructing triangles from three measures of angles or sides, noticing when the conditions determine a unique triangle, more than one triangle, or no triangle.
**CCSS.Math.Content.7.G.B.6** Solve real-world and mathematical problems involving area, volume and surface area of two- and three-dimensional objects composed of triangles, quadrilaterals, polygons, cubes, and right prisms.

**Science:**
 **GLE 0707.T/E.2** Know that the engineering design process involves an ongoing series of events that incorporate design constraints, model building, testing, evaluating, modifying, and retesting.  **SPI 0707.T/E.1** Identify the tools and procedures needed to test the design features of a prototype.  **SPI 0707.T/E.2 E**valuate a protocol to determine if the engineering design process was successfully applied.  **SPI 0707.11.1** Differentiate between the six simple machines.  **SPI 0707.11.2** Determine the amount of force needed to do work using different simple machines.  **SPI 0707.11.3** Apply proper equations to solve basic problems pertaining to distance, time, speed, and velocity.
**SPI 0707.11.4** Identify and explain how Newton’s laws of motion relate to the movement of objects.

**21 Century Skills Assessed/ Objectives for 21 century skills:**

1. **Learning and Innovation Skills**
a. Creativity and Innovation- students will be required to create a new and technologically improved rollercoaster design
b. Critical Thinking and Problem-Solving- students will have to apply the information learned about scientific and mathematical principles for their
designs
c.Communication and Collaboration- students will work in teams and be evaluated based on their productive communication and collaboration
2. **Life and Career Skills**
a. Flexibility and Adaptability- students will be required to work within deadlines and around events or changes in scheduling, as well as absences
b. Initiative and Self-direction- students will have to exert initiative and self direction to complete the project within the time constraints.
c. Social and Cross-Cultural Skills- students will work in diverse groups and be evaluated on their effective group work and conflict management
d. Productivity and Accountability- students will be required to set and meet goals while working in an effective group environment

Source: [www.p21.org](http://www.p21.org)

Objectives for this course:

Here are the lesson objectives that we will achieve throughout this lesson. Don’t be overwhelmed- we will cover all of these with plenty of time!

1. The Learner Will (THAT’S YOU!) TLW develop a model (both graphic and physical) of a new rollercoaster (SPI 0707.T/E.1; CCSS.Math.Content.7.G.A.1-2;)
2. TLW apply principles of mathematical and scientific principles to rollercoaster models (CCSS.Math.Content.7.EE.B.3-4; CCSS.Math.Content.7.RP.A.1-3; SPI 0707.11.1-4)
3. TLW explain and present the design to the class
4. TLW justify the size, distance, and speed modifications applied to the design
5. TLW idenitfy the simple machines utlized in the rollercoaster (SPI 0707.11.1)
6. TLW label the simple machines used in the graphic representation of the rollercoaster model (SPI 0707.11.1)
7. TLW calculate angles to increase speed of the rollercoaster (CCSS.Math.Content.7.G.A.1-2)
8. TLW calculate changes in speed, distance, and time as percent changes (CCSS.Math.Content.7.RP.A.1-3)
9. TLW compare the rollercoaster design to an exisiting coaster to compare speed, drops, angles, distance, and time (GLE 0707.T/E.2; CCSS.Math.Content.7.RP.A.2)
10. TLW create a scale model of the rollercoaster with dimensions and scale size (CCSS.Math.Content.7.G.A.1-2)
11. TLW test the model of the rollercoaster prototype for speed, distance, and time. (SPI 0707.T/E.1-2)
12. TLW research engineering principles and compare their process to that of an engineer (GLE 0707.T/E.2)
13. TLW apply formulas of speed, velocity, distance, force, and work using variables to their rollercoaster models (SPI 0707.11.2-3; CCSS.Math.Content.7.EE.B.3-4; CCSS.Math.Content.7.NS.A.3)
14. TLW describe the time and speed of the roller coaster as a proportional relationship (CCSS.Math.Content.7.RP.A.2-3)
15. TLW identify and explain how Newton's laws of motion relate to their roller coaster designs (SPI 0707.11.4)
16. TLW idenitfy and justify how the roller coaster design adheres to set safety laws and regulations (SPI 07707.T/E.2)
17. TLW apply the size constraints of the rollercoaster to fit into a certain area of land allotted for the project (CCSS.Math.Content.7.G.B.6).
18. TLW identify and compute ratios (CCSS.Math.Content.7.RP.A.3)
19. TLW identify the tools and procedures needed to test the model of the roller coaster design (SPI0707.T/E.1)

Focus of the unit:

This unit centers on one large and multifaceted question, called the Driving Question:

**How would you develop a taller and faster roller coaster for DollyWood Theme Park in Tennessee?**

We will work towards answering this question and others over the next few weeks. All of our activities and lessons will help us work toward answering the question.

Assignments:

1. Reflections/Exit Tickets
	1. These are small reflections or exit tickets that will happen throughout the unit, usually to be turned in at the end of class to make sure you understand what we talked about
2. Scale Model of Roller coaster
	1. Your group will design a roller coaster (drawing or computer-generated) that is the scale model for your larger model.
	2. This model must include:
		1. Time specifications
		2. Distance of the roller coaster
		3. Acceleration
		4. Areas of gravity
		5. Inertia
		6. Area constraints
		7. Amount of materials needed
		8. Budget for the “build”
	3. See the attached rubric and guidelines for more information on grading
3. Materials acquisition
	1. This is part of the construction of your model- you will complete a Materials acquisition form once your group has decided which types of materials to use for the model
	2. This form also must have budget and time considerations
4. Model
	1. Your group will construct a working model of your roller coaster in class.
	2. You will create a short, 5-7 minute presentation outlining all of the specifications listed under the scale model. (you will also be given class time to create the presentation)
	3. You will also TEST your models two days before presenting them to ensure that they work. You will be given time to make adjustments and corrections
5. Effort log
	1. Everyday at the end of class, you are to complete a rating of your personal effort within the group or class for that day
	2. You will also have places to document the grades your group receives for each assignments
6. Goals Checklist
	1. Your group is to keep a goals checklist in which you check off accomplished goals as we work toward completing the unit. (I will specify which goals to cross off when)

Grading:

* All of the projects will be graded based on a rubric. These rubrics are attached to this document and will guide my grading of your projects.
* Grading of individual and small group activities will be based on participation, collaboration and effort within the group, and completion

Group Roles

* There are four major group roles that you can apply for. I will select the project manager, but the rest are up for grabs! Be sure to read the description so that you are aware of your responsibilities and what your new job entails!
	+ Project Manager- this person helps the group stay organized and on-task to get the job done. This person is in charge of time-management of the group and delegating jobs to the other members
	+ Acquisitions Manager- this person is in charge of researching and selecting the correct materials for your model. This person must also make sure that he or she gathers enough materials for the project and is in charge of keeping the group well stocked with materials throughout the design and build phases.
	+ Engineers (2 people)- these people are in charge of designing the roller coaster and implementing the designs into the models. These two must have the approval of the entire group to implement and select designs to build the model from. Engineers must use their knowledge of math and science to build a faster and taller roller coaster that is safe for riders.
	+ Bookkeeper/Accountant- this person is in charge with keeping up with paperwork, group assignments, and helping the group stay on-budget for the project. The accountant must help the group find cost-effective ways of creating a roller coaster without compromising the safety standards.