TCSJ PBL Overview
(Chuck & Wong)

Title:	**Bungee Drop**	**Est. Start Date:** October 24, 2016 (Physics) January 4, 2016 (Algebra 1)	**Duration:** 3-4 weeks
Teacher:	Stacey Chuck and Crystal Wong	**Grade Level:** 9 - 12	
Content Focus:	Mathematics - Statistics	**Other subject areas to be included:** Physical Science, English, Engineering	
Overall Idea: Summary of the issue, challenge, investigation, scenario, or problem	Students will gain competence in collecting data, graphing data, analyzing data and then culmination in an application of that learning. They will investigate the components of a bungee system and apply statistical tools to analyze the data. Apply scientific and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision. [NGSS HS-PS 2-3]		
The Project: What will students design, build, and/or present at the end of the PBL to demonstrate their expertise and solution/answer to the Driving Question?	Throughout the project, students will collect data, analyze it and utilize their findings to help them successfully design and create a bungee cord that will protect an egg during a drop and will predict the amount that the bungee will stretch in a static situation, knowing the height at which the egg will be hung and the mass of the egg. Students will need to investigate Hooke's Law to solve this problem. The students will create a Prezi which details the student's experience in using math and science to successfully protect an egg from being dropped from a predetermined height.		
Essential Question:	How can we use data and its analysis to ensure that a bungee cord will work properly? What are the different types of materials used in bungee cords? What properties do they need to have? What calculations are necessary in order for it to be safe for a range of people?	**Driving Question:**	How can I be sure a bungee cord is safe?
Content and Skills Standards to be addressed: (CCCSS, NGSS, Calif.)	**<u>Math</u>** **S-ID.2** Use statistics appropriate to the shape of the data distribution to compare center (median, mean) and spread (interquartile range, standard deviation) of two or more different data sets. * **S-ID.1** Represent data with plots on the real number line (dot plots, histograms, and box plots). *		

	S-ID.3 Interpret differences in shape, center, and spread in the context of the data sets, accounting for possible effects of extreme data points (outliers). * **Science** **NGSS:** **HS-PS2-3** Apply scientific and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision. **Science and Engineering Practices:** **Constructing Explanations and Designing Solutions** ● Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories. ● Apply scientific ideas to solve a design problem, taking into account possible unanticipated effects. ● Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution. **Disciplinary Core Idea:** **PS2.A Forces and Motion** If a system interacts with objects outside itself, the total momentum of the system can change; however, any such change is balanced by changes in the momentum of objects outside the system. **ETS1.A: Defining and Delimiting an Engineering Problem** Criteria and constraints also include satisfying any requirements set by society, such as taking issues of risk mitigation into account, and they should be quantified to the extent possible and stated in such a way that one can tell if a given design meets them. (secondary) **ETS1.C: Optimizing the Design Solution** Criteria may need to be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain criteria over others (tradeoffs) may be needed. (secondary) **Crosscutting Concepts:** **Cause and Effect** Systems can be designed to cause a desired effect. **English Language Arts** **WHST.11-12.7** Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. (HS-PS2-3)

		T+A	E		T+A	E
21st Century Skills and MPS to be explicitly taught and assessed **(T+A)**	**Analytical Thinking**	**x**		**Make sense of problems & persevere in solving them.**		**x**
	Collaborating		**x**	**Reason abstractly & quantitatively.**	**x**	
	Communicating		**x**	**Model with mathematics.**	**x**	

or that will be encouraged **(E)** by Project work but not taught or assessed:	**Creating & Innovating**		**x**	**Attend to precision.**		**x**
	Finding & Evaluating Information	**x**		**Look for and make sense of structure.**	**x**	
	Problem Solving		**x**	**Look for and express regularity in repeated reasoning.**	**x**	

Presentation Audience				
Culminating Products and Performances	**Group:**	Bungee Cords will be created utilizing the found *k* values for the materials provided. and tested using eggs. Group Prezi's will visually communicate the mathematics and science that students learned through discovery. Videos, graphs, labeled drawings, and equations are all appropriate forms of communicating visually. Additionally, students will present their Prezi using full sentences including appropriate math and science vocabulary.	**Class**	**x**
			School	
			Community	
	Individual:	Perform linear regression based on collected data. They will also calculate mean and median values and find both range and interquartile range, for which they will determine what central measurement will be the best representation of the overall data. Running Journal to document the investigation and creation process.	**Experts**	**x**
			Web	
			Other:	

Project Overview	
Entry event to launch inquiry, engage students:	**Video** https://www.youtube.com/watch?v=l9m4cW2yxy0 Show the first 18 seconds of the video. Stop the video at 18 seconds and ask: What do you wonder about this event? What questions come to mind after watching this portion of the video? **Exploration**: Your goal is to create a bungee cord that will get the doll closest to the ground without crashing. ● You will have two opportunities to test your bungee cord. *(Time limit?)* ● Students will be given access to rubber bands, and a doll ● Students will make bungee cords by looping rubber bands together. They may make the bungee cord as long or as short as they would like. ● Students will attach the cord to the doll's feet ● Students will attach / hold one end of the cord to an elevated height (table, desk, top of lab

	table, etc…) ● Students will run their first test of their bungee cord. The test must be supervised by the instructor. ● Students will make adjustments to their bungee cord design. ● Students will run their second test of the their bungee cord. What elements did you consider when you were making your own bungee cord?
Outline or Conceptual Flow Include assessment points and *clearly identify* opportunity(s) for students to inquire, research, and share their new knowledge with their peers. *Note: Details of lesson plans do not belong in the outline.*	**Statistics is a communication and interpretation tool.** I. Categorical / Qualitative Data A. Collecting and Recording data 1. Collecting categorical data is frequently done through surveys or observations B. Displaying Data 1. Pie charts and frequency tables lend themselves to representing categorical data in easily understood visual formats. C. Analyzing Data 1. Bar graphs, histograms and computational modeling and ways to display both categorical and quantitative data D. Sharing / Communicating Data 1. Sharing Qualitative Data gives more meaning to the collected information by organizing it and creating a visual that can lend itself to deeper insight, interpretation and analysis. **II. Quantitative Data** **A. Collecting and Recording data** **1. Collecting Quantitative data is frequently done through collecting sets of measurements which may be garnered from experiments or observations over time.** **B. Displaying Data** **1. Quantitative data can be displayed in multiple formats, including scatter plots, box plots, and line graphs** **C. Analyzing Data** **1. Bar graphs, histograms and computational modeling and ways to display both categorical and quantitative data** **2. Lines of best fit which are garnered by appropriate tools.** **D. Sharing / Communicating Data** **1. Quantitative data, collected in an objective, unbiased manner is among the best evidence to present findings or persuade an audience. Utilizing the graphs and computational models of quantitative data creates deep visual understanding that would support additional verbal communication.**

Assessments	**Formative Assessments** (During Project)	Quizzes/Tests	**x**		
		Journaling/Learning Log	**x**		
		Preliminary Plans/Outlines	**x**		
		Exit Ticket	**x**		
		Other			
	Summative Assessments (End of Project, identify content areas to be covered) ***NOTE:*** *The end of PBL Summative Assessments do NOT replace The Project.*	Written Product(s), with rubric		Other Products	x
		Oral Presentation, with rubric	**x**	Peer Evaluation	x
		Multiple Choice/Short Answer Test		Self-Evaluation	x
		Essay Test		Other	

Resources Needed	**On-site people, facilities**	Projection Equipment and internet connection
	Equipment	Mass Sets Ring Stands Ring Clamps Electronic Balance
	Materials	Rubber bands Varying sizes of dolls Ziplock Bags Paper Clips Raw Eggs
	Community resources	

Reflection Methods	(Individual, Group, and/or Whole Class)	Journal/Learning Log	**x**	Focus Group	x
		Whole-class Discussion	**x**	Fishbowl Discussion	
		Survey		Other	

Project Teaching and Learning Guide

Knowledge and Skills Needed by Students
(to successfully complete culminating projects and to do well on summative assessments)

Student needs to be able to: Know how to find the measures of center: Mean, Median, Range, and Interquartile Range	**Student needs to be able to:** Accurately collect data from scientific experiments and represent the data in easily readable formats, including tables and scatter plots.
Student needs to be able to: Conduct research that will create data leading to the creation of a product which answers the question "How could you build a bungee cord that would be safe the first time it was used?"	**Student needs to be able to:** Read, understand and interpret statistical data in its different representations in order to safely create a bungee cord which will safely drop the egg.

Questions to be Provided by the Project Teacher
(to successfully complete culminating products and to do well on summative assessments)

Teacher asks questions to recall facts, make observations, or demonstrate understanding: What is Mean? How is it calculated? What is Median? How is it calculated? Where can we find outliers? What is Hooke's Law? What does the *k* value indicate about our rubber bands?	**Teacher asks questions to summarize, analyze, organize, or evaluate:** How can you use the measures of center to help create a bungee cord that meets the criteria of the problem? How are the measures of center similar? different?
Teacher asks questions to apply or relate:	**Teacher asks questions to predict, design, or create:**

What would happen to our measures of center if we had outliers? What additional situations might require the use of Hooke's Law?	How can you create a bungee cord that will successfully support a pre-measured weight? Design a Prezi presentation that successfully communicates the mathematical and physics ideas involved in creating a bungee cord.
Teacher Reflection: **How did the unit flow? What worked well? What needs to be changed for next time? What did the students learn? What evidence do you have to support student's learning?**	

Week #1

Monday	Tuesday	Wednesday	Thursday	Friday
Entry Event: - Video: https://www.youtube.com/watch?v=l9m4cW2yxy0 - Discussion: What do you wonder about this event? What questions come to mind after watching this portion of the video? - Exploration: Create a bungee cord that will get the doll closest to the ground without crashing **Discuss:** Generate guiding questions. **Assess (1):** - Exit ticket: What elements do you think played a role in a successful Bungee Doll Drop? **EL Strategies:** * Hands on learning * Audio / Visual	**Read:** **Prezi on "talking to the text"** https://prezi.com/rbp2twiyurqk/talking-to-the-text-the-t4-method/ - Pass out excerpt of article-scientific journal article on the physics of bungee jumping http://seniorphysics.com/physics/bungee_physics.pdf **Assess (2):** Concept map of related ideas. After talking to the text, students will concept map their ideas to show relevant connections and areas of research needed. What elements/variables do you think might affect the success of dropping an object from a tall height. *(weight of object, type of elastic cord, length of the cord, wind resistance, how the cord is attached to the object)* How can we measure those elements? **EL Strategies:** * Anticipatory Chart - What do you think the article will talk about based on its title? * Talking to the text reading strategy **Intervention Lesson:** -Red, Yellow, green light	**Preparing for Data Collection:** * How do we record and display the data? What makes a clear data table? What formating should be used? **Application: Lab Activity** Give all groups a **spring** and set of masses. Students will Record the original length of the spring. Then students will hang various masses and record the change in length of the spring. **EL Strategies:** * Hands on learning * Strategic Grouping **Intervention Lesson:** * Individual intervention to make sure students are recording data properly	**Front Load Analyze Data Application:** * Students look at classroom data...group as well as collective data, accessing the class spreadsheet through Padlet.com * We are looking for any anomalies or patterns that we can easily identify from the data sets Define: Outliers **Centers:** Measures of Center → Mean → Median → Range → IQR **Assess (1*):** Exit ticket for which measure of center is the best representation of the data collected. **EL Strategies:** * Strategic Grouping * Centers * Connect Vocabulary **Intervention Lesson:** * Small group intervention to re-teach each of the four concepts for Measures of Center using integers	**Create**: * Excel spreadsheet to record data Students will input their data from the previous day into demos and create a graph. **Regression**: Students use Padlet and Desmos to determine a line of best fit. **EL Strategies:** * Technology * Visual demonstrations and connections with vocabulary **Intervention Lesson:**

Week #2

Monday	Tuesday	Wednesday	Thursday	Friday
Application: Lab Activity Give all groups a **rubber band** and set of masses. Students will Record the original length of the rubber band. Then students will hang various masses and record the change in length of the rubber band. **Journal Entry:** Show your steps in solving the problem. **EL Strategies:** ***** Investigations * Collaboration **Intervention Lesson:** ***** Teacher will provide one on one support for struggling students	**Assess (3): Quiz on Regression** Padlet + Desmos **Data Analysis:** Students find the measures of central tendency and create a line of regression in order to calculate the *k* value using their collected data. **Journal Entry:** Show your steps in solving the problem. **EL Strategies:** * Collaborate with people from their group **Intervention Lesson:** ***** Provide video to help students remember how to do regression on data.	**Data Analysis:** * We will analyse the data and discuss the differences and similarities from group to group. * All data will now be combined into one spreadsheet and the process of discussing the data will continue including the concept of random error, outliers and human error. **Synthesis** **Group Collaboration Time:** Students will begin planning and creating their bungee cord, following the rubric guidelines. **Journal Entry:** Show your steps in solving the problem. **EL Strategies:** *** Connect Vocabulary** *effect, affect, skew* and *interquartile* **Intervention Lesson:** * Further instruction on analysis of data to give students more practice in finding key elements.	**Synthesis:** Students will apply the scientific principle of Hooke's law to build a bungee cord that will prevent an egg from break when hung from a height. Build day 1 for students **Materials to be provided:** Rubber bands of one size only Ziplock bags Paper Clips Raw Eggs **Equipment:** Mass sets Ring Stands Ring Clamps Electronic balance **Assess (4):** - Journal Write: How can we use the central measurements to make good predictions to create our bungee cords? **EL Strategies:** * Review of vocabulary for *mean, median, range* and *interquartile range* **Intervention Lesson:** * Additional instruction and practice on finding the measures of center	**Synthesis:** Build Day 2 Test and Redesign **Journal Entry:** Show your steps in solving the problem. **EL Strategies:** * Hands-on activity * Students work in groups **Intervention Lesson:** * N/A

Week #3

Monday	Tuesday	Wednesday	Thursday	Friday
Communication: Students will begin planning and developing their Prezi Presentations. **Synthesis:** Any final modifications that need to be made to the bungee cord should be done at this time as well. **Journal Entry:** Show your steps in solving the problem. **EL Strategies:** * Hands-on activity * Students work in groups **Intervention Lesson:** * Students will be provided with video links to guide and re-teach the production of Prezi presentations.	**Final Test:** <u>Dropping Event</u> Goal- Ideally the egg will not break during either test. Static - Egg will hang from bungee and total stretch will be measured by measuring the starting length and the extended length. Dynamic - egg will be dropped from a height and will oscillate. **EL Strategies:** ***** Hand's-on activity **Intervention Lesson:**	**Communication:** Work day to analyze final results and compose presentations **EL Strategies:** * Collaborate with people **Intervention Lesson:** * Close monitoring by the teacher, who will provide one on one support for struggling students	**Evaluate:** **Peer Edit:** Students will peer edit each other's presentations and provide constructive feedback. Discuss presentation rubric **EL Strategies:** * Students will practice their presentations to smaller groups in order to refine the overall presentation **Intervention Lesson:**	**Communitate:** Students will present their project findings. Audience will ask thoughtful questions and provide positive feedback. Presentations will be scored via the rubric
