ST PAUL'S COLLEGE
Project Based Learning Plan

U N I T O V E R V I E W			
Unit Title:	Convoluted Contraptions		**Unit Length:** 6 weeks
Learning area(s):	Design and Digital Technology		**Year Level:** 6 - 8
Teacher(s):			
Learning Promise	In this unit, your students will learn about simple machines and see how Rube Goldberg used them to make complex devices to complete simple, everyday tasks.		
Learning Goal(s) 3 outcomes you want your students to achieve	1. Accurately identify the six simple machines in everyday items and processes 2. Understand that machines are devices that transfer force and energy 3. Design and construct a complex machine to complete a task		
Driving Question (include student role, issue, problem or challenge, action taken, and purpose/beneficiary)	How might we use Lego Prime Essentials and Lego BricQ to create a Rube Goldberg device?		
Students will	Understand…. • Machines make work easier • To make an object move a machine has to work harder than the force keeping the object in place • Machines give a mechanical advantage which means less force is needed but this is simply a change in the form of the work, e.g. a trade off of force for distance or distance for force	Know…. • The force needed to push, pull or lift an object is called the effort force • The force holding the object in place is called the load force • Machines only put out the same amount of work that is put in	Do…. • Create models of simple machines • Analyse complex mechanisms and identify combinations of simple machines • Design complex machines to complete a task • Mechanise a complex system • Design and write algorithms to control a complex system

Content Descriptors	**Design & Technologies** Yr 5/6 Generate, develop and communicate design ideas and processes for audiences using appropriate technical terms and graphical representation techniques (ACTDEP025) Yr 7/8 Analyse how motion, force and energy are used to manipulate and control electromechanical systems when designing simple, engineered solutions (ACTDEK031) Use project management processes when working individually and collaboratively to coordinate production of designed solutions (ACTDEP039) **Digital Technologies** Yr 5/6 Design, modify and follow simple algorithms involving sequences of steps, branching, and iteration (repetition) (ACTDIP019) Yr 7/8 Define and decompose real-world problems taking into account functional requirements and economic, environmental, social, technical and usability constraints (ACTDIP027) **Science** Yr 7 Change to an object's motion is caused by unbalanced forces, including Earth's gravitational attraction, acting on the object (ACSSU117) **Middle School Engineering** MS-PS3-5. Construct, use, and present arguments to support the claim that when the kinetic energy of an object changes, energy is transferred to or from the object. MS-ETS1-1. Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions. MS-ETS1-2. Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem. MS-ETS1-3. Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success. MS-ETS1-4. Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.		

General Capabilities	Literacy	Numeracy	ICTs	Critical and Creative Thinking	Personal and Social	Ethical Understanding	Intercultural Understanding

CESA Key Capabilities	Literate, numerate and effective communicator	Spiritually aware and inspired by faith	Confident and careful creators and users of ICTs	Knowledgeable, inquisitive and innovative	Self-aware, collaborative and socially adept	Moral, compassionate, ecologically aware	Intercultural and globally minded
Cross Curricular Priorities	Sustainability		Aboriginal and Torres Strait Islander Histories and Cultures		Asia and Australia's Engagement with Asia		

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<td rowspan="2">Evidence of Learning
(Product/Solution/ Skill Demonstration)</td>
<td colspan="2">Task Description:
Students will work in a team to design, make and program a Rube Goldberg Contraption, with at least four distinct mechanisms, to complete a task of their choice. Some examples include:

Knock down a stack of dominos
Pop a balloon
Close a door (Lego!)
Turn on a light
Drop a paper in the bin

Criteria:

You must complete a detailed, annotated design before starting to build
Incorporate at least four simple machines in your project
Each team member must complete at least one distinct mechanism and code
Observe safety procedures, especially with catapult devices
You must follow the concept of a Rube Goldberg machine, utilising humour and complexity to accomplish a simple task
Make sure you are cleaning up appropriately and treating others' projects respectfully

Constraints:

You can only use the Lego BricQ or Spike Prime Essentials kits
You have one week to complete the project

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<td>What will students create individually?
Students will design, make and program a mechanism to form part of the Rube Goldberg Contraption.</td>
<td>Specific content and competencies to be assessed:

How energy is transferred
The relationship between energy and force

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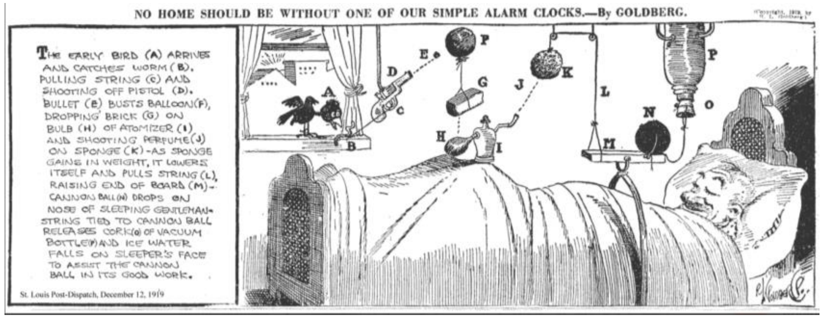
	Students will present their knowledge through annotation and oral presentation	• How interactions between two objects can impact the energy of an object • Application of scientific knowledge of simple machines to solve a problem • Collaborative skills
	What will students create collaboratively (Team)? A complex mechanism that is able to successfully complete a task	Specific content and competencies to be assessed: • Design and engineering journal • Mechanical structure and accuracy • Creativity
Making Products Public	Students will display their completed Rube Goldberg Devices at a school expo, presenting to the general public.	
Resources Needed	Equipment: Lego BricQ Motion and Lego Prime Essentials	
	Materials: Student handouts and rubrics Stopwatch Measuring tape protractor	
	Community Resources: Rube Goldberg cartoons Rube Goldberg Official Site: https://www.rubegoldberg.com/ • 10 Brilliant Rube Goldberg Machines: http://coolmaterial.com/roundup/rube-goldberg-machines/	

Reflection Methods (how individual, team, and/or whole class will reflect during/at end of unit)	Individual Reflection		Rubric	
	Peer Reflection			
	Team Evaluation			

Sequenced Learning Plan			
Lesson	**Learning Outcomes/Targets** knowledge, understanding & success skills needed by students to successfully complete products	**Checkpoints/Formative Assessments** to check for learning and ensure students are on track	**Instructional Strategies for All Learners** provided by teacher, other staff, experts; includes scaffolds, materials, lessons aligned to learning outcomes and formative assessments
1	**Rube Who?** In this lesson, students will research and model the six simple machines: levers, inclined planes, wedges, screws, pulleys, wheels and axle. They will develop an understanding of mechanical advantage and the three classes of levers. 	**Assessment task** Make a model of each of the simple machines using the Lego BricQ Motion kit. Create an information card that: 1. Labels and defines the machine 2. Explains how they work – with diagrams and correct scientific terms	**Rube Who?** BricQ Motion Prime The Rube Goldberg Machine was invented by engineer, cartoonist and Pulitzer Prize laureate, Rube Goldberg (1883-1970). Rube was a mechanical engineer who combined his engineering background and with his artistic skills to produce over 50,000 cartoons! He truly put the 'A' in STEAM! His devices included complicated methods from waking up in the morning, umbrella openers and his "Revolveometer", used for viewing abstract art.

2	**Plane and simple** An inclined plane is a sloping ramp that allows heavy loads to be lifted more easily. An inclined plane does not move, objects move on the plane. A person receives mechanical advantage from an inclined plane because you need less effort to raise or lower an object. The disadvantage is you have to move the object a greater distance. 	**Assessment** Sled races – Discover the perfect conditions to move your sled down the inclined plane faster than the other teams. You may vary the weight and height of the sled but not the length or width. The sled must sit flat on the ramp, no rollers or wheels may be used.	Investigate the mechanical advantage of an inclined plane. Build the Inclined Plane Model on Page 88 of the BricQ instruction Book 2 (45401-B). Substitute the pillar pieces from the Lego Prime Essentials kit to allow easy slope adjustments. Use a Lego rubber band to drag the sled up the slope. Explore the impact by varying the angle of incline and weight of the sled. Sliding down, does varying the weight of the sled impact the speed of movement? Can you develop a fair test to measure your observed changes? What measuring devices will you need
3	**Lever it up** A lever is a rigid bar resting on a pivot, or fulcrum. It is used to move a heavy or firmly fixed load with one end,	**Assessment** Make a short video to demonstrate and explain your Lever test device(s).	Design a lever testing device and explore the relationship of the fulcrum to the load.

	while force is applied to the other. An example of a lever is a crowbar, it is a First Class Lever. There are actually three classes of levers and they all vary depending on where the load is in relation to the fulcrum. A door is a Second Class lever because the fulcrum, the hinge is at the end and the load (the weight of the door) is in the centre, while the effort (pulling on the door knob) is applied at the other end.	Demonstrate and explain each class of lever and how varying the position of the fulcrum and load impacts the force needed to lift the load and the distance travelled.	Move the fulcrum and the load, can you find the best location to reduce the load. Move the fulcrum closer to and away from the load. Which is easier to lift? Draw an example of a lever in action
4	**Pulley Power** A pulley is a rope or chain that is wrapped around a grooved wheel. When the rope or chain is pulled, the wheel turns. Pulleys reduce the force needed to lift a weight, but increase the distance the rope must be pulled. There are three different types of pulleys: fixed pulleys, movable pulleys and combined pulleys.	**Assessment** Create and build a device that uses a perfectly balanced pulley system to trigger an event.	How does a pulley help us to lift heavy loads? Make a model of a fixed pulley and a model of a combined pulley. Using the black weight blocks, compare the mechanical advantage of the two systems.
5	**Wheely?** Often described as mankind's greatest invention, the wheel and axle are used to improve the transportation of people and objects. The effort force is at the axle and the load is on the wheel. Most often, the axle is attached to the wheel.	**Assessment** Car races – repeat the sled races and test to find the perfect wheel combination. Design, build and program a starting device using the Spike Prime Essentials motor. How can you ensure that the start is fair for both tracks?	Use the Inclined plane and test the mechanical advantage of the wheel and axle. Add four small wheels to the sled and observe the improvement to the distance travelled. Does weight change the speed of the vehicle as it moves down the slope?

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<td>How does the diameter of the wheel affect the speed? Compare the three sizes of wheels available.</td>
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<td>6</td>
<td>Bring it all together

Students will work in a team to design, make and program a Rube Goldberg Contraption, with at least four distinct steps, to complete a task of their choice. Some examples include:
Knock down a stack of dominos
Pop a balloon
Close a door (Lego!)
Turn on a light
Drop a paper in the bin</td>
<td colspan="2">Assessment
Criteria:
You must complete a detailed, annotated design before starting to build
Incorporate at least four simple machines in your project
You must include at least one motor and one sensor
Each team member must complete at least one distinct mechanism and code
Observe safety procedures, especially with catapult devices
You must follow the concept of a Rube Goldberg machine, utilising humour and complexity to accomplish a simple task
Make sure you are cleaning up appropriately and treating others' projects respectfully
Constraints:
You can only use the Lego BricQ or Spike Prime Essentials kits
You have one week to complete the project</td>
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Convoluted Contraptions

Simple Machines

Name: ______________________

Student can	Needs additional support	Can work independently	Can teach others
Describe how energy is transferred			
Describe the relationship between energy and force			
Describe how interactions between two objects can impact the energy of an object			
Apply existing scientific knowledge of simple machines to solve a problem			
Engage effectively in a range of collaborative discussions			

Additional comments:

Lesson 6

Convoluted Contraptions

Design a convoluted contraption to complete a simple, everyday task!

90 – 180 min   Beginner   Grades 6 - 8

Prepare

NOTE: This lesson will extend over four 45-minute class sessions.

- Ensure the Spike Prime App is downloaded to a suitable device
- Consider the abilities and backgrounds of all your students. Differentiate the lesson to make it accessible to everyone. See the *Differentiation* section below for suggestions.
- If time allows, plan and facilitate the art extension. See the *Extension* section below for more information.

PART A (45 minutes)

Engage (Whole Class, 10 Minutes)

- Facilitate a quick discussion about how Rube Goldberg used humour and improbable, complex systems to complete simple tasks
  - Talk with your students about creating a contraption that shows energy transfer and utilises at least four simple machines.
  - Ask questions, like: *What types of mechanisms or objects can I use to trigger an event? What does the energy transfer look like? What do I want my machine to do?*
- Introduce your students to the criteria and constraints (small groups, 10 minutes)
- Students will break into groups to complete a 2 minute divergent thinking brainstorm of all the possible simple tasks their device can complete.

- Students will then discuss the options in their group and using convergent thinking identify the task they will achieve

Explore (Small Groups, 25 Minutes)

- Students will begin to design their device.
- Remind your students that they will need at least four distinct steps in their device (A single step is defined as a transfer of energy, or 1 cause through 1 effect.)
- Your students can use the LEGO bricks supplemented with additional materials to explore. Encourage them to come up with multiple solutions and options.

Explain (Whole Class, 10 Minutes)

- Gather your students together and facilitate a sharing session where they present their initial ideas and provide feedback and suggestions to their peers.

(Individual, 15 minutes)

- Each student must draw what their individual component will look like.
- Encourage your students to add lots of detail and label the simple machines to help with the build stage.

(Small group, 20 minutes)

- Each group will discuss the individual mechanisms and work out the best order for them to complete the task
- Each group must draw what their final device will look like, ensuring that motors and sensors are labelled

PART B (45 minutes)

Elaborate (Small Groups, 90 Minutes)

- Have each group Have your students build, program, and test the prototypes and ideas they came up with in Part A of this lesson.
- Remind them to use at least one motor or sensor.
- Encourage them to test and refine their models and programs over 2-3 iterations.
- You can find coding and building support in the *Tips* section below.

Evaluate (Whole Class, 15 Minutes)

- Ask guiding questions to encourage your students to "think aloud" and explain their thought processes and reasoning in the decisions they've made while building and programming.
- Have your students clean up their work stations and kits.

Observation Checklist

- Measure your students' proficiency in applying their existing knowledge of energy transfer and collision to complete the given task.
- Create a scale that matches your needs. For example:
    1. Needs additional support
    2. Can work independently
    3. Can teach others

Self-Assessment

- Have each student choose the brick that they feel best represents their performance.
    - Yellow: I think I can design, build, and program a solution.
    - Blue: I can design, build, and program a solution.
    - Green: I can design, build, and program a solution, and I can help a friend do it too.

Peer-Feedback

- In their small groups, have your students discuss their experiences working together.
- Encourage them to use statements like these:
  - I liked it when you…
  - I'd like to hear more about how you…

Tips

Coding Tip

- There are no coding instructions or Inspiration Coding Blocks for this lesson.
  - Encourage your students to experiment and find their own solutions.

Model Tip

- There are no building instructions or Inspiration Images for this lesson.
  - Encourage your students to create their own models.
  - If they need additional guidance, refer them to the building instructions for previous lessons in this unit and the BricQ Build Instruction book.
- There's no right or wrong model for this lesson.
  - Your students can create entirely new models, find inspiration in the models from previous lessons, or simply recreate models from earlier lessons.

Differentiation

Simplify this lesson by:

- Working together as a class to brainstorm new ideas for a device
- Reducing the number of mechanisms needed

Increase the difficulty by:

- Using multiple motors and sensors
- Utilising real world stimuli to trigger the mechanisms, e.g. light

Extension

- Have your students write descriptions of their devices, clearly stating where the transfer of energy occurs, how it occurs, and how collision impacts the triggers.
- Have your students draw their completed contraptions as a Rube Goldberg cartoon, with letters to identify each action, trigger and component.

If facilitated, this will extend beyond the 180-minute lesson.

Teacher Support Key objectives
Things you will need (one for every four students)

- LEGO® Education SPIKE™ Essential Set
- LEGO Education BricQ Motion Set
- Device with the LEGO® Education SPIKE™ App installed
- OPTIONAL: Additional materials for brainstorming (e.g., notebook paper, science notebook, etc.)

Additional resources Convoluted Contraptions Rubric
Educational standards See Unit Plan