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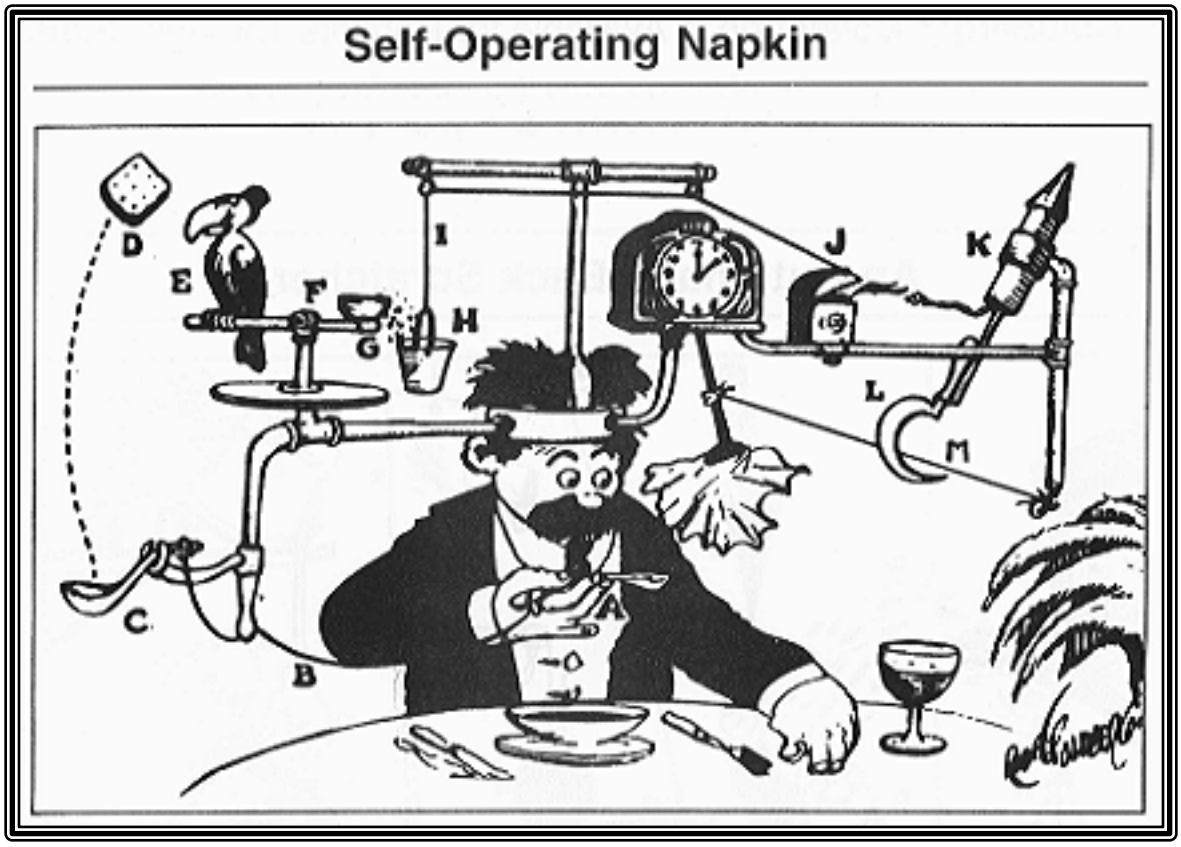
It's a Crazy Chain!

It's A Crazy Chain!: Building Rube Goldberg Machines

Lisa Hauser
lhauser@dadeschools.net
cmshauser4math@gmail.com
iPreparatory Academy
Work Location #7581



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Edwina Lau, Ideas with IMPACT Program Director
The Education Fund
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Email: elau@educationfund.org
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Table of Contents

Goals and Objectives

Rube Goldberg was a Pulitzer Prize winning cartoonist from the early 1900's who developed comical machines to achieve simple tasks. Through his cartoons, Rube Goldberg satirized what he viewed as an American obsession with technology. In this project, students will draw on Rube Goldberg's chain reaction machines to devise and build their own machine. Students will draw on their understanding of simple machines and the design process, and will work in small groups to create their machines. Finally, students will present their machines to the class.

This project is designed for use in a MakerSpace, and is intended to supplement the existing curriculum on force, energy and machines. The project can be adapted for different grade levels and abilities.

Academic Objectives

At the end of this project, students will be able to:

- Understand the six simple machines
- Build a compound machine
- Understand the engineering design process
- Use an electronic device to create a short video narrative

Behavioral Objectives

At the end of this project, student will:

- Improve team work and collaboration capacity
- Develop creative problem solving and perseverance
- Have a shared vocabulary for problem solving

Sample Florida Standards

SC.35.CS-CC.1.3
Identify ways that technology can foster teamwork, and collaboration can support problem solving and innovation.

SC.35.CS-CS.2.4
Solve real-world problems in science and engineering using computational thinking skills.

SC.5.P.10.2
Investigate and explain that energy has the ability to cause motion or create change.

SC.5.P.13.1
Identify familiar forces that cause objects to move, such as pushes or pulls, including gravity acting on falling objects.

SC.5.P.13.3
Investigate and describe that the more mass an object has, the less effect a given force will have on the object's motion.

Course Outline

Inspired by the Rube Goldberg cartoons of the early 1900s, "It's a Chain Thing!" asks students to build chain reaction machines with ridiculously many steps to accomplish a relatively simple task. After reviewing Goldberg's Pulitzer Prize winning cartoons and learning about simple machines (lever, wheel and axle, pulley, inclined plane, wedge and screw), students choose the task their machine will accomplish and brainstorm possible compound machines that would achieve the task with a minimum of three steps.

After settling on a task and brainstorming ideas, students sketch a version of their machine. The finished sketch is presented to the teacher for review. The teacher and students engage in a discussion about the feasibility of each step, and consensus is built around the project. Using the design process, students begin building, testing and fine-tuning their machine until it successfully completes the task.

Before presenting the final machines to the entire class, students create two short videos using their devices: a video narrative of their machine highlighting their favorite element, and a video of the completed machine. These videos are compiled for the entire class to revisit. For a hilarious finale, the machines are presented to the entire class.

The time requirements for this project can vary. This project was originally completed with seventy 5th grade students in three different sections. Each class had a different experience. One class completed the project in three one hour periods, another class in two 90 minute periods, and the third class completed the project in one half school day. This project is suitable for students of all achievement levels, and can be implemented with students from 3rd through 12th grade. The project,as implemented, used LittleBits kits, but they are not instrumental to the project. Although students were divided into smaller groups of 4 students, this can be adapted to meet the needs of the classroom. Finally, lessons 3 and 4 are at the heart of the project. Teachers can skip lessons 1 and 2 and still obtain the benefits of this project.

Successful completion of this project involves coaching. This project was completed with one teacher or adult volunteer per group during the building phase. Parents and support personnel donated their time to assist in this project.

Lesson 1: Simple Machines

Objectives:

- Students will explore all six simple machines.
- Students will be able to identify how each machine makes work easier.

Materials:

- Simple Machine Worksheet or Google Form (if using a Google Form, devices will be necessary)
- *Lever Station*: Wood or sturdy plastic ruler, fulcrum (can be a lego piece, a roll of toilet paper), tape, object to lift.
- *Inclined Plane Station*: Wooden board, books to elevate the plane, one heavy book with rubber bands tied around the books, string tied to the rubber bands.
- *Wedge Station*: Dull scissors, sharp scissors, paper
- *Pulley Station*: Sewing spool, pencil, string, obejct to lift.
- Screw Station: Sheets of paper, scissors, tape, pencil, marker.
- *Wheel and Axle Station*: Matchbox car or hotwheels, ruler.

Classroom Setup:

Create six stations, one for each type of simple machine. Students rotate through the six stations exploring the different types of machines.

Prior Knowledge:

The six simple machines: lever, pulley, wedge, inclined plane, screw, wheel and axle

Activities:

- Divide the class into 6 groups of 2-5 students depending on grade level and ability level.
- Allow students to rotate through each station. This can be timed or students can explore freely, depending on the class. Students might need 8-12 minutes at each station.
- At each station students answer the questions on the simple machine worksheet. Alternatively, students can enter their findings into a google form that the teacher can monitor as students complete their explorations.
- At the end of the activity, allow one student from each group to summarize their findings of one of the simple machines.

Station Activities:

Lever Station: Students will place the fulcrum at different distances from the load. Students will find that the closer the fulcrum is to the load, the easier it is to lift the load.

Inclined Plane Station: Students will adjust the slope of the inclined plane and pull of the string to lift the book. Student will find that the steeper the plane, the more difficult it is to lift the load.

Wedge Station: Students will cut the paper using both types of scissors. Students will find that the sharper the wedge, the easier it is to cut the paper.

Pulley Station: Students will lift an object with the pulley made from string, pencil and sewing spool, and without the pulley. Students will find that lifting the object with the pulley is easier.

Screw Station: Students will make a screw out of an inclined plane. Students will use the ruler to draw a diagonal from one corner of the sheet paper to the other. Students will cut along the diagonal to make an inclined plane. Students will use the marker to highlight the inclined side (hypotenuse – opposite the right angle). Students will line up the pencil with the short end of the triangle and slowly rotate the paper around the pencil. Students will notice that the inclined plane (highlighted side) will form the threads of the screw.

Wheel and Axle Station: Students will roll the matchbox car on its side and on its wheels. Students will measure the distance the matchbox car traveled. Students will find that the car travels farther on its wheels.

Assessments:

- Observation of student collaboration and teamwork.
- Completion of the worksheet and understanding of each simple machine.

Simple Machines Worksheet

Lever Station

Construct a lever using the given materials.
Answer the following questions:
Is the load easier to lift with the lever?
Move the fulcrum closer and farther from the load, and lift the load. Which one is easier to lift?

Inclined Plane Station

Make an inclined place with the wood board and the books that do not have the rubberbands. Place the book with the rubberbands at the bottom of the inclined plane. Thread the string to through the rubberbands and place the stretch the string to the top of the inclined plane. Drag the book up the inclined plane. Notice how much the rubberbands stretch. Adjust the inclined plane to different heights. Drag the book up the inclined plane. Notice how much the rubberbands stretch. Pull the book straight up. Notice how much the rubberbands stretch.
Does the inclined plane make the job of lifting the book easier?
Which slope of the inclined plane stretch the rubberbands the least? The most?

Wedge Station

Use the dull scissors to cut the paper. Use the sharp scissors to cut the paper. Which scissor is easier to cut with? Why?

Pulley Station

Make a pulley using the sewing spool, pencil and string. Lift the object with and without the pulley. Is it easier to lift the object with or without the pulley? Why?

Screw Station

Draw a diagonal from one corner of the paper to the other. Cut along the diagonal. Use the marker to trace the diagonal (inclined plane). Place the pencil on the short end of the diagonal and tape it. Tightly wrap the triangle around paper. Tape the end of the paper. Does the result look like a screw? Is a screw an inclined plane? What part of the screw does the inclined plane form?

Wheel and Axle Station

Place the matchbox car right-side up at one end of the rule and gently roll it. Place the matchbox car on its side and gently push it. Which car moved easier, on its wheels or on its side?

Conclusion:

Simple machines make work easier by transferring a force from one place to another, changing the direction of a force, increasing the magnitude of a force, or increasing the distance or speed of a force. Give a real-life example for each simple machine:

Lever:	Inclined Plane:	Wedge:
Pulley:	Screw:	Wheel and Axle:

Optional Lesson 2: LittleBits

Objectives:

- Students will be able to complete at least one project from the Gizmos and Gadgets LittleBit Kit.
- Students will be able to build circuits with power sources, input controllers, wires, and outputs.

Materials:

- 3 or more Gizmos and Gadgets LittleBit Kits

Activities:

- Teacher will divide students into groups of 2-5 students.
- Students will build at least one of the projects in the Gizmos and Gadgets LittleBit Kit following the instructions in the kit.
- Students will be allowed to combine LittleBit modules to create their own inventions.

Assessments:

- Observe cooperation and teamwork.
- Successful building of at least one LittleBit Kit project.

Tips:

- Clean up and packing of the LittleBits Kits is important. Teacher may want to consider creating a library of pieces instead of storing the LittleBits Kits in their own boxes. Teacher may want to use plastic bins to store the LittleBits modules.
- LittleBits is a great request for Donors Choose!
- Using LittleBits is not instrument to the project. Students can complete the project successfully without the LittleBits modules.

Lesson 3: Design Process and Rube Goldberg Machines

Objective:

- Students will learn and apply the fundamentals of the engineering design process.
- Students will learn about Rube Goldberg Machines and will be able to identify the simple machines in each cartoon.
- Students will draw their own Rube Goldberg Machines using at least three simple machines.

Materials:

- At least two examples of Rube Goldberg Machine cartoons. Digital images or paper reproductions can be used.
- Paper
- Pencils

Classroom Setup:

Students will work in small groups. Teacher will decide how to group students. These will be the groups for the remainder of the project. Groups shoud have 2-5 students.

Activities:

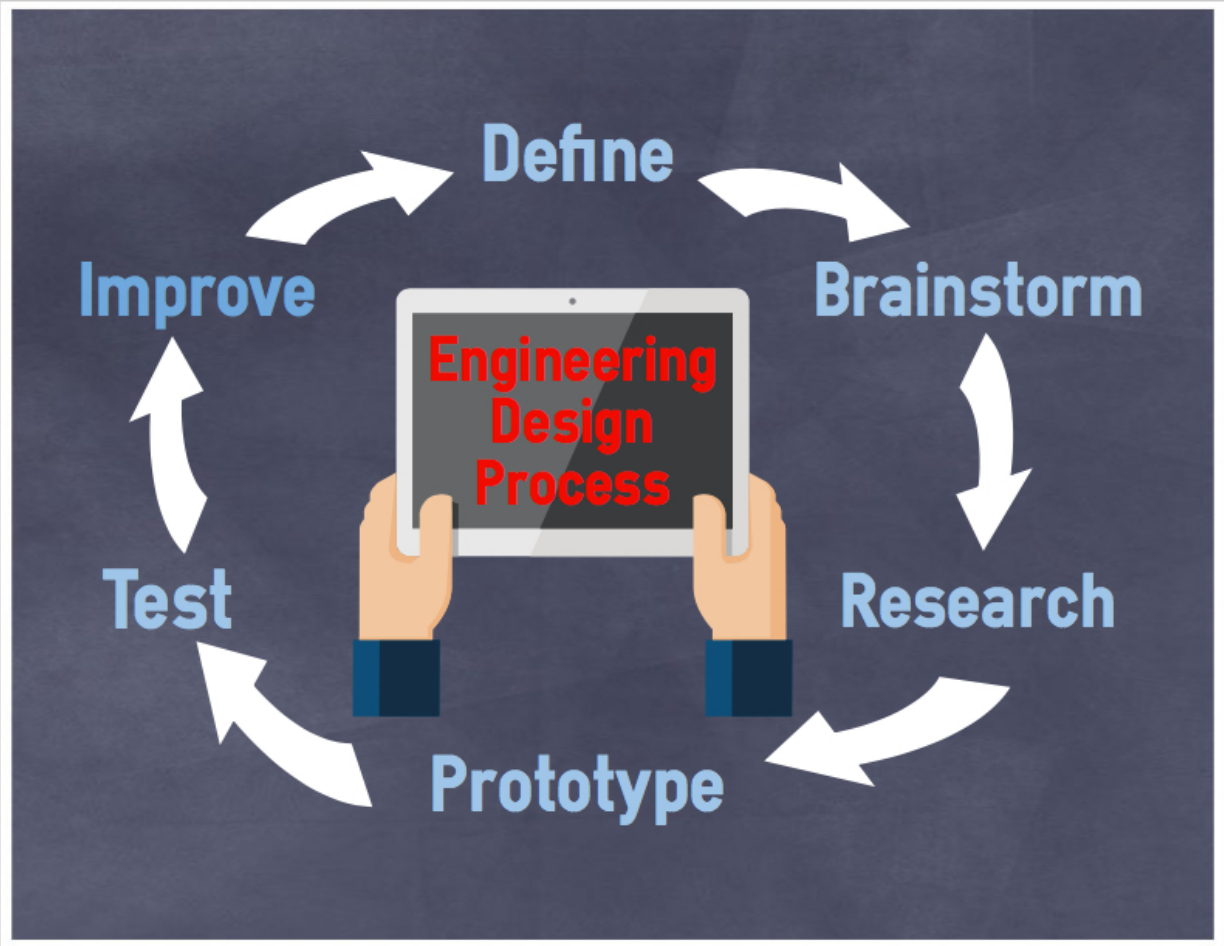
- Teacher will present the engineering design process and discuss the importance of each step.
- Teacher will present a brief history of Rube Goldberg.
- Teacher will show one example of a Rube Goldberg Machine cartoon (see sample below). Other images are copyrighted and can be used for educational purposes, but cannot be published. Teacher will go through the machine indicating the different simple machines used to complete the task.
- Teacher will share an additional example and allow students to work in groups to identify the different simple machines used to complete the task.
- Teacher will explain that students will work in groups to create a real-life Rube Goldberg Machine. Teacher will discuss with the students the materials to used to create the real-life Rube Goldberg Machine. Teacher has the flexibility to decide whether students should bring materials (e.g. legos, toilet paper rolls, string, toys, matchbox cars, etc.) or use materials provided by the teacher.
- Students will divide into their small groups and decide on a task to complete. They will agree on a chore the machine will complete, and draw a Rube Goldberg Machine that uses at least 3 simple machines. Students will identify on their drawing the simple machines. ****OPTIONAL: Teacher may ask students to include a LittleBits in the machine******

- Students will present machine ideas to the class.

Tips:
The teacher will need to work with students to identify the feasibility of each step.

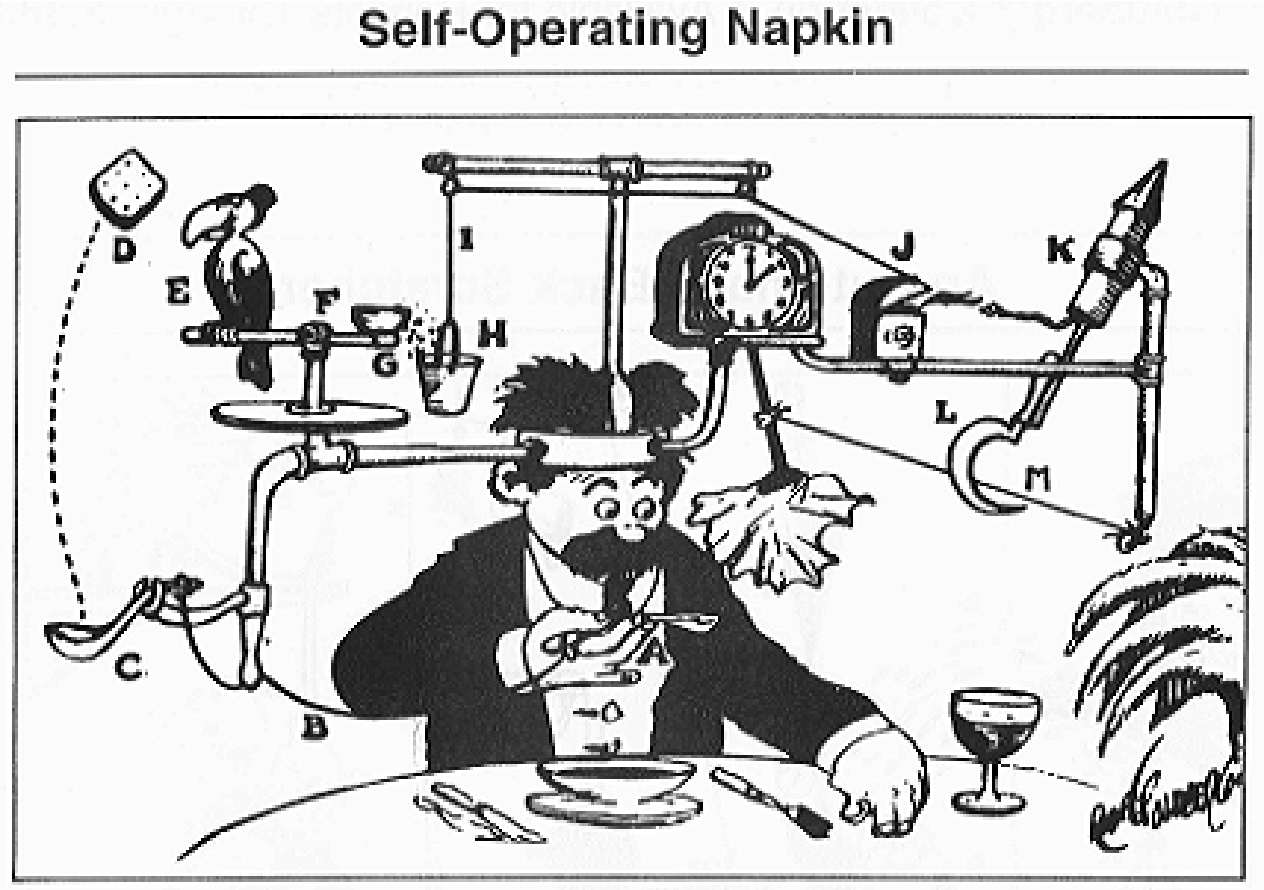
Assessment:
Observe collaboration and teamwork.
Creativity of the design.
Rube Goldberg machines uses at least 3 simple machines.
Optional: LittleBits is incorporated.

Design Process Diagram



Sample Rube Goldberg Cartoon

Note: This cartoon is in the public domain and can be used without permission.



Lesson 4: Building a Rube Goldberg Machine and Creating a Video

Objectives:

- Students will build a functioning Rube Goldberg Machine to complete a simple chore using at least 3 simple machines.
- Students will create a video narrating the different elements of the machine.
- Students will create a video of the machine in action.

Classroom Setup:

Students should be able to work on a large flat surface. Each group should have sufficient space to work and build their machine.

Materials and Resources:

- Adult Volunteers
- Students or teacher will bring the necessary materials described in the plans from Lesson 3.
- LittleBits kits, if applicable.
- Recording devices. Students can use their own devices or the classroom devices to record their videos.
- Computer to collect all the videos and upload to Youtube.

Activities:

- Students build their Rube Goldberg Machines based on their plans from Lesson 3.
- Students will create a short video narrating the different aspects of their machine and highlighting the three simple machines used.
- Students create a short video demonstrating the machine in action.
- Students share the videos with their teacher.
- Students present their machines to the class.

Assessments:

- Observe collaboration and teamwork.
- Observe grit or perseverance.
- Machine uses 3 simple machines.
- Optional: Machine incorporates LittleBits modules.
- Machine accomplishes task.
- Video narrative is clear and complete.
- Video of machine is clear and complete.

Tips:

- Ask students to bring materials a day or two before the scheduled build day to prevent loss of productive work time.
- Students will be very frustrated! It is OK. Adult volunteers will help students persevere.
- The machines will not match the intial design. That is OK, too. Students should use the engineering design process to create iterations of their design.
- Pay attention to clean up. Each classroom is different. Sometimes the machines can remain in their place for a few days, sometimes they need to be taken apart. It is up to the teacher, but something the teacher should consider before implementing the project.

Resource List

LittleBits, Gizmos and Gadgets Kit
To buy, go to https://shop.littlebits.cc/products/gizmos-and-gadgets-kit-2nd-edition or google LittleBits.

Rube Goldberg and Rube Golberg Machine Challenge
https://www.rubegoldberg.com

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