Western Engineering Outreach

Ziplines

Grades 6-8

Meet Today's ENG HERO!

Emily Lalone – Assistant Professor with Western Engineering

Dr. Lalone completed her BSc in Medical Science and her PhD in Biomedical Engineering at Western University. She also completed a CIHR Fellowship at McMaster University in the School of Rehabilitation Sciences. Dr. Lalone is an Assistant Professor in the Mechanical and Materials Engineering department at Western University. Her research interests are in biomedical and mechanical engineering, medical imaging, orthopedic surgery, and rehabilitation.
To learn more about Dr. Lalone visit:
https://www.eng.uwo.ca/mechanical/faculty/lalone_e/index.html

Learning Goal:

- To investigate forces and use that knowledge in building a zipline.
- Curriculum Connections: Grade 7 - Form and Function; Grade 8 - Systems in Action

Materials Needed:

- String
- Scissors
- Tape or hot glue
- Ping pong ball
- Pencil

For building your own zipline you can choose from the following materials:

- Cups
- Straws
- Pipe cleaners

- Metal washers or something else to use as a counterweight
- Paper
- Skewers
- Cardboard
- Popsicle sticks
- Any other materials you may want to use in your design

Engineering and Science Connections:

Ziplines

Ziplines are a structure made of a cable that runs from one point (tower) to another. The point at which the zipline starts is higher than the point where it ends. The zipline uses the natural slope to carry the rider from the starting point to the ending point. The rider is attached to a pulley that moves along the zipline cable. A pulley is a wheel that has a groove or rim, and it travels down the cable.

Ziplines have become popular as an adventurous recreational activity. They have also started to become a tourist attraction because it is an interesting way to see an area from a higher vantage point.

Forces that Impact a Zipline

There are various forces that are acting on a rider as they move along a zipline. A few of the most important ones are highlighted here.

Gravity- is an invisible force that pulls objects with mass towards each other. Gravity is the reason that you come back down to earth after you jump (instead of just floating off into space) and it is the reason things fall to the ground when you drop them. Gravity is important for a zipline to work because it causes the rider to move forward and down the cable. Remember, the starting point is higher than the ending point so gravity helps pull the rider along.

Friction- is a force that resists motion when two objects rub together. Anytime that objects rub together, there will be friction. Friction acts in the opposite direction of the motion and can cause the objects that is moving (in this case, the rider of the zipline) to slow down. To make the zipline rider go faster, friction has to be reduced. Using a pulley that moves along the cable reduces the friction as the rider moves down the zipline.

Inertia- is a force that keeps objects that are at rest (not moving), at rest and that keeps objects that are already moving, to continue moving. Essentially, inertia wants the objects to continue acting as they already are. This is part of ziplines because as the rider starts to pick up speed, the inertia force helps the rider keep moving.

Zipline Structure

A zipline is anchored at two spots (towers). The tower that is the starting point of the zipline is always higher than the tower at the ending point. The towers typically have a deck area that the rider uses to take off from and to land on.

Even though the fun of a zipline is in the fast ride, braking is also needed because the ride must come to an end. There are different types of braking mechanisms that can be used. Physical braking can be used, where sometimes riders literally use their hands (while wearing protective gloves) to brake as they start to approach the end of the zipline. Braking can also be passive, which is when there is a slight upward slope near the end of the cable to help the rider slow down.

The Engineering Design Process

The engineering design process is a set of steps that engineers use when they are designing, building, and testing their products. Following these steps helps engineers clearly understand the problem they are trying to solve and allows them to make their innovation or solution the best it can possibly be.

The steps outlined below are the steps of the engineering design process and can be used when you are designing and building your zipline today.

DEFINE THE PROBLEM - This step is important because as an engineer you need to know what the problem is you are solving and what constraints there are that will impact your solution.

DO YOUR RESEARCH - Ask yourself questions like what do you think you will need to solve this problem? Does anything else exist that already deals with this problem? Learn as much as you can by researching.

DEVELOP POSSIBLE SOLUTIONS - This step is where you brainstorm as many possible solutions as you can think of. At this point it is important to remember to just think of as many possible solutions as you can - do not worry about how you would build them yet.

DESIGN YOUR SOLUTION - You will need to make a plan for how to build your solution. At this step, you should make a design that shows how you intend to build your solution and what it will look like.

BUILD YOUR PROTOTYPE - Follow the plan you created and build your solution!

TEST IT - Now that you've built your design, it's time to test your solution to see how it performs. Does your design do what you want it to? Or do you need to make adjustments?

EVALUATE - What could you do to improve your design? What changes could you make? It is important to remember that even if your original design didn't work exactly how you expected it to, that's okay! Engineers almost always make multiple adjustments to their design to perfect their product. Every time a prototype doesn't work exactly how you expected it to, it creates an opportunity for learning and is all part of the process.

Video Recommendation:

Defining Gravity: Crash Course Kids #4.1 https://www.youtube.com/watch?v=ljRlB6TuMOU
What is Friction? | Physics | Don't Memorize https://www.youtube.com/watch?v=n2gOs1mcZHA

Activity:

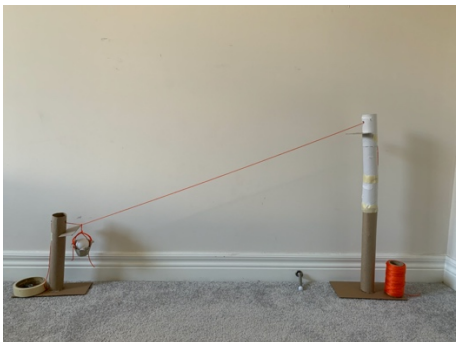
This activity is a design challenge, which means that you can design and build your own solution to the problem. The steps below go through the engineering design process as you create your zipline.

1. Define the problem - the problem that you are trying to solve is outlined in the challenge written below:

Challenge: Design and build your own zipline!
Your zipline needs to travel from one tower to another along a string. Create some sort of apparatus that will safely transport the ping pong ball from one tower to the other along the string. The string represents the zipline cable and the ping pong ball represents the rider. The towers at each end of the zipline should be free-standing, which means that they are not using anything else to help them stand up (including leaning on something or taping the tower to the floor). Your zipline should be at least 100 cm in length (from tower to tower).

2. Do your research - research ziplines to understand what they look like and for ideas on what you want to include in your zipline.
3. Develop possible solutions - brainstorm as many different ideas as you can think of for making your zipline. Think about things like what materials do you have available? How tall do you want it to be? How are you going to create something for the ping pong ball to travel in?
4. Design your solution - pick one of the ideas from your brainstorm to proceed with. Draw out on a piece of paper what you want your zipline to look like and which materials you will use.
5. Build your prototype - build your prototype based on the design you created in the previous step. Put the whole thing together.

Note: the picture of the zipline is just an example to reference and can help you brainstorm ideas if you are stuck. This design challenge is your own and you can design your zipline any way you want.



6. Test it - try out your zipline. How did it work?
7. Evaluate - now that you know how your zipline works, ask yourself a few questions. Did it work how you were expecting it to? Did your rider get stuck part way down the zipline? What can you do to try and improve your zipline?
8. Make the changes to your zipline that will make it work even better and try it out again. You can continue repeating these steps until you have a zipline that works exactly how you want it to.

What Did You Learn?

- What is a zipline?
- What forces impact a zipline?
- What is the engineering design process and were you able to use it when you made your zipline?

Future Learning

- Try to make your ping pong bottle travel between the two towers in under three seconds.
- What can you do to make your zipline more complex? Can you incorporate a pulley into your design?
- What other materials would you use if you did this design challenge again? Would you change anything about your design or would you leave it the way you built it?

Share your creations!

We would love to see what you made. Email as at discover@uwo.ca or tag us on social media.

Instagram: @westernueng
Twitter: @westernueng
Facebook: @westernueng

Thanks for discovering with us!