STEM on a Budget 2.0: A basic guide for teaching STEM in OPS afterschool programs

Tyrome Williams

University of Nebraska at Omaha

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STEM on a

Budget 2.3

A basic guide for teaching STEM in OPS afterschool programs

Tyrome Williams

New and improved: with ELO’s, High-Def Colored Marker Drawings!
The Author’s 2 Cents:

My name is Tyrome Williams. I’ve had the pleasure of teaching STEM in Omaha Public Schools’ (OPS) afterschool programs for 8 years now with the program Building Dreams and the Tyrome Williams Foundation. I have a bachelor’s degree in Nonprofit Administration and a Master’s degree in Business. I am not a professional teacher, nor do I hold a degree in teaching. However, I do believe: “I have a curious mind, I’m willing to try, and I’m willing to fail when I’m learning new things”. These are a few of the qualities I would like to instill into the students of Omaha. It’s ok to be curious. It’s ok to try new things. And, it’s ok to fail.

I would like to request that you as the reader attempt some of these activities yourself, with your own children, or possibly a kid that you mentor in order to learn something new and have a good time doing so. If you missed out on the first guide, you can find it on the Tyrome Williams Foundation Page on Facebook.

This guide is meant to be an informal outline that anyone can use to teach or instruct a STEM program. While the activities focused upon in this group are targeted towards elementary school children, the contents could be modified to be relevant to students of an older age. I hope that you as the reader gain some insight on “how you can run an awesome program that is fulfilling and dedicated to students”. I would also like to thank Collective for Youth and the Peter Kiewit Foundation for their support of STEM programming in Omaha, Nebraska.

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**Intro for this STEM Guide:**

This guide was written with the goal of providing a rough lesson plan, which could act as a supplemental guide for sustainable activities in order to better serve their students and children in the Omaha area. The STEM lessons I chose in this guide are engaging, hold educational value, and are cost effective if used properly. This book contains valuable information to supplement STEM learning. Whether you’re a teacher, instructor, supervisor for children, or a substitute; you will always be the most valuable asset in your classroom. This is a free use document and should not be sold for any monetary gain. Also, please visit, the Tyrome Williams Foundation on Facebook, and see other interesting projects we have going on. Feel free to like as well.

**Word of Caution to the Reader:**

I attempted to write this book so that anyone would be able to pick it up, understand, and then teach the lessons/activities to an individual or group of students. I highly recommend that you -as the instructor- attempt to do the project(s) prior to teaching the material. While most of these activities are fairly straight forward, I still recommend you attempt them first on your own before doing them in class. If nothing else, you will become more familiar with the activity in order to build your confidence, especially if you or a staff member are relatively new. Thus, you won’t have to reference the instructions as often and it will allow you to answer questions in class or provide assistance to your students if they are having trouble. You will also gain a better understanding of potential issues students may have along the way. The cost of activities noted in this book may vary from location to location. **The cost per activity is based on a class size of 15~30 students.**

Alwaysd try to teach your students is: “It’s ok to fail.” Make learning experiences memorable. More importantly, keep your learning environment safe and make learning fun. You’ll inspire your students to imagine, create, and gain an interest in science.
What’s NEW & How to Use This Guide

As I added more information into this guide, it seemed less like a guide and more like a book. I wanted to keep this as simple as possible, but I also wanted to prepare those who needed actual references to educational standards for their program. A little more meat with the potatoes. Things that have been added since version 1.5 are actual reference ELO’s. I tried to use relevant ELO’s based off of the national or state standards like the example I’ve given below.


<table>
<thead>
<tr>
<th>Subject</th>
<th>ELO code,</th>
<th>What grade,</th>
<th>What is the learning expectation</th>
</tr>
</thead>
</table>

I’ve also noticed that there are a lot of readers from other countries reading the previous guide. If you live in a different country, you most likely have different educational standards, which is fine. For the sake of reporting, it would be in your favor to look these up if you intend to submit an application for a grant, sending a report, etc. However, if you are using this for personal use, or a small club, etc., just consider this an additional resource you can use if you like. These are constantly updated and can change over time. You can find these on the internet.

CCSS = Common Core State Standards

- Summary of what students should know for English & Math in K-12 by grade.

MS-ETS1 = Middle School - Engineering Technology & Applications of Science

- part of Next Gen Science Standards

NGSS = Next Gen Science Standards

- K-12 Science Standards developed by states to improve overall quality.

I divided individual activities into subjects of STEM (Science, Technology, Engineering, & Math) based on how I felt they should be sorted amongst the other activities and what the educational learning outcomes were. Regardless of how I sorted them, these activities are still related to the other subjects in different ways. Example, rulers relate to fractions, which relate to percentages or time, which relates to math, however measurements can
definitely be useful in engineering. The kazoo activity uses a ruler for measurements, which also relates to sound waves relates to the wave machine. Lessons can be stand-alone or built upon by other activities in this book or common core lessons outside of it. Feel free to try these in any order, but I would recommend you attempt them yourself before doing them in class to be better prepared.

The last thing that I added in this guide are my 2-bit marker drawings versus the crayon drawings from version one. Hopefully they are clear and add a little bit of fun. Enjoy!
**Common Abbreviations within this Book:**

**Activity:** The explanation of what is done for each project.

**Continuous:** Whether or not the topic should be reoccurring until students achieve mastery.

   Depending upon difficulty revisiting topics are recommended to stay fresh. **Yes/No.**

**Cost:** How much does this activity cost to do? **Less than, Greater than, varies, or about (~)**

   The cost per activity is based on a class size of 15~30 students.

**Difficulty:** How difficult is this project? **Low, Moderate, High**

**Discussion:** This part used for refining what was learned with students in a group discussion. It is also used for associating ELO’s (Educational Learning Outcomes) with the task, student reflection, and to refine learning.

**ELO’s – Educational Learning Outcomes:** This is what the students will learn from doing the activity. Often, if you as a teacher, instructor, or employee who has to report to someone higher up, a donor, etc. This is what you tell them your students will be learning in class or can reference for what the educational standard is. These math and science standards may vary per country, state, & district. See previous section of How to use this guide.”

**Materials:** Some are optional, others are required. Try your best to use recycled materials to keep costs low in your class. Also feel free to try new materials if you think they will help.

**Pro-tip:** A little section containing my own personal opinion. Labeled in red to get your attention. This advice is meant to save you trouble, time, or as a safety precaution when doing the activities.

**Summary:** The explanation for the intended activity. This will give you a general idea of what the activity is about.

**Time:** How much time does this project take to do or preparation involved?
Easy donated items to look for:

These items are generally easy to find or to ask for from your school, site, your own home, or students can bring in. They are usually waste byproduct based, so there is no acquired cost since the products are generally thrown away by the consumers. These are some items that can be useful in your classrooms, with a little imagination and can be made into a STEM activity.

- Egg cartons,
- newspaper, regular paper, construction paper,
- cardboard sleeves from toilet paper rolls and paper towel rolls,
- plastic lids or caps of soda/water bottles,
- small boxes (including cereal boxes, large pieces of cardboard, juice boxes)
- empty pill containers (with labels off), film containers,
- art supplies (pompoms, straws, cloth),
- empty cardboard milk cartons, bottles, milk jugs, containers, empty soup cans,
- broken crayons or short crayon pieces.
- Ice cream buckets, plastic bins, etc.
- Look for things from the Goodwill, Salvation Army, Dollar Store, Dollar Tree, etc. if you have to buy something.
- Scrap paper of any kind. Ask the art teacher if they have a discard pile for paper that was cut or discarded before it’s thrown away.
- Packing peanuts or bubble wrap
**Science:**

**Simple Chemical Rockets**

**Cost:** 3.00–$5.50   **Difficulty:** Low   **Time:** Hour   **Continuous:** No

**Summary:**

Students build tiny rockets that are chemically powered. The body of the rocket are made of paper. Additional weight is added by taping either a single penny or a small metal washer. The chemicals used to power the rocket is anti-acid pain relief dissolvable tablets mixed with water. This creates carbon-dioxide to build up in the film canister until the top is blown off.
Expect rockets to fly a distance of about 4 feet. This project can be done safely, however protective eyewear is recommended if standing within a close distance from the rocket.


Supplies needed:

- paper
- film canisters (can purchase these affordably off of the internet)
- tape
- scissors
- anti-acid pain relief dissolvable tablets such as Alka-Seltzer
- washer(s) or penny
- access to a water source

Activity

1) Define the parts of a rocket. I would recommend that you build your own rocket first so students can have an idea of the task at hand. This will also allow you to discuss the major components of a rocket by pointing at them. These parts can be discussed as: What is the cylinder shaped part? (Body) What does it do? [Other parts of the rocket connect to it. It also carries the fuel.] What are the little triangle shaped pieces at the bottom of the rocket? (Fins) What are their purpose? [Balancing the rocket during flight.] What about the piece at the top? (Cone) What purpose does this serve? [It makes the rocket more aerodynamic.]

2) Now you’re ready to get started. First pass out a film canister to each student or to each group along with a thick washer (penny), tape, and paper. The washer (penny) is being used for added weight to your rocket. If you are shooting them in an exceptionally windy area, you will get a lot less flight when your rocket is light. Tape the washer to the bottom side of the film canister. You can use a penny since the cost of a penny is far less expensive and will be smaller than the diameter of film canister.

3) Important. Now roll a sheet of paper around the film canister with the penny facing inwards (towards the paper) and the lid of the canister facing outwards. If you do this backwards your rocket will not fly. Tape the seams of the paper parallel to how the paper
over laps. You should now have a tight paper tube/cylinder around your canister with the lid flush with one end.

4) Cut a rounded triangle, similar to a pizza slice as shown in the example at the beginning of this activity. This will be used to make our cone. Wrap it like an ice cream cone and use some tape to hold it together.
   a. **Pro-tip:** For smaller rockets, a cone isn’t crucial considering it will only fly a limited distance, however teaching the concepts of aerodynamics will be good for the students to learn. A cone on the tip makes the rocket more aerodynamic. You can make a comparison of the cone shape to the end of a football being thrown a perfect spiral. A spiraling football flies farther than a football that wobbles through the air.

5) Tape the cone to the body of the rocket. Make sure the cone is taped to the open end which is opposite to the film canister.

6) Now cut a right triangle. This will be one of the fins. You can use the first triangle and trace it with a pencil and cut several more so they’re evenly shaped. If you are working with younger students that haven’t developed motor skills/hand dexterity you can have triangles pre-traced or use a template out of cardboard. Or print triangular shapes on paper, and have the students cut them out.
   a. **Pro-tip:** I would recommend 3 fins, however you can let your students decide for themselves and use it as a learning experience. I’ve seen rockets with 1 fin. I’ve also seen rockets with 12 fins and two sets of wings like an airplane. Observe their flight and have them make a hypothesis (educated guess) as to what will happen and why the results occurred.

7) Tape the fins to the base end of the rocket (the side with the film canister) and space them out evenly if possible. Put tape on both sides of fins to prevent them from falling off during flight.

**Ready for flight!**

8) Locate an open area to launch rockets.

9) Take one anti-acid tablet and break it into 2 pieces. You only need a half piece.

10) Put 1 teaspoon of water into the film canister of your rocket.

11) Put ½ a tablet into the canister and then snap the lid shut and set on the ground.
    a. **Pro-tip:** Anti-acid tablets when mixed with water produce carbon dioxide; which will rapidly fill the chamber.

12) Step back about five or six feet.

13) Rockets should launch in about 8 ~ 10 seconds. If it doesn’t launch wait at least a half a minute before checking. Nothing would be worse than having a cap fly in your face or a student’s face when going to inspect it.

14) Have the students try to determine which rockets flew the highest. Were some lighter than others? Had more (less) fins? Wind happened to blow during launch? Too much tape? Was something was blocking the film canister lid?
Finished rocket
Chemical Rockets Reflection ~ Activity Sheet

Isaac Newton’s 3 Laws of Motion explained.

1) An object at rest stays at rest, until an outside force acts upon it. An object in motion, stays in motion until an outside force acts upon it.
2) \[ F = ma \] (Force equals mass \times \text{acceleration})
   a. This is the formula to calculate force. Items with different masses at the same speeds generate different amounts of force, making them more dangerous.
      Example: getting hit by a baseball versus getting in a car accident.
   b. Let’s compare the masses of two different objects: an apple and a motorcycle. If we apply the same amount of force to push both, due to their differences in mass it would produce a different amount of acceleration to each object. Most people can throw an apple, but cannot throw a motorcycle because it requires more force.
3) For every action there is an equal and opposite reaction.

Questions for discussion:

1) Why did the rockets fly?
2) What did the anti-acid tablets produce when combined with water?
3) How did the rocket’s design affect flight?
4) What are the main components of a rocket?
5) How did the rocket fly when considering Newton’s 3 Laws of Motion? (3rd Law)
6) How high or far did the rockets fly? (Use a ruler and proper units.)
7) What affected how high or far the rocket flew?
8) Have students draw a schematic of their rocket and all the parts including the film canister, penny, fins, cone, and body.

Newton’s Laws of Motion (3PS2-1, MS-PS2-1, and MS-PS2-2)

3PS2-1: Plan & conduct an investigation to provide evidence of the effects of balanced and unbalanced forces on motion of an object.

MS-PS2-1: Apply Newton’s 3rd Law to design a solution to a problem involving the motion of two colliding objects.

MS-PS2-2: plan an investigation to provide evidence that the change in an object’s motion depends on the sum of the forces on the object and the mass of the object.
Science:

Creating Waves with a Wave Machine

Cost: 5.00~$6.50  Difficulty: Low  Time: Hour  Continuous: No

Summary:

Explaining waves. Sound can be expressed as a vibrating body passing through a medium (such air or water). The vibrations move in a wave like pattern. There are several different methods of expressing its movement for a demonstration/visual aid. This is one of the easier and inexpensive ways of doing so. This activity can be done in conjunction with the “Kazoo” activity in Engineering section.

using an appropriate tool. (CCSS.MATH.CONTENT.2.MD.A.3): Estimate lengths using units of inches, feet, centimeters, & meters. 2nd grade. Science (4-PS4-1) Develop a model to describe a scientific principle, 4th grade

Supplies needed:

- Duct tape
- BBQ Skewers
- Gum drops, Gummy bears, or any uniform small confectionary candy
- Ruler (for uniform placement of BBQ skewers)
- Marker/pencil

Activity

1) Find a spot in the classroom where you can place one long piece of tape between two desks or two chairs (something that won’t move). The duct tape you place will need to be under tension. If your chairs are too light, you can place several books or have students sit in chairs to keep them from moving. The overall weight of this project is low, however it is important whatever you connect this to, has a low chance of moving for it to work properly.

2) If you use a table or chair, pull a strip of tape about 3–4 inches long to connect to one end. Flip your roll of tape upside down (with the sticky side up). Use first piece of tape to connect one end to your table, leave a small space to put both sticky ends together. The long strip of tape you string you want to face up for attaching the BBQ skewers.

3) Pull one continuous piece of tape at least 6 ~ 8 feet long and string it to the other table. Tear off from your roll and then connect this end with another small 4 inch piece facing down to connect to the other table/chair.

4) Have students use rulers to measure and mark spaces where the skewers will be placed on the duct tape. A general spacing to use would be about 2” between each skewer. This is a good opportunity for students to practice using a ruler or measuring tape. Use a marker or pencil to mark the sticky side of the tape for skewer placement.

5) On average there are usually about 100 skewers in a bag which will cost about a dollar. Place these skewers on the designated marks parallel to each other.

6) After skewers have been placed, slide on random alternating colored gum drops (for visual effect) onto skewers carefully. You will notice that tape will begin to become lopsided due to the added weight. Take your time, and make sure the tape line is still secure on the ends of the table. If you think it may release, use more duct tape to reinforce the connections. Finish adding gumdrops to the rest of the skewers.

7) Your wave machine should be lying horizontally flat. If the tape is leaning more to one side instead of being flat horizontally, attempt to either adjust skewers or rebalance gumdrops on skewers themselves until they are flat like in the picture.

8) Now go to one end of your tape strip and give one of the gum drops a lift and then release. View what happens. The wave movement should start from the gumdrop you lifted and then follow the tape all the way down, and come back again towards you.
9) Have the students try to determine why this happens.

**Wave Science & Kazoo Design**

**Why does this happen?**

You notice that the gum drops move up and down through your machine but they aren’t actually moving through laterally (left to right). What you are actually seeing is the tape pivoting up and down. The weights (gum drops) are causing the tape to move more slowly; making the movement easier to see. So by disturbing one end, you are visually seeing the energy being transferred from one end of your machine down the path and back again.

If you were to wiggle a gumdrop faster, you would see a shorter wave lengths equaling a higher frequency (more waves and higher sound).

This is also what occurs when playing the kazoo. Lots of high frequency waves.
Science:

Mechanical Advantage

**Cost:** 0.00–$3.00  **Difficulty:** Low  **Time:** 30 mins ~ Hour  **Continuous:** No

**Summary:**

Work means using energy (or force) to move an object across a distance. The further you have to move an object, the more energy it requires to move it. This is represented by a simple equation Work = Force x Distance. This activity can be done in conjunction with the “Simple Machines” activity in Technology section. This activity can be done completely with a pencil and paper or supplies suggested. This section is further covered in the “Simple Machines” activity in the Technology section.

**ELO’s – Science & Engineering (3-5-ETS1-1); 3rd ~ 5th grade.** Define a simple design. Science & Engineering (3-5-ETS1-3); 3rd ~ 5th grade. Carry out investigations. Math, Fractions (CCSS.MATH.CONTENT.2.MD.A.1): 2nd, 3rd ~ 5th grade, Measure the length of an object using an appropriate tool. (CCSS.MATH.CONTENT.2.MD.A.3): Estimate lengths using units of inches, feet, centimeters, & meters. 2nd grade. Science (4-PS4-1): Develop a model to describe a scientific principle, 4th grade

**Supplies needed:**

- Pencil and paper
- **Alternative supplies:** Wooden 2x4 scrap block, 1x6 common board, a weight.
• Alt2~ alternative supplies: a playground teeter totter, a weighted grocery/garbage bag, and a person to push down on one side.

Activity 1

1) Place a board on a wooden block or draw a line over a triangle. One end of the line should be longer than the other similar to the example figure at the beginning of this activity.
2) The work load is placed on the shorter end. While it will require more movement to push down on the longer end, it will require considerably less downward force to lift the weight giving you mechanical (work) advantage.
3) In order to achieve mechanical (work) advantage, more movement is always required resulting in less applied force (strength) required to move an object on the opposite end of your fulcrum.

Activity 2

1) Go to the playground teeter-totter.
2) Take your grocery bag or garbage bag. Fill it with enough weight to notice when lifting (ex. 2~5 lbs.).
3) Tie the bag to one end of the teeter totter. Start off on the end of the teeter totter.
4) When pushing down on the opposing end of the teeter totter you should be able to feel the resistance against you equal to the weight you attached.
5) Move bag inward towards center pivoting point (fulcrum).
6) Attempt to push down again and lift (Weight should feel less).
7) Continue to move inward again with weighted bag.
8) The closer the weight moves to the pivoting point (fulcrum), the more work advantage you gain to lift.
9) In order to achieve mechanical (work) advantage, you will always have to move more on the side you are pushing in order to require less force (strength) to move an object on the opposite end of your fulcrum.
Technology:

Simple Machines

A machine is any tool or instrument we can use to make work easier. This section will cover simply machine technology that we use every day, perhaps without even thinking about it or considering it a machine. The cost listed for this section covers all activities.

Cost: 0.00~$3.00  Difficulty: Low  Time: Hour  Continuous: Yes

Summary:

Students learn about simple machines and how they make work easier. This will also touch on mechanical advantage, often called work advantage and other associated terms. This can be done in conjunction with other projects such as using the “Ruler” activity in Math section, and “Mechanical Advantage” in the Science section.

ELO’s – Math, Fractions (MA 2.1.1) 2nd, 3rd ~ 5th grade, Science, 4th grade, Mechanical Advantage; Science & Engineering (3-5-ETS1-1); 3rd ~ 5th grade. Define a simple design. Science & Engineering (3-5-ETS1-3); 3rd ~ 5th grade. Carry out investigations.

Supplies needed:

- Blank paper & pencils. (This can be done solely on paper with a pencil, however students would benefit from this more by actually doing a hands-on activity.)
- Empty water bottles, bottle caps, skewers, string, paper, cardboard, tape, scissors, & a tiny toy car.

Several Activities to choose from

This will have several activities which include: inclined pulley, inclined plane, lever, wheel & axle, wedge, and the screw.
Technology:

The Pulley

Built like a wheel and axle, except the pulley uses a rope or cable to lift heavy objects.

Supplies

- Empty water bottle
- String
- Paper/cardboard
- Bottle cap
- Glue stick
- Scissors
- BBQ Skewer
- Weights (something small to put in your bucket such as: pennies, marbles, erasers, water, etc.)

Activity

1) Grab a bottle cap and carefully poke a hole in it with a pair of scissors (as the instructor you will want to do this part).
2) Use the glue stick to glue the bottle cap to two circles cut from a sheet of paper. You want these circles to be larger than the bottle cap itself. You can trace a coffee cup with a pencil to create perfect circles.
3) Stick a BBQ skewer through the paper, the hole in the bottle cap, and out through the paper again. This makes the pulley portion of your machine.
4) Use the bottom half of your empty water bottle to create a bucket by cutting it in half with the scissors.

5) Poke a hole on opposite sides of the bottle to thread a piece of string through and tie in a knot to use as a bucket.

6) Balance and hang your pulley between two chairs and then thread the string through your pulley.

7) Try putting a little weight (pennies, marbles, erasers, etc.) into your bucket and attempt to use your pulley.

8) Try using different size bottle caps – does it make a difference?
**Technology:**

**Inclined Plane**

**Supplies**

- Tiny toy car
- Paper/cardboard
- Scissors
- tape

**Summary**

This may seem to be the least impressive out of all the simple machines, but the amount of work advantage you can gain from this could mean the difference of impossible or getting work done.

**Activity**

Tape some paper or cardboard and construct an inclined plane or hill for the tiny toy car to roll up or down.

**Scenario**

Imagine you have a 300lb marble and you want to move from ground level to another level that is about 3 feet higher. 300lb may be too heavy for you to lift by yourself. How would you do this? Well if you had a plank of wood to create an inclined plane, it is considerably easier to roll something heavy up a slope, than it is to dead lift an object up a similar height. The same is said in reverse. It is easier for a car to roll down a hill than it is to jump off a ledge safely. The longer the board, the easier it is to move since the slope won’t be as severe. So we know from machines that it requires **less strength needed, equals more distance required traveled**. The same holds true to a slide or ladder. It may be difficult to move something heavy from the high position to a low position, but a slide or a slope makes it easy and fun.
If you wanted to do a comparative experiment, tell the students they can only use one finger. They need to move the toy car from the floor onto the top of a table. Initially, balancing and weight may be an issue. Now if you use an inclined plane, you can do more work with less strength. You have more control over the object over the distance, making it safer. Another example is a slide. It requires much less effort and is safer to go down a slide, then jumping from a 8 foot tall tower and land on the ground. With that impact you may break a leg, or twist an ankle. It also much easier to climb a ladder than it would be to jump 8 feet high, climb a rope, or climb a pole to get to the top of the slide.
Technology:

A Lever and Cantilever

Supplies (Here are several different examples that could be used.)

- Teeter totter
- A ruler, a heavy book, a thick marker on a table, and a small bag of weight

Summary

The basis for this machine is that a lever (or arm) is attached at a point known as the fulcrum (the part at which the lever pivots) giving you a mechanical advantage. There are hundreds of ways to demonstrate this in class. I provided 4 examples; however the last example is probably the easiest and least expensive if available.

Activity

1) Take a ruler and place it on the edge of a table with the thick marker underneath it. The ruler should stay on the table and pencil until it is past its center of gravity. If the ruler isn’t balanced, it will fall off of the table.
2) Now place the ruler on the edge of the table with a heavy book on top of it. (Cantilever)
3) You can now hang the ruler even further off the table or hang a small bag of weight (marbles, pennies, etc.) from it.
4) You could probably continue to pile weight on this ruler until either the arm fails, meaning your ruler breaks, or the heavy book moves causing the ruler and the weight to fall.
5) If you put more rulers under the book on the table, you could hold even more weight.

A teeter totter in the playground is a lever. If you have two kids of different weights on opposite sides, one child will need to do considerably more work than the other since the teeter totter is unbalanced.

A wheel barrow works the same way. This machine combines a wheel & axle, an inclined plane, and a lever together. It allows you to carry more weight over a farther distance because the fulcrum (pivot point) is adjusted to make the weight seem lighter when rolling. The lever attached to the wheel is carrying part of the weight for you. A pry bar is a combination of a wedge, and a lever. It must get between two surfaces similar to that a knife (also a wedge). Once inside you can use the arm as a lever, the box’s edge as a fulcrum to pry the lid open. These are called compound simple machines.

You can increase the amount of weight at the end of your ruler by putting supports underneath of it. This turns your lever into a cantilever. You see this commonly on buildings for supporting sections that stick out a farther distance than the foundation of the building. This is very common for balconies.
Technology:

Wheel & Axle

Supplies (Here are several different examples that could be used.)

- a gym dolly, skateboard, a desk chair with wheels, square piece of wood with 4 caster wheels to use in gym, or anything with wheels (optional)
- an old blanket or sheet (goodwill)
- Paper/pencil (optional)
- Stopwatch (optional)

Summary

The wheel and axle is probably the most discussed simple machine since it is relates to many machines that most people think about or can relate to today. That’s not to say a shovel is not a great machine, just under appreciated. The wheel and axle is a great, simple machine since it removes considerable friction and resistance when moving something heavy across a surface. This can be one of the easiest, and most enjoyable activities for students when trying to teach work advantage and about simple machines.

Activity

1) A gym dolly would be best for this activity. However, I find most teachers and instructors have access to an instructor’s chair with wheels in a classroom so I will use this as an example along with a blanket or sheet that can be bought from the goodwill. You can also use one of the alternatives noted above.
   a. Pro-tip: Make sure students are not pulling or pushing anyone backwards due to the risk of them falling off. Also be sure no one gets swung or flung while riding on a chair or gym dolly due to the risk of a student getting hurt.

2) Students will determine how work advantage provides them with additional speed and less resistance when trying to complete a task (work).

3) In this activity, the task to be completed is one student will pull another student in the sitting position over a distance xx feet. This distance could be half of an elementary school basketball court or whatever distance you feel you can maintain safety without anyone getting knocked over or falling. Would recommend doing this activity on a smooth surface, however it can be done on grass with a quality blanket or sheet.

4) The student being pulled should be sitting down with their legs crossed and holding the blanket or sheet in front of them so they don’t fall backwards. Be mindful of students that could become overzealous in this activity. Obviously, it’s great that students are having fun, but just be aware of potential issues.
5) Students not actively participating, should record time with a stopwatch while another documents the time with a pencil or paper.
6) There should be a time recording with the blanket and sheet, and a time using a gym dolly.
7) How much faster was one than the other? What caused one student’s group to be faster?
Technology:

Wedge

Supplies (Here are several different examples that could be used.)

- Paper/pencil
- A chisel (optional)
- A plastic knife (disposable picnic cutlery kind found in the lunch room)
- Door stop

Summary & Discussion

To me, the wedge is can be one of the slightly boring yet still extremely useful tools. It is probably one of the first tools invented as well. A knife by definition is a wedge. It is used to cut into something to break it apart. A knife does this by definition except it gives us a cleaner edge since it should be sharp versus a jagged edge. Wedges are generally used for separating things, however they can also be used to hold something in place. Allow me to explain. A door stop is kicked underneath a door and wedges between the edge of the door and the floor to hold the door open. A nail is also a wedge. It is hammered into wood and again can hold things together or hold something up. Have the class identify different types of simple or compound simple machines that include a wedge.

Here are some examples:

Wedges: knife, push pins, nail, a tack, door stop, a shim, & saw

Compound machines using a Wedge: shovel, pry bar, & pick axe
Technology:

A Screw

Supplies (Here are several different examples that could be used.)

- Screw driver or wrench
- A screw, lag bolt, a piece of wood, or any discount electronic from the goodwill
- Paper/pencil (optional)

Summary

A very common machine that converts rotational motion into linear motion. This is actually used more often than the wheel and axle, but is less likely to be thought about. The strength of the screw is dependent on the width of the threads and the actual distance between them (pitch). When the threads are closer together and wider, the screw becomes stronger. This could be a discovery activity used for not only understanding how often the screw is used in the assembly or everyday use, but also the different types of screws or bolts that exist

The Screw is used for:

1) Holding things together.
2) Lifting heavy loads,
3) Drilling holes into things.
Activity

1) Provide students with an opportunity to use a screw driver to assemble or disassemble something. This could be an inexpensive toy purchased from the goodwill or a used goods store. It doesn’t matter if the item is broken or not. This will allow students to see how things are held together.

Pro-tip: Make sure all batteries are removed and discharged prior to this activity. I do not recommend items that have large capacitors such as monitors, TV’s, or other items that are plugged into the wall. These items tend to hold their electrical charge for longer in small components known as capacitors, which can discharge with quite a lot of electricity. Small battery operated items are generally safe to use and lose their charge very quickly after unplugging batteries. If you have any concerns, use the non-electronic activity I’ve listed below.

2) Non-electronic Activity:

The non-electronic route is fine and can be inexpensive as well. Get a piece of wood from the discount pile at your local hardware store, on Facebook marketplace, or at a garage sale and then purchase several different sizes of screws. In most cases, the hardware store will cut down oversized pieces for you upon request or you can find a handy neighbor if you do not trust yourself. Students can practice attaching two random pieces together while learning how to use a new tool and discovering how they fasten together. They can also see the different types of screws and how they vary per use. This will also assist in developing fine motor skills and providing students with a sense of responsibility. I’ve noticed that younger students, often become excited since they’ve seen their parents or guardians use such tools as home.

Pro-tip: If you have concerns about tool usage and younger students, you can limit the number of tools you bring to class so you can properly supervise. Also tell the students that they should ask their parents before using such tools at home to prevent accidents.
Technology:

Compound Simple Machines

Supplies (Here are several different examples that could be used. You can use pictures or actually bring these items into class.)

- Wheel barrow
- bicycle
- a shovel
- a pencil sharpener
- scissors

Activity

Attempt to identify compound machines and what machines make them so. Compound machines are basically two or more simple machines combined to make a more sophisticated machine.

For example a wheel barrow combines a wheel & axle, a lever, and an inclined plane in order to make carrying heavy objects over a distance easier.

A shovel is a combination of a wedge and a lever making it easier to cut into the earth and then use the handle to pry (dig) a hole open. Use the knowledge you’ve obtained from the previous activities to identify compound machines and how they make work easier.

1) Show an example to the class (visual aid or actual item).
2) Have the students identify what the machine does and what the tool is called.
3) What is it used for? This is a key component for identifying what simple machines make up this compound machine.
4) Build an activity. If you have a school garden, try to dig a hole by hand, versus digging with a hand spade or using a shovel. Which was most difficult? Why is it easier to use one machine versus the other? While answers are obvious sometimes, putting a lot of thought to using the right tool for the job can save a person hours of time. Or save someone from breaking a tool. For example, using a screwdriver as a pry bar. It may work, but the screw driver will most likely break.
Engineering:

Building a Kazoo

There are many different musical instruments that could be built to reference a series of different math standards. Specifically, students need to measure pieces in order to cut and build their musical instruments. This project can be a continuation of the Ruler activity in the Math section. This activity will also assist in developing fine motor skills, understanding the need for following instructions, and the order in which they must be completed. While this particular project is fairly self-explanatory, you can make it exponentially difficult depending upon the type of instrument you are intending to build and make slight variations in order to manipulate sounds.

Cost: 0.00~$2.00  Difficulty: Low  Time: Hour  Continuous: Maybe

Summary:

Students will construct a musical instrument (kazoo) and determine what size or shape produces the best quality of sound or the loudest sound. Kazoos are constructed from readily available recycled materials in order to keep costs low. This activity can be built upon the ruler activity in the Math section of this guide. This project can be completed in one class period, you could however make it partially continuous by having the students develop new designs or styles of kazoos in order to attempt to increase the sound or quality of sound the instrument provides.

ELO’s – Science & Engineering (3-5-ETS1-1); 3rd ~ 5th grade. Define a simple design.
Science & Engineering (3-5-ETS1-3); 3rd ~ 5th grade. Carry out investigations. Math, Fractions (CCSS.MATH.CONTENT.2.MD.A.1): 2nd, 3rd ~ 5th grade, Measure the length of an object using an appropriate tool. (CCSS.MATH.CONTENT.2.MD.A.3): Estimate lengths using units of inches, feet, centimeters, & meters. 2nd grade

Supplies needed:

- Toilet paper roll or paper towel tubes. This can be collected from your school custodial staff if you ask nicely enough or bring them cookies in exchange. You can also task
students to bring them in from home. Alternative: roll poster paper or card stock into a cylinder and then tape it. A large sheet of poster paper is $0.33 at the dollar store.

- Rubber bands (your school should have these or you can buy them as a dollar store.)
- Wax paper (one roll should be enough for the whole class); Alternative: grocery bags
- Rulers would be great, if you are combining this activity with the Ruler activity in the Math section.
- A pencil to poke holes with.
- Optional: Markers to decorate or put the students name on.

**Design**

**Activity**

1) Take one of your toilet roll tubes. This can also be made from poster paper/card stock rolled tightly into a cylinder shape if you do not have enough cardboard tubes. Use a pencil to poke a hole in the side located in the center of both ends. You can support the
inside of the tube with your finger, just take care not to poke your finger if using something sharp. This hole will allow air to partially escape from the tube and will balance vibrations through the cylinder when humming or talking into the tube.

2) Take your wax paper. You will need a circle larger than the diameter of one end of the tube. A diameter of the end of a toilet roll is about 1 3/4” diameter. I would recommend cutting your circle large enough as to keep the paper down with a rubber band.

3) Place wax paper over one end of your cardboard roll. Use a rubber band to properly secure it loosely fitted onto the end so the wax paper can vibrate. Don’t tighten your rubber band so tight that it crushes your tube.

   a. **Pro-tip:** Vibration is what causes sound, also known as a “soundwave”. See the **Science** section regarding “Waves” for activities and additional information.

4) Now attempt to hum through the tube by placing your mouth to the open end of the tube.

5) How does your voice sound different? Does your voice sound like a robot? Can you hum a scale? (Do-Reh-Me…) Make adjustments as needed to get a better sound.
**Kazoo Science**

If you have ever owned a Kazoo or happen to go out and purchase one as an example for class, you will notice several things that are heavily dependent on cost. You can buy Kazoos for less than $0.30 a piece or buy via a bundle around $2.50 for 8 depending upon which store you go to. If you actually go to a music shop, you can buy a metal one for about $6~7. The one thing I notice immediately when inspecting a Kazoo is the overall shape and the material it’s made of.

When inspecting a more expensive one like in the crude drawing I made below, you’ll notice it’s not a perfect cylinder shape. It also has several weird angles on the bottom when looking at it from the side profile. From the top view, most are similar in shape even if you buy a cheap one. The red lines I’ve drawn shows a basic flow of air passing through a Kazoo. The bottom angles cause air vibrations from you humming to refract in multiple directions with sound coming through the top wax paper causing a buzz. The excess air comes out the front to maintain speed. This is why we poked a hole in our homemade version. We have two points of resistance on our Kazoos. One is a large hole muffled with wax paper, and a smaller hole that allows continuous flow of air to shoot out. It’s a simple toy with a lot of thought put into it.

![Diagram of Kazoo](image)

- **Mouth Hole**
- **Excess air**
- **Your voice (Buzz) coming out through the wax paper.**
Engineering:

**Building with Cardboard**

**Cost:** 0.00–$5.00  **Difficulty:** Low  **Time:** Hour  **Continuous:** Maybe

**Summary:**

Some of the most basic and crucial lessons of engineering are gained when you allow students to just build and explore. This activity can be done simply with cardboard and tape, or just cardboard by itself accompanied by scissors. Allow students the opportunity build a box fort or something structural in design using disposed cardboard from your school cafeteria, local store, or cardboard from home. The biggest expense for this activity is the cost of tape if you decide to use it, but it isn’t necessary.

**ELO’s** — Science & Engineering (3-5-ETS1-1); 3rd ~ 5th grade. Define a simple design. Science & Engineering (K-2-ETS1-1); K-2nd Grade. Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool. Science & Engineering (K-2-ETS1-2); K-2nd grade. Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem. Science & Engineering (CCSS.MATH.CONTENT.2.MD.A.1): 2nd, 3rd ~ 5th grade, Measure the length of an object using an appropriate tool. (CCSS.MATH.CONTENT.2.MD.A.3): Estimate lengths using units of inches, feet, centimeters, & meters. 2nd grade

**Supplies needed:**

- Cardboard
- Scissors
- Tape (optional)
- Paper/pencil (design)
Slot Assembly

Cutting slots into cardboard with scissors is one method of attaching them firmly without the use of tape. This will keep your cost down and will teach students other methods of fixing two things together. This method is used in wood working.

Pro-tip: Unless you have really thick cardboard, the channel does not have to be cut wide. Making a small slit with some scissors the same length will allow you to slide them together firmly. This can also be an opportunity for students to measure with a ruler and then cut to make sure that the channels are the same length to ensure a proper fit.

Slot & Tab (peg)

While this isn’t a true “peg” it works similarly to a peg by being inserted into a slot created in a cardboard surface. Make a small cut in order to insert a tab into a slot.
Math:

Making Sense of Fractions & Percentages

Per Math standards, fractions are learned as early as the 2nd Grade, but are reiterated at grades 3, 4, & 5. I recommend using these visual techniques to assist your students in gaining a better grasp and understanding of the relationship of fractions and their use.

Cost: 0.00~$1.00  Difficulty: Low  Time: Hour  Continuous: Yes

Summary:

Students learn the basics of fractions and their relationships to each other using the standard method and spatially. This project is completed over a period, a week to a session or semester until mastery is achieved. After students show mastery of using this tool, try teaching the class using the standard pencil and paper to confirm students understanding. This can be done in conjunction with other projects such as using a ruler.

ELO’s – Math, Fractions (MA 2.1.1) 2nd, 3rd ~ 5th grade, Percentages (MA 5.1.1 Number System) 5th & 6th grade.

Supplies needed:

- Print out sheets provided on next pages. Perhaps a pencil if you or the students fill out themselves.

Activity

For this activity, print out enough sheets for all the students in class. You can either use the pre-created tables on the next two pages or fill out your own on page on the page after that.
Visually Teaching and Learning Fractions

Print out these Sheets.

The rows below are divided into 12 individual cells. Cut out on the solid black horizontal lines. The vertical black lines represent where to cut vertically. The blue dashed lines represent how many parts per the fraction allowing another method to learn for the students. This diagram will be useful for not only teaching fractions but what their relationship is according to size, or how many are in per group. If the student is have trouble grasping $\frac{1}{2} + \frac{1}{2} = 1$, perhaps showing them that two of the “$\frac{1}{2}$ rectangles” equal the same length as the $\frac{1}{1}$ (1 whole). Or that 6 of the blue dashed parts is half of the total (12), therefore it equals $\frac{1}{2}$. Having several methods to visually understand can be helpful in teaching and learning.

**Pro-tip:** I am familiar with the use of the pie method (showing pieces of a pie) and fractions. There is nothing wrong with this method. I personally run into issues attempting to subdivide a pie equally when cutting it into increasingly smaller pieces. It can also be difficult to proportionately draw a circle (pie) and still have equal parts without the use of a compass, ruler, etc. You can always fold paper. Folding two sides together will always give you a half, making the pieces the same size if you can’t draw. If you prefer the pie method, I have included the Fractions & Time section from the 1st STEM on a Budget guide right after this section.

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<tr>
<th>1 Whole</th>
<th>1/1</th>
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</tbody>
</table>
## Fractions, Percentages, & Decimals

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<tr>
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<th>100%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/2 (0.5)</td>
<td>50%</td>
</tr>
<tr>
<td>1/3</td>
<td>0.33333</td>
</tr>
<tr>
<td>1/4</td>
<td>0.25</td>
</tr>
<tr>
<td>1/6</td>
<td>0.166</td>
</tr>
</tbody>
</table>
I have purposely left this page blank for your use. You can create more difficult fractions by printing it out and manually writing it in. You can also make your own using ruled notebook paper, a pencil, and a ruler. Or continuously folding a piece of paper, and then cutting it out on the folds. If students do not know how to read a ruler, then it’s double learning day. Use the “One Ruler” section in Math regarding activities for rulers.

Print this Out and Make Your Own!
Math:

Fractions and Time (revisited from Guide 1.5)

Cost: About $3.00  Difficulty: Low to Moderate  Time: An hour  Continuous: Yes

Summary: Teach students math, fractions, counting, and how to read an analog clock. Large print outs are included at the end of the lesson. The number of students that struggle when doing fractions, algebra, or even telling time on an analog clock is higher than you might expect. This is a good activity for teaching primary skills and ELO’s that should be refined during in-school time as well. A clock is the best pie to dissect into equal parts. There are 60 parts in total that can be divided by 30, 15, 12, 10, 5, & 2.

ELO’s – Math, algebra, fractions, reasoning, time, punctuality, making a schedule, order, critical thinking. Math, Fractions (MA 2.1.1) 2nd, 3rd ~ 5th grade, Percentages (MA 5.1.1 Number System) 5th & 6th grade.

Supplies needed:

- Printed clocks sheet(s)
- Paper watch sheet
- Scrap paper or cardboard
- Optional: laminator, dry erase markers
Pro-tip: Generally most teachers have access to a computer and printer, making this an inexpensive activity. If you also have access to a laminator and dry erase markers it can make this lesson even more effective in class by making the sheets reusable by laminating them.

Simple Clock Templates:
Making the connection between Fractions and Time, then Back again…

Discussion:

The reason why telling time on an analog clock is important is because it's related to fractions. Students who haven't mastered telling time on an analog clock are more likely to also struggle with fractions. Or possibly the reverse could be said, students who struggle at fractions, are more likely to be unable to read an analog clock.

Let’s review the diagram above, and see exactly how they are related. 1/1 is one whole or could be represented as one whole hour. While ½ is represented as a half an hour or 30 minutes. This is the same as half past five or 30 minutes until 6. A ¼ represents 15 minutes on a clock, since 60 divided by 4 is 15. Fifteen until 5pm or a quarter after three. And 1/12 represents 5 minutes. Students will improve not only reading the clock faster but making an association of fractions with math & time by practicing to count up or down fives.

If students are struggling, have them break the clock down. Have them say the hour hand first, and then ask the student where the minute hand is. Is it less than ¼’s of the way? Or less
than half? Less than \( \frac{1}{4} \)? Count by 5’s, then add one’s. There are many different variations. Find one that works for the student and also have them use their super cool personalized watch.
Math:

One Ruler to Rule Them ALL

“One Ruler to rule them all, one ruler to measure them. One Ruler to bring them all and in the knowledge bind them.”

Per Math standards, measuring is learned as early as the 1st Grade (measuring by comparing two objects). However, using a ruler or yard stick is started in the 2nd grade. I would highly recommend using this activity for both Elementary School and for Jr High. I’ve met some adults that do not know how to read a ruler. That is ok, learn with the students. It’s also important to learn relative measurement. If a student knows how tall they are, how long their foot is, how long their hand is, etc., then they will understand how much bigger or smaller something is during a conversation they are having about something else that the speaker is talking about. For example, I have a dog. Some may say he’s big, but I think he’s small compared to other dogs. I say a measurement or compare the size of my dog to the length of twice my boot size, the listener understands roughly about how big that is. The measurement is relative to our own personal understanding of size and length.

Cost: 0.00   Difficulty: Low ~ Moderate   Time: Hour   Continuous: Yes

Summary:

Students learn the basics of measurements and its relationship to the size of other things. Shoes, height, distance, etc. Preparing an activity that makes the lesson more meaningful, fun, and creative will bring more value and purpose in the classroom.

ELO’s – Math, Fractions (CCSS.MATH.CONTENT.2.MD.A.1): 2nd, 3rd ~ 5th grade, Measure the length of an object using an appropriate tool. (CCSS.MATH.CONTENT.2.MD.A.3) Estimate lengths using units of inches, feet, centimeters, & meters. 2nd grade.
Supplies needed:

- Printable Ruler template / or actual rulers (wooden or plastic)
  - Search “Free printable ruler” on your search engine. You should be able to find a ruler to print off. Inchcalculator.com has a great one that uses both inches and centimeters.
- Scrap paper and/or cardboard
- Pencils
- Scissors or tape (Either could be useful. Cut out the ruler or simply fold it and tape the folds down. Do not cover the measurement side of the paper though.

Activity

1) For this activity, print out enough sheets for all the students in class.
   a. Teaching ruler basics (see next section.)
2) Pass out scrap paper and pencils for every student or every group.
3) Have one student stand on a piece of paper, or they can take off their own shoe and then trace the bottom outline with a pencil.
   a. Having students work together is a good activity and prevents shoes from being all over the floor, but that is also one of the more interesting parts of the activity.
   b. Other things that can be measured are height, distance, size of objects.
4) Use rulers to measure each other’s shoe outline.
5) Have everyone present their discovery to the class. When the students report the findings, do not show the traced outline to the class. Have the students say, “Sarah’s shoe was 5 inches long. Now students can attempt to look at their own rulers, find the “5 inches on the ruler”, and understand how long what the speaker was talking about actually was.

In this activity you have the following pattern.

1) Learning measurements and how to calculate it by using a tool called a ruler.
2) Investigation of Relevance and how it is related to them individually.
3) Discovering using a ruler is useful, and can be used for comparing objects, especially if you cannot see an object in front of you.
4) Report Findings to class.
5) Listening students use their rulers to better understand the speaker.
Math:

Ruler Basics

Things you need to know about rulers to teach.

1) Find where the ruler starts. On rulers (like wooden or plastic ones), zero often is indented in a little bit as noted by the green arrow in the picture above (Figure 4). There is a lot of speculation in regards to why rulers are like this. I like to think it’s done to preserve accuracy if a ruler is dropped, excessive wear on the edge, etc. If it’s indented, you can still find 0 since it’s usually about 1/16” to 1/8” indented in from the left.
   a. Instructor Knowledge - This is also why carpenters will occasionally “burn an inch”. The metal tab at the end of a measuring tape tends to bend over time due to use; giving an inaccurate measurement. “Burning an inch” means measuring from the “1 inch” line as if it was ‘0’ and then subtracting 1” inch from what you measured in total to get the exact measurement.

2) Make sure your ruler has the appropriate measurements noted on your rulers you intend to use in class and become more familiar of what to look for.
3) Again, look at the picture. What is difference between the top and bottom part of this ruler? Traditionally standard rulers have both inches and centimeters. The one in this picture only shows inches and on one side it actually shows the factional value of the measurement.

   a. **Pro-tip:** Having the fractional values noted on the ruler can be useful for teaching or reiterating lessons related to fractions similar to the previous activity in this guide, *“Making Sense of Fractions and Percentages”.* However, per math standards, students are required to be familiar with both inches and centimeters. Decide which ruler is more suitable for your use.

4) An inch of the ruler can be divided into an even amount of parts. In its simplest form, it can be divided into 4 parts (1/4, ½, ¾, 1) as noted by the purple arrows in Figure 4. The second longest lines divide it up by eighths and the smallest lines divide it by sixteenths. Dividing by 16 parts is standard, however there are some rulers out there that only show 8 parts.

   a. **Instructor Knowledge:** In the trades (woodwork, plumbing, metal work, etc.) the ruler is divided up to 1/32” inch is considered standard. This can be the difference between a perfect cut and a gap caused by the width of your saw blade. Let’s keep it simple for the time being and use 16 parts. The smallest piece being 1/16 of an inch.

5) Notice the numbers on the bottom side of the ruler noted by the blue arrow in Figure 4. There are small numbers: 1,3,5,7,9,11, 13, 15, & 1” inch (representing 16) with the even numbers being represented by their fraction. On the top part of the ruler, the same lines are there, but they are not notated with any number. Lines not notated is considered standard for rulers. Depending upon your planned usage find an appropriate ruler that will work for your needs.

6) Get measuring! Ok, you’re ready to start measuring. Determine how accurate of measurements you want to use. If students have never used a ruler before, start off with just inches; which are notated in the large numbers on your ruler. Students will learn this relatively quickly since they are easy to see, and they are whole numbers. You can move
to quarters of an inch (1/4, ½, ¾, etc.) or practice rounding up or down if measurements are in between. From there, you can progress into more difficult segments.

7) Writing measurements down.

   a. Write the whole number, fraction/decimal, and then end with ” meaning inches.

   b. Example: 1 ½” or 1.5” or 1.5 inches. (Regardless if you use fractions or decimals, both come before the ” or inches.)
Math:

Measuring Length

Here are some examples of ruler exercises you can make with handouts. It can be as simple as creating blue lines on a Word document or Excel file. Students use their rulers to determine lengths like in the example below (Figure 5). Leave a space for students to write the answers.

Determine the lengths of the blue lines.

What is the length of the blue line below? _____________

What is the length of the blue line below? _____________

What is the length of the blue line below? _____________
Math:

Make Math Problems Meaningful

One thing I often struggled with when I was a child was geometry. Questions that often came to mind were: “why do I care about this triangle you’ve drawn on the chalkboard? When am I going to use this?”

This was something I have often thought about and I am sure teachers have heard at least once from a student during their career. From my viewpoint as an adult, not only having built things with my hands, and having more experience, geometry even in its most basic form seems more crucial to me. There are several different ways you could better try to relate this problem to students. My recommendation is to try changing your delivery method for solving the similar or redundant problems that occur.
Math:

Meaningful Moments in Teaching…

Geometry or Whatever...

I believe kids like to play, they love to run, and love to climb; whether is furniture, jungle
gyms, tables, etc. Here is a small discussion or story along with the same problem I would have
in class.

Example Problem 1:

Me: Who here likes to climb trees?
Students raise hands or say me.

Me: I don’t like to climb trees, because I am scared of heights.
Students laugh.

Me: So if I wanted to climb a tree (I draw the figure below on the board for students to see), how
could I figure out the height of the tree before climbing it so I don’t get so scared that I’m afraid
to climb down?

![Diagram of a tree and a person standing next to it with a right triangle formed by the line of sight from the person to the top of the tree and the ground]

It’s the same exact problem just presented differently to the class. The method is relative,
because children may have a fear of climbing or may love to climb, but also have had that “uh-
oh” moment in their life. This problem could be made extremely advanced, or kept it simple
with basic geometry, or be used by ding o a measure by comparison. (Ex. How much taller is
that tree compared to me? It’s about twice, three times, etc. larger than I am. This is comparison. We understand one is larger than the other. Extreme accuracy isn’t important, but a rough estimate should be the focus.)

**Pro-tip:** One thing I would like to bring attention to regarding this story is that I made myself the butt of the joke when presenting the problem in class. I did not ask, “Which students didn’t like climbing?” I also didn’t ask, “Who was also scared to climb trees?” This makes the focus of the subject to me as the instructor and my fear of climbing trees. Honestly, I am not afraid of heights, but this example humanizes me to my class. Second, I would rather the students tease me about my imaginary fear of climbing trees versus a student teasing another student for their actual fear of climbing trees.

**Example Problem 2:**

Our math problem doesn’t even need to involve trees to be relative. We can pretend it’s the day after Halloween. We went trick or treating the night prior and we have a big bag of candy. Our younger brother/sister loves candy too and we have to try to protect our stash. (If students don’t have a sibling, they can have a dog or pet that loves to eat candy.) Your sibling is two feet tall. Their arm reaches about 10 inches above their head and they can jump about 4 inches high. How tall of a dresser do we need to put in our room to prevent our sibling from being able to reach our bag of candy?

Both of these problems are: more relevant to the audience, include math, measurements, and involve critical thinking skills. Try to design interesting scenarios around the simple,
redundant problems in class in order to gain your students’ attention, interest, and make problems more relevant for your audience.

**Suggestions for Student Reflection**

I try to get my students to reflect on the activities or provide input, but their responses are like… kids! Well they are kids. This is common, students will in general provide complaints such as boring or they didn’t like something, but can be very reluctant to provide positive feedback unless very motivated. As an instructor you can motivate or provide incentives for both positive and negative feedback such as students who fill out their student activity reflection feedback, get to participate in a slime day or something along that line. Other small rewards may be appropriate depending what is available at your site or in your class.

On the next page, I have listed some general questions that you can ask students regarding any activity in this book or change them if you try new activities or lessons. It is a good way to assist students in reflecting upon what they did, what they learned, and what they hope to learn in the future.
Student Activity Reflection

Name:           Date:

I learned that…

Learning this made me feel…

The best part of the project was…

We can make this project better next time by…

Next time I hope I can learn about…

When I grow up, I want to be a…

Science is important because it helps us….
Author Reflection

Well, you finally made it to the end of this guide. Congratulate your students for their effort and a job well done! Don’t forget to pat yourself on the back too. You should feel proud, especially if STEM was a new topic for you. Whether you’re actually a STEM instructor or not, you tried. Hopefully, you and your students learned something along the way, and had fun in the process. That’s what’s important. Many students and adults in general feel nervous or even scared when trying new things. They are afraid to fail or look bad in front of their peers or even their own children. This is especially true with Science. It’s important is to have a curious mind and to try your best. Even if you fail, learn from the experience and then try to improve with every opportunity you have.

Hopefully you found this guide useful at your school, site, or in your classroom. I hope it sheds a little bit of light on some of the STEM activities you can do with students, while maintaining a budget for your program. If you have any thoughts you would like to share, feel free to contact me on Facebook, at the “Tyrome Williams Foundation”. I appreciate your time and consideration in reading this guide. Now, go be awesome for kids!

Best regards,

Tyrome Williams