K-12 Engineering Activities to Support Math and Science Learning, Creativity, & Innovative Thinking

Created by: The Relevant Education in Math and Science (REMS) Program at *RIT, KGCOE, TPS Lab, and WE@RIT*[1]




The REMS Program uses real-world scenarios to make math and science fun and meaningful for students in grades 5-12. Activities are designed to provide improved understanding and retention of mathematical and scientific concepts through the use of engineering practices.

The curriculum options include nine online lesson plans and interactive activities themed to examine three pressing challenges in the US: preserving sustainable, competitive manufacturing; distributing products and services across the world; and developing and delivering efficient health care services. Each of the lesson plans provides age-appropriate math and science curriculum that tie to the Common Core Learning Standards for elementary, middle and high school students.

PROGRAM GOALS

1. *Create an effective math and science curriculum for grades 5-12 with a hands-on engineering focus.*
2. *Increase number of 5th – 12th grade math and science educators using age-appropriate activities linking math and science to real-world engineering challenges.*
3. *Increase the number of students who have access to fun, age-appropriate hands-on activities that link math and science to real world problems.*

WHY USE REMS LESSON PLANS TO TEACH K-12 ENGINEERING?

- **Learning through Experience** - Children learn through experiences, and the earlier we create STEM-based experiences, the better. Engineering builds upon knowledge of science and math – with its impact reaching far beyond!
- **Enhance Scientific and Mathematical Literacy** - Use of the REMS lessons and activities engages students in some everyday applications of science and mathematics to improve their understanding of fundamental, and often complex concepts, in a way that makes sense to them.
- **Not an Engineer? Not a Problem!** - Engineering is all around us. REMS lessons use engineering concepts to integrate known math and science fundamentals through a variety of activities.
- **Not a Computer Whiz? Not a Problem!** - Lessons are a freely-accessible, user-friendly environment for K-12 teachers and engineering educators. All you need is an internet-capable computer. The lessons and activities contain consistent components, so once you become familiar with one lesson, you understand the structure of the other lesson plans

[1] *Made possible through Toyota USA Foundation funding, the Relevant Education in Math and Science (REMS) Program was developed by a collaborative effort between two programs at Rochester Institute of Technology (RIT) – the Toyota Production Systems (TPS) Lab and the Women in Engineering Program (WE@RIT), both housed within the Kate Gleason College of Engineering(KGCOE).*

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CONTEMPORARY MANUFACTURING

CYCLE TIME Assemble a skateboard on an assembly line and learn about the concept of cycle time. See skateboards built on an assembly line via videos and animations/simulations. Students experience the basic steps of the manufacturing, or assembly process and will gain an appreciation for how changing or redesigning the work can impact the cycle time. *Duration: 30-50 min.*
Curricular Topics Include: *Averaging and Comparing Numbers, Collecting and Analyzing Data, Percent Increase/Decrease, Equation Writing*

LINE BALANCING Experience the process of balancing an assembly line, using videos and simulations of skateboards being manufactured. Students learn how changing the work being done at each workstation or changing the number of people working can impact the flow of the assembly line. *Duration: 45 min.*
Curricular Topics Include: *Averaging and Comparing Numbers, Collecting and Analyzing Data, Ratios, Proportions, Percent, Bar Graphs, Normal Distribution, Extrapolation, Hypothesis Testing, Drawing Conclusions, Cost Analysis*

PERFORMANCE TESTING Study the conversion of potential energy to kinetic energy and the relationship that connects the variables. Data from releasing a skateboard on a ramp is used to demonstrate this conversion of energy and provide insights into the conservation of energy. *Duration: 45 min.*
Curricular Topics Include: *Linear Equations-Graphing and Computing, Problem Solving, Conservation and Conversion of Energy, Friction, Hypothesis Testing, Collecting and Analyzing Data, Drawing Conclusions, Functions, Interpolation*

DISTRIBUTION AND LOGISTICS

MEAL PICKING
Under Construction

ERGONOMIC DESIGN Learn the concept of ergonomics and process of designing products to accommodate physical limitations of the human body. Students perform anthropometric measurements as part of an ergonomics assessment used to design systems so people can safely, comfortably, and easily use the systems. *Duration: 45 min.*
Curricular Topics Include: *Collecting and Analyzing Data, Comparing Numbers, Statistics-Mean, Median, Mode, Quartiles, Standard Deviation*

HOUSEHOLD CONTAINER RECYCLING Understand and design single stream recycling methods that are cost effective and minimize waste. Using videos and simulations, students compare data generated from recycling processes and brainstorm pros and cons of changes to the processes. *Duration: 45 min.*
Curricular Topics Include: *Recycling, Sustainability, Collecting and Analyzing Data, Comparing Numbers, Graphing, Functions, Cost-Benefit Ratios*

HEALTHCARE

PATIENT FLOW Concept currently being designed is a core element of the problem solving process called "root cause analysis". Students will simulate a visit to the doctor's office, collect data in regards to patient wait time, and brainstorm ideas to make the flow of patients smoother and therefore quicker.
Curricular Topics Include: *Problem Solving, Rates, Fractions, Ratios, Formulating Hypotheses, Converting Units of Measure, Probability*

ERGONOMIC PACKING
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HAZMAT DISPOSAL
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Additional Research and Resources

Parents

Strategies for Parents to Support Daughters in STEM
https://www.unr.edu/girls-math-camp/resources/parents/tips

Engaging Parents in Kids' STEM Education
http://www.usnews.com/news/stem-solutions/articles/2015/06/29/engaging-parents-in-kids-stem-education

Parental involvement is as easy as PIE!
http://www.educationworld.com/a_curr/curr030.shtml

Parental Involvement Critical to STEM Interest
http://www.usnews.com/news/stem-solutions/articles/2015/04/14/op-ed-parental-involvement-critical-to-stem-interest

Educators

3 Ways K-12 Teachers Can Encourage Girls to Love STEM
https://onlinedegrees.sandiego.edu/girls-in-stem-how-teachers-can-help-break-stereotype/

Changing the Conversation: Messages for improving Public Understanding of Engineering
https://www.nae.edu/19582/Reports/24985.aspx

See our website for more resources
http://www.rit.edu/kgcoe/women/resources/links

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Additional Camps and Activities

These camps are a great place to start looking for further engineering experiences!

WE@RIT's WE Explore

Open to 4-6th grade girls with an interest in hands-on exploration of the engineering design process through two unique design-build activities. Navigate to we.rit.edu, click on K-12, then WE Explore. Typically the first Saturday in March from 9am-12pm.
http://www.rit.edu/kgcoe/women/we-explore-0

Camp Tiger: A Summer of STEAM

Lots and lots of camps for grades 5-12th in coding, engineering, and beyond!
http://www.rit.edu/academicaffairs/koc/

Bioscience Exploration for Middle and High School Students

These camps offer a variety of different sessions about medicine, diseases and sustainability.
http://www.rit.edu/healthsciences/cbet/camps.php

RoboCamp

Students engage in hands on activities in the robotics field including motors, sensors and programming at varying levels.
https://robocamp.rit.edu/

Summer Math Applications in Science with Hands-On (SMASH)

This camp is unique in that it is only for girls and it focuses on building confidence in science and math through hands on activities.
https://www.rit.edu/castle/programs/smash/overview

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6 Ways to Make STEM Cool!

Number 1: "I want to be just like you, mom!"

Kids want to be just like their parents. If they constantly hear "I do not like math" or "I was never good at science" and "I never used any chemistry after high school", then chances are your kids will pick up on and repeat those feelings. Regardless of how competent a parent is in math, science or technologies **keep the messages positive**. Reinforce how you might be better at math if you would have tried harder or seen the challenge in it.

Number 2: It's a household chore…

When you think about it, math, science and chemistry are used in everyday activities. Some examples include cooking, building, changing oil in the lawn mower, sewing and even balancing the checkbook. Parents should find ways to draw attention to these practical uses or even come up with challenges as their kids do these activities with them.

Number 3: Schools out for Summer!

Vacations and visiting new locations are ways to include sciences and technology during unexpected times. Look for technology-based exhibits, museums or events to include in your travel itinerary and help show how it can be fun and interesting to discover new things.

Number 4: "I can't wait to open my presents…"

While a chemistry set may not be on your daughter's birthday or holiday list, that doesn't mean you can't sneak some math or science gifts into your gift giving. There are plenty of fun on-line games and hands-on kits that can engage kids of all ages and potentially spark their interest in something new.

Number 5: Here is Your Math Trophy!

Everyone loves a scavenger hunt or earning special privileges. Search on-line or create your own games for your kids to discover math or science around them. This can be great in the car or on rainy days, and can include rewards of their favorite foods or outings. There are also a number of apps that are tailored to math/science/computers where the kids can win points that they can use later to play games.

Number 6: Last summer, at chemistry camp…

Your daughter might be asking to go to gymnastics camp or soccer camps which are valuable in their development. You can help widen their interests by including a science, math or technology camp in their summer plans as well. Most communities have a variety of options for kids, including local colleges or science museums. RIT has several camps offered every summer! Search RIT K-12 Academy for more information!

*The above information has been adapted from GE Girls.

For more information, visit **http://ge-girls.com/**

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DIY Science

Measure the Speed of Light Using Chocolate and Your Microwave

E=mc2 is the wonderful formula that explains the theory of relativity for us. One of its most interesting pieces is its constant “c”, the speed of light. By using your microwave you can calculate the speed of light using even something as simple a chocolate bar!

Oobleck

Oobleck is a non-Newtonian fluid, or a fluid that doesn't behave the way fluids we think of as "normal," like water, behave. Oobleck, in particular, is interesting because its viscosity, or its resistance to flow, increases when pressure is applied to it. That is why when you squeeze it in your hand, it feels like a solid, but when you let it sit in your palm, it flows like a liquid. You can create a non-Newtonian substance in your own home!

Extract the DNA from a Leaf of Spinach

You can isolate the DNA from a sample of spinach using a blender, dish soap, and rubbing alcohol. First the cells are broken up in then blender. Next the detergent is added to emulsify (or break up) fat. The meat tenderizer is added to break down the proteins in the spinach. DNA is soluble in water but not alcohol. This last step allows the DNA to precipitate out so we can collect it!

Make your Own Ice Cream

For ice to melt, it takes in heat from its surroundings. Adding salt to the ice reduces its freezing point, so a lot of heat is taken from the little bag. Therefore, the milk and sugar become frozen, creating yummy ice cream!

Bend a Bone

Without calcium, bones become soft. Use vinegar to remove minerals from the bone to make it bendy! Because vinegar is an acid, it dissolves the minerals like calcium in the bone. Remember, milk provides our bones with calcium, and acids in soda can take calcium away. Think before you drink!

*The above information has been adapted from CanTEEN.

Find instructions and many more DIY activities at

https://carnegiestemgirls.org/stem-activities/activities/

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Useful Links

CanTEEN Girl	Career Exploration is an innovative resource to inspire girls to envision themselves in STEM careers through gaming and online activities.
Engineer Girl	Engineer Girl is a similar site to Braincake that has been developed specifically for middle school girls.
Engineering Your Life	Engineer Your Life is a website about engineering for high school girls that includes inspiring role models
SWE Aspire	Society of Women Engineers Aspire provides an assortment of activities for doing engineering outreach.
Dotdiva	Dotdiva is a collaboration of young women who promote the potential of a computing career to build a better world.
Girl Geeks	Girl Geeks is an online community for women and girls interested in technology.
Gotta Have IT	Gotta have IT, developed by the National Center for Women & Information Technology (NCWIT), provides resources to encourage girls in computing. These resources encourage girls in computing and enhance K-12 computing education.
Sally Ride Science	Sally Ride Science offers books and activities as well as a downloadable copy of a parent handbook to help encourage their daughters' interests in science, math, and technology.
The Nerd Girls	The Nerd Girls are a group of women who strive to boost confidence and self-esteem by breaking down the stigmas that intimidate women from engineering. They are dedicated to bringing creativity to design and create things that benefit humanity.
The National Girls Collaborative Project	The National Girls Collaborative Project™ (NGCP) is designed to reach girl-serving STEM organizations across the United States.

These links can be easily accessed by visiting

http://www.rit.edu/kgcoe/women/resources/links

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Test Drive a Career in STEM

See What's Up at Your High School

Take a look at your high school's courses and programs to see what's available that could give you a sneak peek. Some schools offer Technology Education/pre-engineering programs, such as Project Lead the Way which provides interesting hands-on engineering experiences. Even if your school doesn't offer engineering-related programs, talk to your counselor or teachers in the math and science departments about what other opportunities might be available, including after-school programs, workshops, contests, or special events.

Attend a Summer or After-School Program

There are short-term programs that will allow you to actively experience engineering firsthand, make new friends, and have a fantastic time. A good place to start looking for opportunities is the Engineering Education Service Center's database of pre-engineering summer camps where you can do a quick search by state. You can also check out the Society of Women Engineers' calendar for fun engineering events with practicing engineers nationwide, and join SWENext. And be sure to research Web sites of local colleges, universities, and high schools to see what after-school, summer, and pre-college programs they may offer. For instance, RIT offers K-12 Academy.

Watch TV!

Design Squad is a PBS television show in which eight high school contestants tackle engineering challenges for an actual client. In the final episode, the top two scorers battle for the Grand Prize—a $10,000 college scholarship. The Design Squad Website offers plenty of information for high-school age kids about engineering.

Talk to an Engineer or Engineering Student

Talk to an engineering student or professional, whether it's over e-mail, lunch, or in a formal mentoring or job-shadowing situation. You'll find many enthusiastic and willing hosts.

Consider an Internship or Part-Time/Summer Job

Explore opportunities for internships (paid or unpaid), part-time work, or summer jobs at engineering schools or companies. Job opportunities often appear on an organization's website, but you may also be able to find information through your school's guidance office or your local library.

*The above information has been adapted from Engineer Your Life.

Find more ideas and information at

http://www.engineeryourlife.org/cms/makingithappen.aspx