

Solution Fluency

STEM

Learning IDEAS GUIDE



STEM Projects for K-12 Learners



Bring STEM to *Your* Classroom

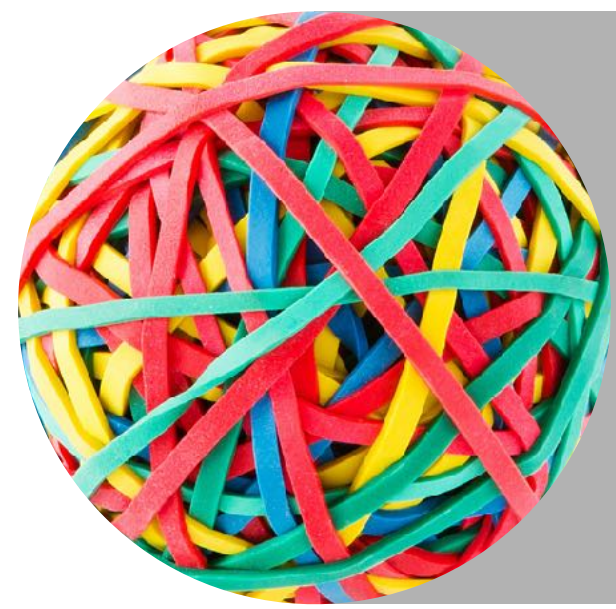
STEM learning takes students on a cool journey of creativity, exploration, and true real-world relevance. **Solution Fluency** provides the building blocks for this. It's a way for students to learn good problem-solving skills and to become successful with any challenge. This *STEM Project Ideas Book* will help them do exactly that.

Inside are STEM project ideas for years K–12. There are 12 awesome projects for science, technology, engineering, and mathematics to choose from with choices for primary, middle, and senior grades.

What if a scenario idea you like isn't for your specific grade? No problem—these lesson ideas are customizable and scalable for *any* grade level. They're also cross-curricular in nature, and can be adapted to other subject areas.

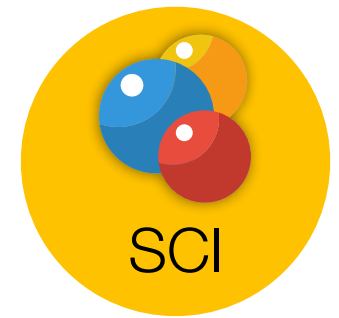
Explore these scenarios and think creatively about how you can bring STEM learning to life for your students.





Rubber Bandstand

How can we use everyday objects like rubber bands to make music?



*Science, Music, Arts & Crafts,
Language Arts, Math*

People have been making music since humankind began. The voice was probably the first musical instrument, and people quickly discovered that objects could be used to make music as well. Although musical instruments have evolved since then, people are still making music with everyday objects.

An arts group in your community is organizing a concert to raise awareness about the need for funding of school music programs. To make the point that effective music education does not necessarily require spending huge amounts of money, they are looking for some students to take part by making music with everyday objects.

You and a group of your classmates decide to participate by playing instruments you make yourself using rubber bands and other common materials. Play with different objects and discover what sounds they can make.

In addition to your performance, you will emphasize the connection between music, science, and mathematics education by giving a presentation that includes a brief scientific explanation of how your instruments work.



DEFINE: In this lesson, student groups will play a song using instruments they constructed themselves using rubber bands. After their performance, students will discuss the science behind their rubber band instruments.



DISCOVER: Students begin by exploring sound pitch, musical instruments, and performance. How can they turn everyday objects into instruments that make unique sounds? How would such instruments be made?



DREAM: What types/thicknesses of rubber bands will they need for their instrument? What additional materials will be needed to construct their musical instruments? Do they want to write a song, or cover one?



DESIGN: They should now identify the materials needed to construct their musical instruments and have a clear plan for constructing them. Students can also decide on a song to play and who will perform what parts of it.



DELIVER: Students use rubber bands to construct musical instruments that produce different sound pitches. Next, they perform their songs, and then talk about the science behind the different musical sounds they created.

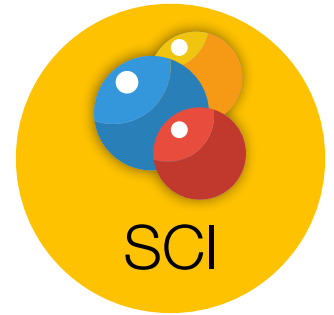
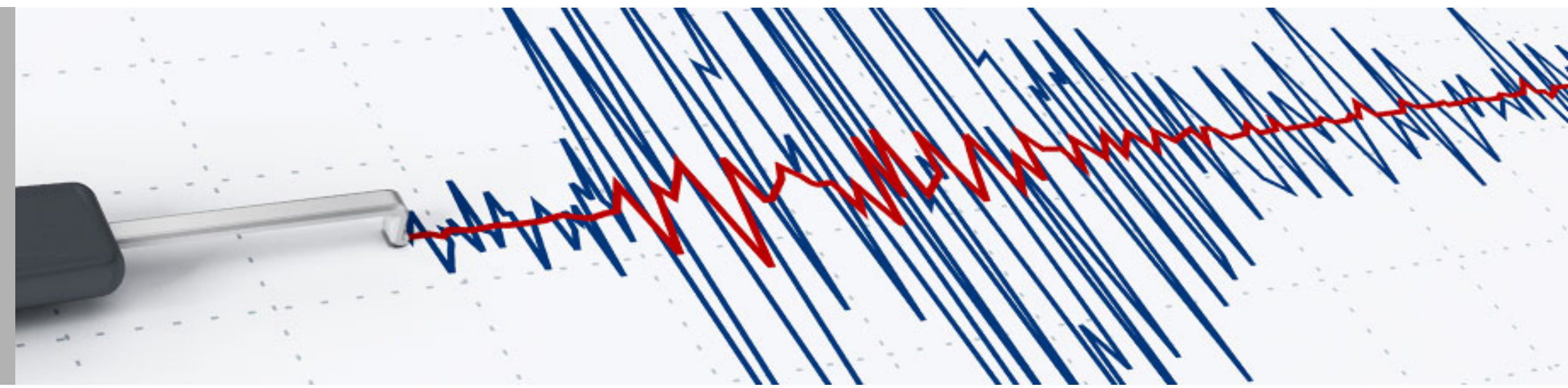


DEBRIEF: What did the students learn about sound and how to create it? Have them share those aspects of their presentations they thought best illustrated the different pitches of sounds and frequencies of vibrations.



Earthquake Machine

What happens to the Earth's crust during an earthquake, and how can this be simulated?



Science, Engineering, Math, Technology, Language Arts

Students get to shake things up in this lesson when they get together in groups to design and build an idea for a working earthquake simulator. They are invited to either produce their idea as an animated digital presentation, or build an actual working model of their design.

This is a machine that will allow people to experience the sensation of being in an earthquake. Research the accounts of people who have experienced them, and learn about the sensations they describe. Use the information from your research as the basis for your design.

Create a scale model using readily accessible materials or, if you wish, on a software program. The key to your earthquake machine is to design it so the whole artificial environment has to move, not just the ground. That way there is no visual perception of movement, only feeling—just like a real quake.

The presentations for this lesson will last between five and 10 minutes. Describe and illustrate the components of your earthquake machine in your presentation and how they work to simulate an actual earthquake.



DEFINE: Students will work in groups to create either a working model or a digital presentation of a functional “earthquake machine” that simulates the movement of an actual earthquake.



DISCOVER: The student groups research earthquakes and their causes. Have them collect information on physical ground movement during a quake, and investigate reports of individuals who have experienced an earthquake.



DREAM: What kind of a model or demonstration can learners design that effectively simulates the movement of an earthquake? Have them brainstorm ideas and get down some rough drafts for their design.



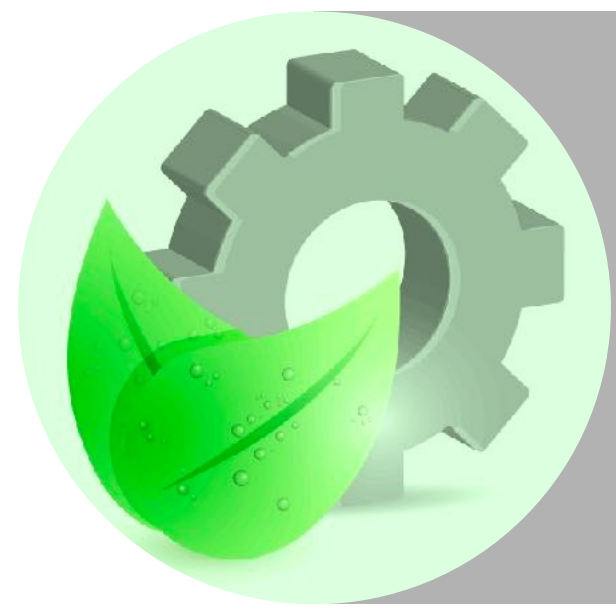
DESIGN: Will students create a diorama-style model of their machine, or bring it to animated life in a digital presentation? Is it mechanical or manually operated? They can really let their imaginations work here.



DELIVER: The groups will now demonstrate the ideas they have for an earthquake simulator machine. Their designs should work in a manner that effectively demonstrates ground movement during an earthquake.

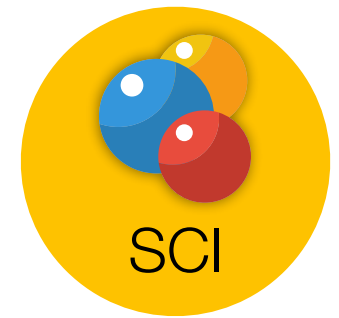


DEBRIEF: Ask students if they feel the ideas presented have provided accurate simulations of earthquake movement. What have they learned about earthquakes and how they change and affect the Earth?



The Clean Machine

How can we use waste products to counteract our dwindling conventional fuel sources?



Year
10–12

*Science, Design, Mechanical Engineering,
Language Arts, Math*

More and more, we are looking to alternative fuel sources as the answer to many of our current environmental issues, including waste and recycling. With ingenuity and experimentation, entrepreneurs and scientists all over the world have developed concepts for deriving usable energy from otherwise unconventional sources.

Your challenge is to come up with an idea for your own machine that runs on an alternative fuel source. You are building this machine to serve an actual purpose; it is required to have a specific function intended to offer something that most people would find useful or helpful.

Think about what it will use as a fuel source that will also combat a waste problem. It could be powered by trash of some kind, or use some kind of recyclable material. Present your design using plain illustrations or digital software and blueprints (which can be rendered in the same ways).

In two weeks, you will need to provide the patent office with a full explanation of how your machine works and its purpose, in a technical manual format.



DEFINE: In this unit, students work in groups to come up with a unique idea for their own personal invention for society that runs on an alternative fuel source, while also addressing widespread trash/recycling problems.



DISCOVER: Students will look into how trash and recyclable materials have been used as energy to power different “clean machines” conceptualized by inventors in different parts of the world.



DREAM: What will their clean machine look like? How will it operate and what is its purpose? What fuel source will it run on? How can they design its fuel consumption mechanics effectively and economically?



DESIGN: Student groups will now begin expanding their visions of an alternatively-fuelled invention using design programs and illustrations to conceive its operating characteristics, appearance, and functionality.



DELIVER: Student groups have completed their final clean machine design presentation projects and present them to a chosen audience for critique and assessment, fully explaining their purpose, functionality, and benefits.



DEBRIEF: Have the groups consider all the designs they saw from the other students in this lesson. How did each design illustrate a desire for a cleaner, healthier world? What would they have done differently with their own?



Brainy Inventions

How can knowledge of the local and global market help us improve a gadget or tool?



Technology, Math, History, Science, Language Arts, Design

Have you ever thought about how people lived in the past without some of the inventions or gadgets we use today? What do you do when an invention or gadget is no longer as useful to people as it once was? Give it an update, and use Solution Fluency to breathe new life into an old idea!

Your group of inventors will add an improvement or redesign to an obsolete invention or gadget to make it work better and once again useful to people. Students must produce the redesigned invention or gadget using the resources necessary for its production. They must also demonstrate the usefulness of the invention or gadget to include in an advertisement marketing the newly redesigned gadget to the public.

Choose to either create a new gadget or select a gadget to redesign in order to produce and sell it to the public. You must identify the price for the product by comparing it with other similar gadgets on the market.

Use creative designs, storytelling, mathematics, and science to work with your team and make something that's old brand new again!



DEFINE: Students pick an invention to improve on and learn about how it was created. They'll also think about how it could perform better than it does now and how they'll choose to improve it.



DISCOVER: Get students to think of how the gadget will be improved compared to other gadgets or a previous version. What are similar inventions doing that's better and more efficient?



DREAM: Students now imagine their ideal redesign or reconstruction of their invention for the public. How will these improvements help people? What is their dream for the perfect redesign?



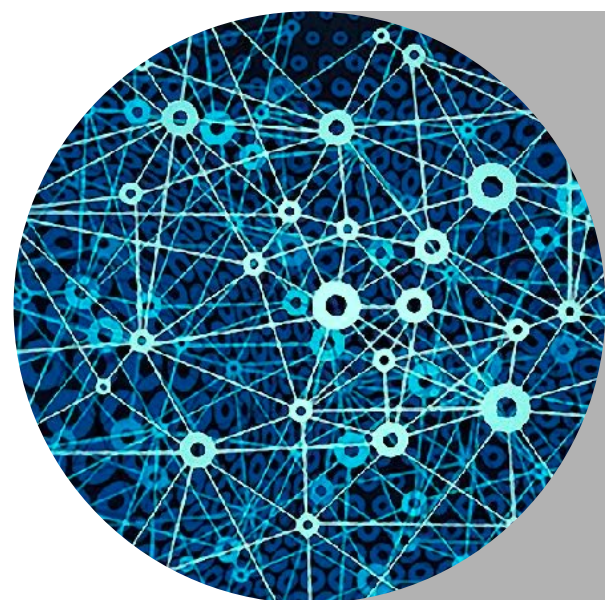
DESIGN: The groups will begin charting out their new improvements and get them down on paper. They can also build models for interactivity and for demonstration.



DELIVER: Students now present their improved invention. Have them describe what they improved, how they did it, and why they felt it was a necessary upgrade.

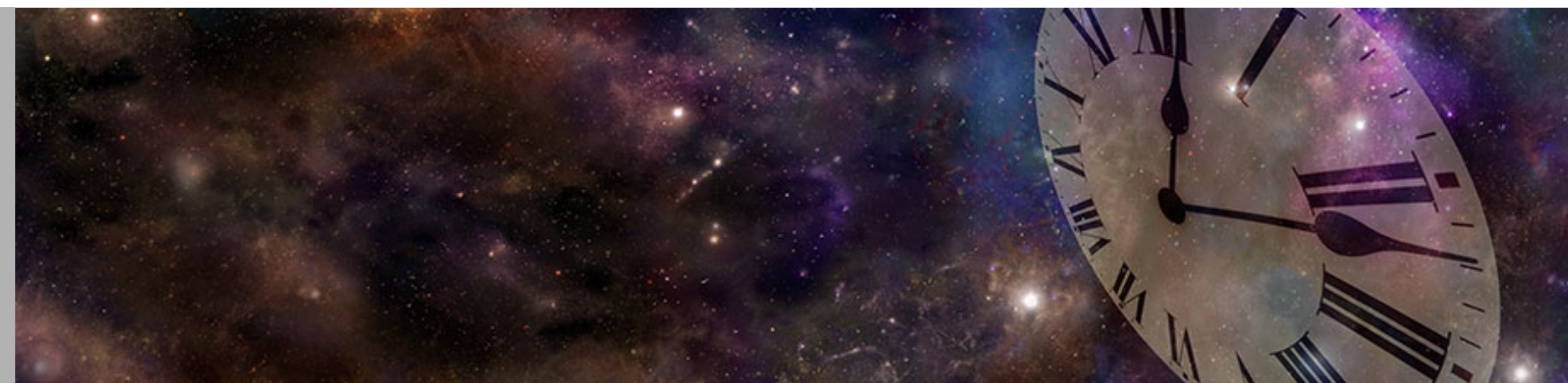


DEBRIEF: What were the challenges of redesigning or recreating this gadget? If they could choose a different gadget to produce, what would it be and why?



Webs of Time

How can we use technology to represent history in creative and compelling ways?



Technology, Web Design, History, Language Arts, Media

Imagine Martin Luther King Jr., President Abraham Lincoln, Albert Einstein, Shakespeare, or Odetta Holmes having the same access to technology we have today. What if they all had websites? What could their genius and passion have accomplished that wasn't possible in their own time? How far could their voices have reached across the world, and how would their messages have changed?

In this lesson you will be picking a point in our history that was the defining moment of an important figure from the past, and designing a web page from the point of view of that individual, to share their ideals with a new generation.

You'll be digging deep into the mind of an important historical icon of your choice and learning about their morals, values, and the message they worked tirelessly to bring to the world. Next, your goal is to build a web page as though you were that person, but with the power to get your message across the planet in an instant with the help of technology.

How will you use the Internet to spread your historical character's voice to a world that doesn't yet know how much they need to hear it?



DEFINE: Students will be working in groups to find a creative way to represent the values and beliefs of an important historical figure by designing a web page as though they were that person using the technology.



DISCOVER: Let students begin by choosing an historical person whose message resonates with them and learning as much as they can about that person's message, why it was important, and how it affected the world.



DREAM: Now learners imagine they are in the shoes of their favourite historical figure, with the Web at their disposal. What do they want to say, and why? What is their goal? What would their web page look like?



DESIGN: Students start creating their first drafts of the web pages they want to create. As they do this, they will need to think about how their designs align with the personalities of the historical figure they are portraying.



DELIVER: It's time for students to finalize and display their web pages for everyone to see. How are these timeless beliefs and messages brought to life with the power of technology, and how does this change their message?



DEBRIEF: What did the students learn about the power technology has to reach people and make a difference in the world? How do they feel they did at representing their historical icon, and what would they do differently?



The River of Life

What are some economical methods for purifying non-drinkable water?



Year
10–12

*Technology, Science, Language Arts,
Environmental Studies*

One of the most precious resources we have on our planet is water. It is purifying, life-giving, and vital to our health and our very survival. Most of the Earth is covered by water, and yet only a small percentage is usable to us. What could we do to fix such a seemingly impossible challenge?

Imagine that you are part of a team of scientists living in a future world that has depleted its freshwater drinking supply. The supply is nearly gone, and you are on a mission to save your world. Devise a workable method for purifying the salt water covering your world and suggest ways that the population can conserve and manage this new resource personally.

You will be researching water purification and conservation techniques to help you present a correct process for making undrinkable water drinkable. Show in a short five- to 10-minute presentation how the people of your world can conserve water wisely, and demonstrate to them your discovery for making potable water from what is currently non-drinkable. Using graphics and animations, illustrate your ideas and theories in a digital presentation for a global audience to watch and learn from.



DEFINE: Students are saving the planet's water supply by combining research and teamwork to create purified water from non-potable sources. They will also suggest conservation guidelines intended for a global appeal.



DISCOVER: The groups begin with researching and comparing the ratio between drinkable and non-drinkable water on our planet's surface, and determining why our freshwater supply is so limited.



DREAM: How will students proceed to discover a proper method for turning impure water sources into something drinkable by the whole planet using research and imagination to collaborate on their presentations?



DESIGN: Students will now begin outlining their presentations. Their research will continue throughout this phase as they test out actual working processes for water purification using what they discovered earlier on.



DELIVER: In this phase, students will be spending time finalizing their proposals for their water purification procedures before presenting them for critique and assessment.



DEBRIEF: What if our water supply actually was completely compromised or used up? Would a global solution be easily implemented? How could the world come together to solve this problem?



My World Wonder

How can we preserve natural landmarks while allowing for the growth of global tourism?



Engineering, Social Studies, Design, Language Arts, Economics, Tourism

There are so many spectacular places here on Earth to see, many of which are visited by millions of sightseers from all over the world every year. Many of these places are in danger of becoming severely damaged. It seems that more and more of Earth's natural beauty is becoming endangered for different reasons. How can we change this for the better?

In this lesson, students suggest how to preserve our natural landmarks. They will create solutions for accommodating a growing number of tourists to a world landmark in a way that protects it from further deterioration. Their recommendation will be designed to allow many people to continue enjoying these landmarks in the years to come.

Collect information on the kinds of things that are threatening them, such as foot traffic or pollution. Your team will construct an informative presentation of a landmark site describing its brief history and why it is important, and why it's a popular tourist attraction. Your presentation will also include your proposed solution for protecting and preserving it while allowing for the continuation of annual visits from tourists.



DEFINE: Students research landmarks that are being endangered by the growth of tourism. They will come up with a unique solution for protecting and preserving this landmark to accommodate the continuing global tourist trade.



DISCOVER: Ask them to focus on those landmarks that are in danger of deterioration and possible extinction. Why is it considered so important to protect and preserve these sites?



DREAM: Find a way to protect and preserve your landmark and allow for the continuing growth of the tourist trade. What could protect these landmarks while allowing an increasing number of people to visit and enjoy them?



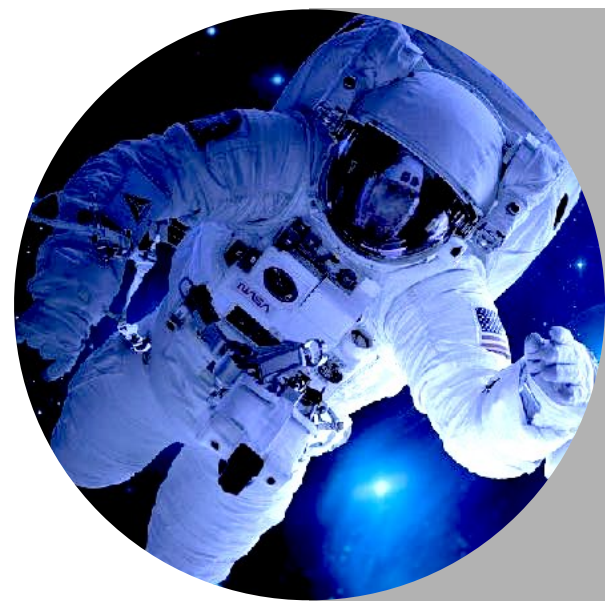
DESIGN: Each group will now begin designing the solution they have in mind for preserving their landmark sites. Their solution must include an estimation of tourist growth that they made during the Discovery phase.



DELIVER: Groups present the solutions they have designed for protecting their chosen natural landmark. Their visual representation of the landmark is the main focal point.

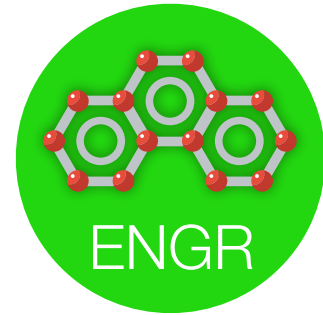


DEBRIEF: Have them share what they have learned about our natural landmarks from their research. What did they learn about designing ways to protect them, and why their preservation matters?



Moon Water Park

How would you design a theme park for an extreme environment?



Year
6–9

*Engineering, Physical Science, Design,
Tourism*

The owners of a small water park in your area are hoping to help their struggling business by capitalizing on lunar colonization. They've decided to generate some buzz in the local media by releasing plans for their water park on the Moon. Based on your knowledge of physical science, they've asked you to help them out by coming up with a preliminary water park design and presenting it at the owners' monthly meeting.

Your tasks are clear. Your design and 3- to 5-minute presentation must include the following:

1. An interactive map that shows the entire water park
2. Blueprints for three different waterpark rides or attractions
3. An analysis of how the physical state of water will be affected by conditions on the Moon, including gravity and temperature
4. A description of how the water park and its rides will be designed to meet the challenges of an extreme physical environment

You will have one week to prepare your design, so reach for the Moon!



DEFINE: Students design a water park for the Moon using their knowledge of physical science. They'll analyze how the physical state of water will be affected, and describe how their water park will meet those challenges.



DISCOVER: Students research physical states of water and how they change from one to the other. Learn about how engineering can overcome physical constraints, and think about how to apply this to their designs.



DREAM: Each group visualizes the physical environment for the park and how the lunar environment will be controlled. They'll also make practical considerations like who will go to the park, what they'll wear, and so on.



DESIGN: In this stage, students map out the production process for the design of their water park, as well as their presentation describing it. What specific rides will they include in their blueprints?



DELIVER: Students present their water park designs using their interactive maps to illustrate the layouts. They describe their three water rides using their blueprints in the description.

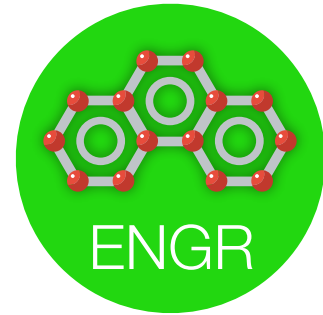


DEBRIEF: Ask students to think about what parts of their water park designs and ride blueprints were most effective and what they would do differently to improve their park and their three attractions.



The Right “Dome-ain”

How can we design and market a bio-dome for a chosen planet’s environment?



*Engineering, Science, Design, Technology,
Environmental Studies*

Do we have the skills and knowledge to colonize other planets? If it is to be achieved, we must consider ways of preventing poisonous gases from harming us, keeping ourselves and the food we grow at the right temperature, recycling our wastes, coping with a different gravitational force, and harnessing oxygen to breathe.

Your challenge is to build a dome-shaped habitation and modify the design to suit the specific conditions of your chosen planet. The design must be lightweight, cost efficient, and easy to maintain. It must support a family of 10 people and provide any supplies they would need for a comfortable existence in their home away from home. Any animal products will be farmed off-site, but any vegetable or fruit products will be grown within the “dome-ain.”

It’s a difficult task, but the fate of humankind may rest on the ability to expand to other lands in the solar system. You’ll be producing a virtual tour using computer animation. Include the unique challenges to survival on your planet, an estimate of the costs and weight of your design and its key features, and a description of how the needs of the inhabitants are being met.



DEFINE: Students will work in groups to research the conditions that the inhabitants of another planet would encounter, and design a dome-shaped habitat to comfortably support a family of 10 living on that planet.



DISCOVER: Begin by constructing a makeshift dome using full-size drop sheets or by constructing scale models. How can they make it work for a family of 10, considering everyone’s needs?



DREAM: The students can now design the layout of their structure, consider the materials that will be used, and the rooms that will be needed, taking into account all personal and communal family necessities for 10 people.



DESIGN: Students will finalize a computer-based version of their “dome-ain” for the virtual tour. In addition, they will plan how to communicate the workings of the unique features of their “dome-ain.”



DELIVER: Each group completes a final version of their virtual tour that includes a description of their “dome-ain,” planetary features, materials used, and costs. They can now present them to the class.

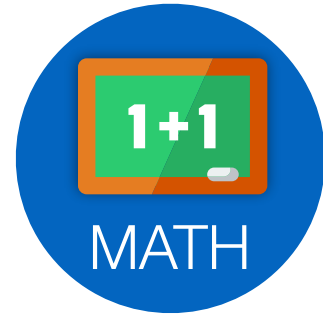


DEBRIEF: How did the construction of the “dome-ain” help the students in designing their habitat? What was the most challenging part of their own “dome-ain” design?



Easy as Apple Pie

How can you help save the jobs of the workers in your area by using your knowledge of math?



Math, Economics, Home Economics, Advertising

The recent weather has jeopardized the apple crops at the local orchard. The apples have ripened earlier than expected, and if the crop is not produced into apple products soon then the crop will be wasted and the orchard will go out of business. The local orchard employs over 30 people—you must help them process and sell the food or a lot of people will lose their jobs.

Your school is running a bake sale to collect money to help the struggling apple orchard. The orchard has an abundance of apples, but due to the unseasonal weather they stand to lose a great deal of the crop due to spoilage. Your team must use their knowledge of multiplication and division to portion the apples and produce them into delicious goods for consumers. They must use their knowledge of the production cycle to transform a natural resource like apples into a profitable product to sell to consumers.

Finally, the group must produce a bake sale advertisement to spread the word to consumers, volunteers, and community members. The apples do not have long before they rot, so you've got to work fast!



DEFINE: Your student group is stepping in to plan and volunteer for a school bake sale with the profits going back to a struggling orchard. Your group must research delicious apple-related foods to produce for the bake sale.



DISCOVER: Have students discover numerous dishes, baked goods, or other products containing apples. Remind them to select from the list of the baked goods or other apple dishes they will serve at the bake sale.



DREAM: What will be needed to produce these goodies? What supplies, equipment, etc. will the groups need to operate the bake sale? Who can you ask to help with any of the foods that need baking or cooking?



DESIGN: In this stage, students will identify the resources and recipes needed to produce each apple product. They'll also calculate costs for supplies, prices, profits, etc.



DELIVER: The students distribute their bake sale summary to the orchard for their future bake sales, and construct an advertisement to distribute to the local community to promote awareness of the event.

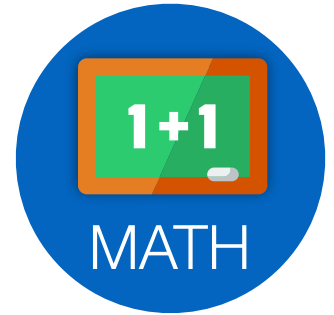


DEBRIEF: How does it make you feel to volunteer your time to help others? Why is it important to help neighbours and businesses in your community? Would you change any apple dish after seeing some of the others' recipes?



Light Painters

How can you combine your knowledge of math, art, and design to help resolve a problem?



Math, Art & Design, Technology

A heavy storm recently struck your city, and ravaged a prominent stained glass window in a landmark church. Rather than build a replica of the broken window, the church council has called for artists to submit design templates for a brand new window. That's right up your alley.

You have a good design sense and a talent for creating geometric patterns. Why not try your hand at creating a window design? Work in pairs or groups to create the most remarkable stained glass draft you can think of, using the tools of mathematics and fun research. The patterns must include clear geometric shapes and symmetry.

You will need to know the shape and the exact measurements of the window opening to plan the dimensions of the major sections of your design. Using a large window in your home or school, note all important measurements in the template, including the measurements of the major angles and sections of the design. When your design is complete, you will go on to construct a full size overlay of the stained glass window. Create a light-infused work of art!



DEFINE: Students are creating a geometric design for a stained glass window. Use measurements of a window at home or in the classroom, and create a pattern to fit in it.



DISCOVER: Explore the patterns and history of stained glass windows. Look for stained glass windows in the community, and look at window designs from around the world.



DREAM: Now that they have seen a number of geometric window patterns, students begin to think about designs for their own windows. Ask them to sketch a pattern on a rectangular piece of paper.



DESIGN: After they have experimented with different ideas and designs, the students can begin to create a rough draft of their windows. Have them identify the design elements in their drafts.



DELIVER: Students have drafted the final designs for their stained glass windows. If possible, have them do a full-size overlay using black paper, tape and coloured cellophane.

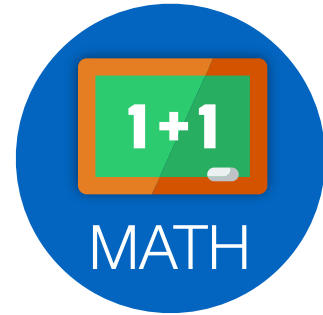


DEBRIEF: Encourage them to reflect on their own design experiences. How do artists use geometry in their designs? How do they create perfectly symmetrical patterns?



Order Up!

What are the important factors you need to consider when designing a business?



Year
10–12

Mathematics, Language Arts, Marketing, Advertising, Food Science, Interior Design

Most of us have a favourite spot that we like to go to eat and drink. Something about the atmosphere, the ambience, and the vibe about the place just appeals to our individual tastes. And of course, it helps to have great food!

Ask yourself, “If I were designing a restaurant, what would it look like? What kinds of food would I serve? Who will be my main clientele? What about signature dishes my establishment could one day become famous for? How will I promote it?” Find out by designing your unique theme restaurant.

Think of your theme, plan what it will look like, and create delicious and appealing menu items. Your restaurant will need a name and special logo. You’ll also need to plan a radio or TV spot for your new business and maybe even a webpage that people can go to for a look at your new place.

Come up with illustrative concepts to represent the theme of your restaurant and a menu of four specialty items that your business offers. You will also need to create a promotional spot that must be at least 30–45 seconds long.



DEFINE: In this unit, students will design their unique theme restaurant, along with a unique name and logo for their business. They’ll also create an exciting promotional spot for TV or radio, and come up with 4 signature dishes.



DISCOVER: Students should learn about small business ownership, including all legalities and responsibilities, graphic and logo design, advertising, and interior design principles.



DREAM: Have them visualize their interiors, and the specialty menu items. What is the radio or TV promotion that will bring people to them, and keep them spreading the word?



DESIGN: Students will now begin developing their ideas into concrete visions. Each group will use the talents of each member to share the tasks and build the theme restaurant vision, as well as create promo content.



DELIVER: The groups are now going to present their design ideas in their chosen format for the rest of the groups to assess. They can even cook their recipes for actual sampling if they wish.



DEBRIEF: Encourage them to reflect and discuss what goes into making an establishment appealing and enjoyable enough to people to maintain an expanding business over time. What would they do differently next time?

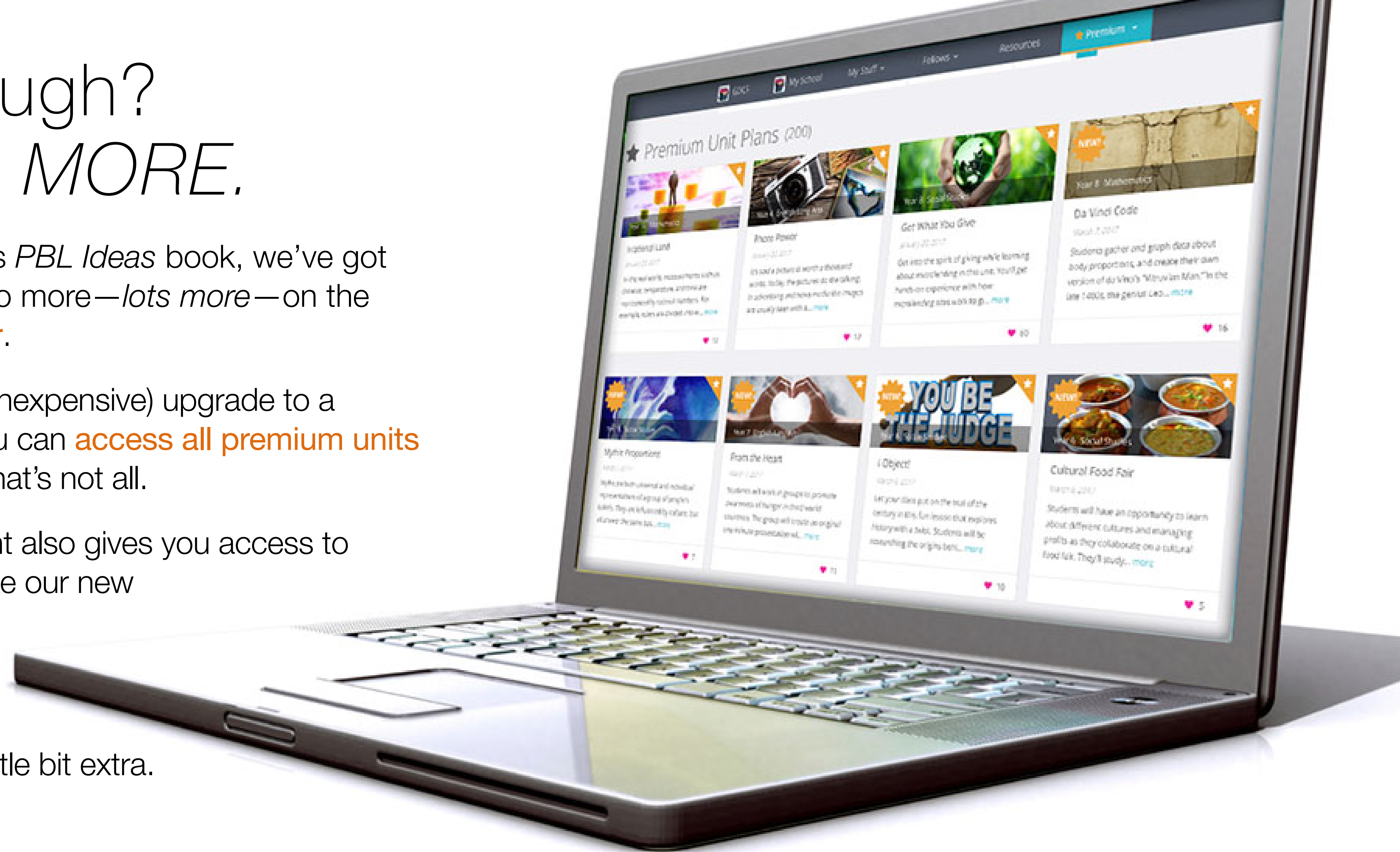
Can't Get Enough? Then Get *MORE*.

If you enjoyed the scenarios in this *PBL Ideas* book, we've got good news. You can get access to more—*lots more*—on the [Solution Fluency Activity Planner](#).

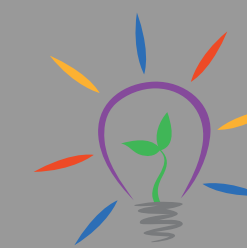
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