

STEM

Hempstead Union Free School District

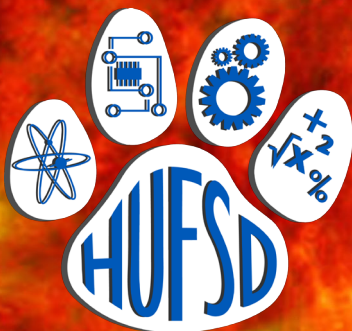
An Energy Issue
Save Our Planet...Please

National Hispanic Heritage Month

10 Profitable Reasons to
Major in Math or Science

Birth of a Weather Station

By Mr. Shawn Hudson



Mr. Bishop's Class

October 2016
1001V



Dr. Subrina D. Oliver

Given her own non-traditional career choices Subrina D. Oliver is considered a trailblazer by her peers and community for such feats like earning an Automotive Technology Degree in half the time prescribed by Denver Automotive & Diesel College and most notably, returning to her Alma Mater, Hempstead High School where she became the first female and only certified Automotive Technology teacher, teaching Vehicle Maintenance & Repairs and Transportation Systems.

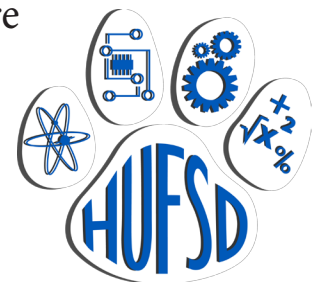
A veteran Technology Education teacher (another male-dominated discipline); enlisted and honorably discharged from the U.S. Navy Construction Battalion (NMCB-21); and currently, serving as Hempstead Union Free School District (HUFSD), Director of STEM (science, technology, engineering and math) for K-12.

Under her leadership combined with dedicated school-community support, HUFSD is on its way to becoming the very first public school in Long Island, NY to integrate STEM from grades, kindergarten through twelve.

Of all of her professional accomplishments, the recent 2016 graduate of Pace University's Doctoral of Professional Studies from the Seidenberg School of Computer Science and Information Systems, Subrina D. Oliver maintains she is proudest of her entrepreneurial endeavors, a new Blog Radio online talk show, The STEM Project with SubrinaO .

As she Bridges the divide One conversation At-a-time, a non-profit effort that shares a variety of resources (www.Facebook.com/TheSTEMProjectwith-SubrinaO), created to expose, diversify, leverage and expand STEM experiences and opportunities for the under-represented.

Through her brands & businesses, SubrinaO, O-High Technologies, LLC, and the O-High Foundation, Inc., Subrina D. Oliver continues to trail blaze with transformative 21st Century reform for needed to progress modern society and future economies.



Mr. Bishop's Class

Birth of a Weather Station / *By Mr. Shawn Hudson*

Expanding ENERGY Literacy / *By Erin Twamley / Seoul, South Korea*

STEM in Our Daily Lives / *By Karl Hess*

Uncovering Math Daily / *By Dr. Richard Larson, MIT*

**"REPRESENTA-ROMA" Un Proyecto En Castellano Que
Une Tecnologias, Arte Y Tambien Pais**

/ By Professor Rita M. Campos

10 Reasons to Major in Math and Science

/ By Sarah O'Brien

Teaching...Without an Expense Account

/ By Dr. Linda Karges-Bone

MARS Lander Program / *By STEM Magazine Staff*

We believe that the key to success in seeing higher graduation rates, improved testing results, student inspiration, creativity, excitement and career satisfaction rest in the hands of the teacher. The example and inspiration of individual educators carries tremendous weight on a daily basis, greatly impacting the quality and effectiveness of the classroom environment.

Our mission: Encourage curiosity, inspiration and creativity, the foundations of every career passion.

Wayne Carley

Publisher

STEM Magazine

STEM for Women Magazine

STEAM Magazine

STEM Mars Lander Experience

478.319.7177

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“**customized versions**” are available.

To find out more, simply send your
E-mail request to:

wayne@stemmagazine.com

STEM Magazine is a non-profit monthly education publication for teachers, students, their parents. The example and inspiration of individual educators carries tremendous weight on a daily basis, greatly impacting the quality and effectiveness of the classroom environment.

Wayne Carley is the publisher and senior editor for all content in STEM Magazine.





White House Initiative on Educational Excellence for Hispanics

Between 2010 and 2020 the overall employment in Science, Technology, Engineering and Mathematics (STEM) occupations is projected to increase by 17 percent, yet not enough Latino students are pursuing degrees and careers in the STEM fields to meet the increasing demand.

Only 67 percent of Hispanic students have access to a full range of STEM courses (Algebra I, Geometry, Algebra II, Calculus, Biology, Chemistry and Physics) in high school. The lack of STEM representation is more prevalent at the postsecondary level with only 16 percent of Hispanics and 8.8% percent of Latinas completing their STEM bachelor's degree.

There is a focus on girls and young women, in rigorous STEM courses and research opportunities to promote STEM careers through mentorships, internships, after school programming,

and summer opportunities that can put these students on track to pursue STEM disciplines in college. There is also an urgent need to increase the STEM teacher workforce and provide resources for STEM teachers.

This will be a priority for the Hempstead Union Free School District STEM programs and our new STEM Magazine resource.

Please note the STEM article in Spanish included in this issue.

Two great resources to review:

<https://www.uspto.gov/learning-and-resources/inventors-entrepreneurs/hispanic-heritage-and-inventions>

<http://ed.ted.com/periodic-videos>

Mr. Bishop's Class

When people thought about Mr. Bishop and entered room nine, they immediately began to think that in this class it would be extremely difficult. However, they began to associate my classroom with being the place to explore, learn, become familiar with a variety of animals, and feel good about the overall learning experience.

After the first week, all of the students realized my classroom was an experience that would tap into all possibilities. Within the class they began to see that STEM isn't only about doing science experiments or solving mathematical problems. It is also about constructing a roller coaster, marble run, or Rube Goldberg machine. It is also

figuring out new recipes, designing furniture or clothing. Interest and engagement in STEM can be increased if educators offer STEM activities based on students interests.

Through STEM, the students generate multiple ideas for solving their problem. One thing they learn is that there are usually multiple solutions for problems – not “one right answer.” This is the step that separates real STEM learning from cookie cutter lab experiments. After students get some ideas on the table, they can select one to try and investigate/explore. For example, the teams might explore ideas expressed within small groups.





Ideas that are student generated. As they work together, monitor how their teamwork is going they are working in true multidisciplinary/cooperative groups and solving real-world issues. They begin to realize that science, technology, engineering, art, and mathematics are intertwined within the “real World”. As a result, they begin to find niches where they have strengths or sincere interest. This builds greater inquiry and the students begin an endeavor down a path of investigation.

Our year was spent with exploring questions that were initiated by student generated inquiries. Engineering and design was explored through paper patterns and how to make designs in the most efficient manner. After viewing a pot of soil dried by the radiator, the students began an exploration about the formation of crystals.

As a result, this exploration turned into a deeper exploration about color and

design. Another exploration was focused on using air speed to create lift. This exploration included the use of paper airplanes and how people could use the planes to travel faster with natural resources.

However, the most enjoyable experience was the use of a hydroponic garden within the classroom. This exploration began an inquiry about sustaining a healthy food source in areas where it is not easily acquired. This created an exploration into government, civics, and the prospects of populating other planets. As a result, the students began to enjoy all aspects of learning without a feeling of being overly directed by boring lessons.

Each student found a place where they had substantial knowledge to make considerable contributions toward the overall experience. The learning was most enjoyable and rewarding.

Mr. Bishop's Class



Birth of

by Mr. Shawn Hudson

The Weather Station idea started during the summer of 2015 when my principal Mr. Richard Brown brought to me an idea of the weather station through the WeatherBug Schools Program, suggesting that I “check it out.” I looked into the program and I found it very interesting.

The next steps would consist of if

several questions could be answered. How would the weather station be operated? How would it be financed? Mr. Brown and I came up with what we thought were good answers.

Jackson Main School would have a Science Club with the focal point being the weather station in our efforts to bring a STEM initiative to the school. I would be the facilitator for the

a Weather Station

Science Club. The weather station would be financed within our school and (or) district budget.

The Science Club consisted of 3rd and 5th grade students. They met for an hour every Monday. Some of the projects were creating a bouncy ball, rain gauges and simple machines. The WeatherBug Schools Program provided interactive lessons relating to weather such as: Rainbows, El-Nino/La Nina, Rain! Rain! The WeatherBug Schools Program provided interactive lessons relating to weather such as: Rainbows, El-Nino/La Nina, Rain! Rain! Forecasting Weather and many more.

All lessons were standard based, real world conditions, explorative and enriching. Some third grade students expressed their thoughts. Zonia Sierra said, "What I learned from the water gauges is that you can get water from everywhere and what I learned about rainbows is they are shaped like a half circle or arc and have the colors orange, yellow, green, blue, indigo and violet." Carlos Gonzales said, "The sun could hold one million earths and the sun is 93 million miles from earth."

Kenneth Sistruck said, "I learned data from the weather station about weather for the week." Sarah Leon said, "Throughout the year the weather changes and as it changes you have to change the kinds of clothes you wear so be ready."

Some of the goals of Science Club and utilizing the weather station were to give students an opportunity to explore, discover and utilize real world experiences in an enriching manner that allows them to learn today to be leaders for tomorrow.

The weather station allows students, staff and the community to be informed and safe through its' daily information and alerting system of all weather conditions locally and throughout the world.

These opportunities would not have been possible without my principal's support, my persistence and the support and approval of the districts' Assistant Superintendent for Elementary Curriculum & Instruction Regina Armstrong.

“REPRESENTS -ROMA”

A Project in Castilian that Unites Technologies, Art and Also Countries.

“REPRESENTA-ROMA”

UN PROYECTO EN CASTELLANO QUE UNE TECNOLOGÍAS, ARTE Y TAMBIÉN PAISES.

by Professor Rita M. Campos

“No bastan en una nación las fuerzas sin la unión, ni la unión sin fuerzas”

-Séneca-

“REPRESENTA-ROMA”, palabras que resumen la filosofía de nuestro Proyecto.

Presentar el espíritu y el contenido de esta iniciativa y presentarme, son las dos primeras cosas que haré en este artículo. Ya hice la primera. Ahora me toca hacer la segunda, soy Rita M. Campos, profesora Titular de Tecnologías en un Instituto de Enseñanza Secundaria “Cuatro Caminos”, situado en una pequeña ciudad de la CC.AA. de Extremadura-España-, Don Benito.

En nuestro centro, hay alrededor de 1.200 alumnos matriculados en diversos cursos obligatorios y



voluntarios y unos 95 profesores impartiendo sus materias.

Es un centro dinámico, donde el profesorado suele estar siempre a la vanguardia de las posibles iniciativas educativas que nos ofrece la C.E.E. y aquí es donde aparece nuestro Proyecto.

Tuve la suerte de ser invitada a un Congreso entre países miembros, al que asistían profesores que estaban inscritos o trabajando en la Plataforma Digital Educativa Europea e-Twinning.

Este encuentro, se desarrollaba bajo la iniciativa “Habl-Arte” del Consejo Nacional de Educación de España, en su segunda edición. La iniciativa “Habl-Arte”, intenta promocionar el uso del castellano en esta Plataforma, aunando tecnologías, lengua y cooperación educativa internacional. La reunión se celebró en Madrid y dio bastantes frutos: nuestro Proyecto, uno de ellos. Alrededor de 100 participantes (profesores de secundaria) de toda Europa, fuimos teniendo la oportunidad de conectar, sin habernos visto jamás, para realizar

algo en común con nuestros alumnos, tan alejados y tan unidos por las tecnologías.

Su gusto por el uso de los accesorios digitales, forma parte de sus vidas, sus teléfonos móviles, sus “tablets”, sus reproductores MP3 Y MP4 y sus ordenadores ¡esto une mucho! ¡las “maquinitas”, como decimos aquí, les tienen locos!

Aprovechando esta “locura” adolescente, propuse a mis alumnos de 4º curso, de la asignatura de Informática, formar parte del Proyecto, allá por el mes de Enero. Algunos me miraban con cara rara, otros con cara de intriga y otros simplemente miraban, pero todos dijeron, sí.

No sé si lo mismo les ocurrió a mis colegas: Betty Oliveros, Giacinta Mecucci, Greta Sopo y Faten Ben Jebril, todas profesoras de Castellano y amantes de las Tecnologías, con sus alumnos respectivos, porque aún no hemos hablado de cómo les convencieron, pero algún día me lo dirán.

Y así nació nuestro Proyecto, producto de una idea que surgió pensando en los países de Betty y de Gia, durante nuestro encuentro en el Congreso. Francia, Italia, España, latinos, romanos, el teatro romano de Mérida (Capital del Imperio Romano), a tan sólo 70 km. de nuestra ciudad.»

convencido después y Greta, tan activa y eficiente se convenció sola, casi desde el principio. Mis colegas entregadas y nuestros alumnos tan dispuestos, permiten que ahora esté en pie, nuestro Proyecto, que se va moldeando con cualquier idea que cada una de nosotras va



ALUMNOS-ESPAÑA-CON PROF

¡Tan vivas aún sus ruinas entre nosotros! ¡seguimos usándolas para los Festivales Nacionales de Teatro Clásico! ¡ Teatro romano de Lyon! ¡Coliseum!

Salimos de nuestro Congreso con “las ideas enfundadas”, dispuestas a trabajar, las tres; a Faten la hemos

ALUMNAS-

aportando. Nuestro ideario de trabajo, a parte del ámbito tecnológico y lingüístico, trabaja también, la autoestima, auto-motivación, el ámbito personal y social (inteligencias múltiples). Nuestros alumnos, son los receptores y colaboradores de nuestro trabajo y los ejecutores del producto que se ve.

Son agradecidos y dispuestos para estos asuntos. Y por suerte, hasta ahora nuestra compenetración ha sido exquisita.

Hablemos ahora de la parte estructural y técnica:

socios inscritos y hacerles propuestas de Proyectos, siendo necesario que haya implicados en cada Proyecto, un mínimo de 2 socios fundadores. Lo que si está claro, es que a todos los inscritos, pertenezcamos a la especialidad que pertenezcamos, estamos unidos por las TIC'S, en cualquiera de sus manifestaciones.



TUNEZ

ALUMNOS-ESPAÑA-CON PROF-GRUPO2

Como se apunta anteriormente, trabajamos en una plataforma educativa online, llamada e-Twinning. En la que nos acreditamos libremente los profesores europeos, previa certificación y autorización de nuestros respectivos centros educativos y estatales. A través de ella, podemos contactar con otros

Tenemos un espacio propio para trabajar online en nuestro proyecto, vinculado a esta Plataforma Educativa- <http://www.etwinning.net/es/pub/profile.cfm?f=2&l=es&n=111683> nuestro Twinspace <http://twinspace.etwinning.net/5411> , que se

nos asigna online, una vez que es aprobado por el Consejo Nacional de Educación y en el caso del resto de los países socios, por sus respectivos órganos pertinentes. El nombre que le dimos a nuestro Proyecto: “REPRESENTA-ROMA”, es creación genuina de nuestra colega Giacinta Mecucci. Cuando nos lo propuso, nos encantó y rápidamente le bautizamos. Actualmente, estamos registrados 150 miembros: 145 alumnos y 5 profesores.

El Proyecto se podrá desarrollar en dos o tres fases, cada fase se corresponde con un curso académico, aunque como su desarrollo hasta obtener el producto final, dependerá del grupo de alumnos que tengamos asignados cada curso, pues podrá acelerarse o dilatarse en la generación de las tareas intermedias, dependiendo de las posibilidades de trabajo con estos alumnos.

Las eventualidades de moldeabilidad y el dinamismo del Proyecto dentro de sus líneas de actuación, son aspectos que hacen seductora

esta Plataforma Digital Educativa ya que las mejoras y los cambios pueden realizarse constantemente. Hace que el Proyecto sea modificable en sus fases intermedias, permite cambiar de dirección cada intervención e incrementar o disminuir el número de participantes ¡está vivo!

[¿Cómo conseguimos aunar currículo y actividades del Proyecto? ...](#)

Creo que con imaginación y creatividad y muchas ganas de hacer cosas nuevas o diferentes, aunque estén hechas con las herramientas de siempre. Los profesores siempre enseñamos, es “de-formación” profesional.

En mi caso concretamente, al impartirles la asignatura de Informática en un curso como es 4º de Secundaria Obligatoria, pues, por ejemplo, incluyendo en el apartado de tratamiento de la información, la búsqueda de información con el uso de distintos navegadores, utilizando diversos buscadores y seleccionando adecuadamente, los enlaces de información de entre todos

sus encuentros; por ejemplo, una búsqueda para nuestro proyecto sería, encontrar información sobre la civilización romana, concretamente, atuendos y moda , maquillaje, ropa militar, etc. Esto lo incluiré en el apartado de “alfabetización en navegación por la red” del currículo, ya que esta actividad encaja totalmente.

En el corto camino para poner en marcha este Proyecto, me he encontrado con personas que nos están ayudando a que este plan se desarrolle:

-El Claustro de Profesores de este Centro, con su apoyo a nuestra iniciativa.

-El Equipo Directivo, facilitando espacios, coordinando horarios y dotándonos de medios.

-Diego Ramos, que trabajó en el Dpto. de Artes Plásticas como Profesor y de quien fui colega hace 6 años. Actualmente es Gerente y Actor en Producciones “El Desvan”, aquí en nuestra CC.AA.

-La Profesora del Dpto. de Lengua Castellana y Literatura de este Centro, Montaña Pantrigo, ayudando en la tediosa tarea de reorganizar este escrito.

-Todos los centros educativos integrantes de la red de socios de nuestro Proyecto, en sus distintos países.

-Todos nuestros alumnos.

Y por supuesto, si no se han cansado todavía de leer, pueden conocer esta iniciativa, gracias a la curiosidad e interés por nuestro trabajo del Señor Wayne Carley, a quién debo agradecerle su disposición para publicar este artículo. Una cadena de personas y amigos a los que unen, las redes, las tecnologías y las ganas de aprender y conocer. Queda mucho por hacer, pero esta, es también “la parte interesante y cautivadora”. Alumnos, Profesores, familias que apoyan las iniciativas de sus hijos, colegas que ayudan, colaboradores, tecnologías, esto bien agitado es el cocktail:

” REPRESENTA-ROMA”



OUTSIDE

High School: “A New World of Science”

By Joseph “JJ” D’Alessandro / student

One year ago, *when I started my first year of high school*, I was excited to think about a new school, new people and new levels of study. During middle school, I discovered that I had a passion for science and math. My favorite television shows were “How It’s Made,” “MythBusters” and “How the Universe Works.”

So when I enrolled in my new high school courses, the three classes that I was most interested in were Earth Science, Algebra and Computer Literacy.

In Computer Literacy, we learned mostly about Microsoft Office and internet security. In Earth Science we had a “lab period” every other day where we would take what we learned in class and apply it in small experiments.

Some of the topics we learned focused on calculations, such as carbon-dating and nuclear half-lives, but other topics had a visual concepts such as plate tectonics and astronomy. The courses were interesting and challenged me. But despite the things I learned, I felt myself wanting more.

I have always wanted to be a scientist or an engineer. Whenever I talked about my dreams, my parents talked about extracurricular activities at school that focused on STEM. There were such activities – Science Club and Robotics, for example – but these clubs either met infrequently or were dominated by seniors. I didn't feel like I got as much from them as I would have liked.

My parents noticed my disappointment, so as freshmen year ended, we looked to see if there were any summer programs that focused on STEM. Then one day, we discovered an internship for high school freshmen at the Brookhaven National Laboratory called the STEM-Prep Summer Institute. It was a four week program made up of weekly modules dedicated to Physics, Biology, Chemistry, Scientific Computing and Environmental Science.

This was exactly what I wanted to do, but I had to go through a formal application process. There was an application to fill out and an essay to write about my interests in STEM. Then I had to be invited to the Laboratory for a formal interview. Dressed in new suit that my parents bought for the occasion, I was interviewed by Dr. Robert Palomino, who is one of the scientists working on Brookhaven's new National Synchrotron Light Source II project.



He was very kind. We discussed our mutual interest in science and what I wanted to do in the future. Then Dr. Palomino gave me some advice. He described how the STEM profession can unfold in different ways for people.

He shared how even though he earned his Ph.D in physical chemistry, when he was in high school, he didn't like chemistry at all. It wasn't until he was in grad school when he discovered his love for the subject. So he advised me

National Synchrotron Light Source II



to be open to all STEM subjects even if I don't enjoy a particular subject in high school.

The day after the interview, I received an email from the program director, Dr. Aleida Perez, informing me that I had been accepted and that I had to complete training modules before Day 1 of the program. When I logged on and saw all the training I had to complete, I thought to myself, "Boy, these people are serious."

I had to complete (and be tested on) Cyber Training, OSHA's Laboratory Standard, Chemical Hazards, Controlling Exposure, Handling and Storing Chemicals as well as a training on how to avoid Ticks and Lyme disease. If I didn't pass these courses, I wouldn't be allowed to start the program.

"I made sure I passed."

The first week of our internship began

with Environmental Science.

We spent two days building Remotely Operated Vehicles that would collect DNA samples from a lake. We then spent the two days on field trips, including a major hike to four different ecosystems where we learned about the local wildlife as well as the history of the landscape and by extension Long Island.

Our second field trip was spent canoeing where we studied different plants and took samples for our upcoming activities. I had no idea Environmental Science was so exhausting!

The second week was dedicated to Biology and Chemistry where we spent a great deal of time barcoding the DNA of our samples. When we weren't working on that, we were working with (safe) E Coli samples and changing the bacteria's genetics to make them glow under UV lights and make them immune to medications. We also studied Chemistry where we learned how to change the pH values of different substances, as well as watching chemical reactions.

Week three was dedicated to Physics, one of my favorite subjects. Every day we studied different types of energy as well as topics related to power sources.

We studied static electricity, nuclear fusion and fission. We studied nuclear power sources and learned about stars, half-lives and nuclear decay.

My favorite topic was Particle Accelerators (Brookhaven National Laboratory has a Relativistic Heavy Ion Collider). What I enjoyed was learning about how they work and also about the different types of research that is taking place. This week was special to me because it covered real-world applications that interested me the most: electricity and power.

Our final week at Brookhaven was dedicated to Scientific Computing. It was nothing like the Computer Literacy class I took in school. We created simulations by calculating various mathematical equations. One of the most notable activities we did was creating a maze in a computer. Our objective was to make it so complicated that the computer would have to exceed 200 steps trying to solve it.

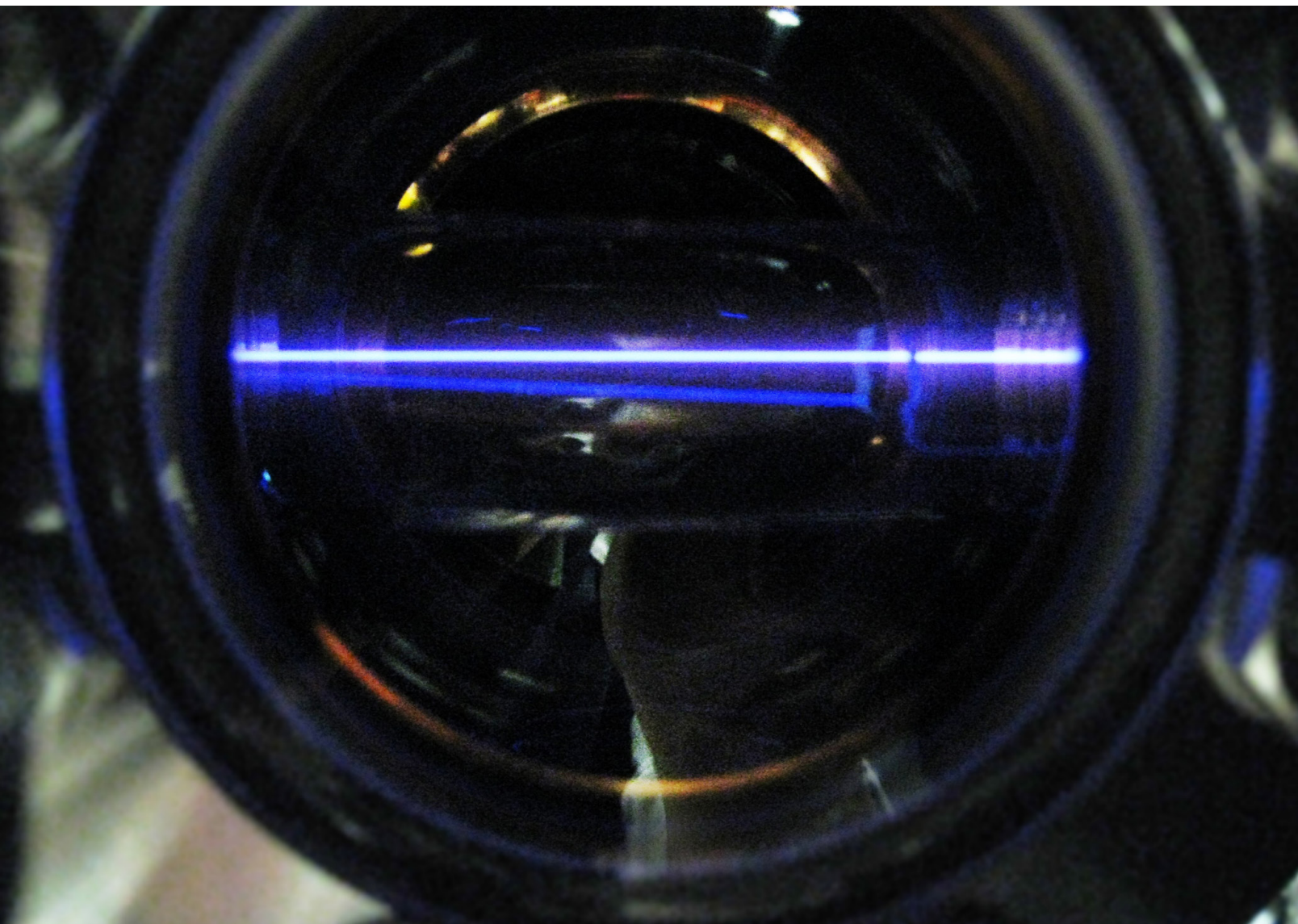
This program was a wonderful experience for me because I learned many things that I hadn't been exposed to before. I even learned how to design and create a professional science poster, which we all presented on the final day of the program.

While I still have a great deal more to learn in high school, I am so fortunate to have access to programs like the ones offered by the Brookhaven National Laboratory. They have their own Office of Educational Programs for students and also for teachers who want to incorporate current research topics into their curriculum.

I know that not everyone lives near a national laboratory, but anyone interested in STEM (students and teachers) should look around in their local community and see what is available. Colleges and Universities often provide

workshops and programs. Taking advantage of what is around you is a great way for aspiring scientists and engineers to learn about their careers options and get a head start on their future.

When the program ended, I again had the feeling of wanting more. But that feeling was not out a sense of not learning enough, it was out of sense of excitement that *there is so much out there to explore.*



Expanding ENERGY Literacy:

Understanding the Consequences of Powering our Lives

By Erin Twamley / Seoul, South Korea

We all know that we get heat and light from the sun. We invented windows in our homes and businesses to help us capture those elements. We use skylights for artists to provide natural lighting and greenhouses to help grow plants.

We developed a world of mobility. Automobiles, ships and planes that move goods from one end to another. Maybe more importantly, we connect people around the world with transportation. We defy Earth's boundaries and geopolitical limitations to reach and see great distances.

For nearly 6 billion of us, we can flick a switch and suddenly our day can be 24 hours long. With the light bulb we create more time for us to work, play and maybe most important, educate. Electricity expands our ability to do things - to be a 365 day 24/7 population.

But all of these require energy. Where does this energy come from? How do we produce it and how do we consume it? Who is being impacted?

How much do we have left?

This is the disconnect. The “power” of our lives rests in understanding our production and consumption of energy. We don't understand where our energy comes from or why it matters. Nearly 90% of electricity globally is powered by fossil fuels. Every so often we complain of the consequences - the pollution is making the sky hazy or I hate that diesel smell. Nearly 90% of us around the globe are now experiencing air pollution.

What does it take to reconnect us? We need to understand the role of energy in our daily lives and use this knowledge to make decisions at the individual, community and governmental levels.

This understanding is energy literacy.

We need to teach not only the science and math of energy, but the technology revolutionizing its production and the engineers designing new technology. Students need to take their STEM learning of energy and apply it in social studies and language arts. From examining the history of energy production in specific countries to researching and debating local energy solutions.

Words like Lumen, carbon footprint, energy efficiency and conservation should be added to non-science classrooms.

We need to build investigative habits in our classrooms using energy. Without asking questions and having discussions we cannot dare to create a better world. It is time to have students take the power back and decide - How do YOU want to power your life?

*Erin Twamley is an educator and author. She currently teaches and resides in Seoul, South Korea. Her books **Climate Change: Discover How It Impacts Spaceship Earth** and **Renewable Energy: Discover the Fuel of the Future** aim to positively engage youth in learning about renewable energy and addressing climate change through hands-on STEM activities.*





Science Challenge Question

If the -

average temperature of Sun is ***10,000 degrees F.***

and it's ***92 Million Miles***

And the -

average temperature of space is *-450 degrees F.*

from the Sun to the Earth



How do you explain where Earth's heat comes from?

STEM IN OUR DAILY LIVES

By Karl Hess

Book: Working Knowledge: STEM Essentials for the 21st Century

ENERGY

There are many forms of energy that we will explore in coming issues of STEM Magazine and we know that from those forms come many useful applications that we need in our daily lives. We supply energy to our body by eating, because the food contains chemical energy for the needs of our bodies. We use electrical energy when we turn on the light, the telephone, the computer, the kitchen stove, the washing machine, the TV, and a very long list of useful machinery and appliances.

Naturally we use the energy of fuel when we drive cars or fly airplanes. Energy is also needed by the farmers who work in their fields when they plow or supply fertilizer and produce the food that we later use. If one wishes to describe what we need most in our life, then it is energy, and energy again in many possible forms. In fact we need and use so much energy that we often hear that we need to look

and see that more energy is being “conserved.” The STEM expert notices, of course, that this is not what we need to do. Energy is always conserved automatically.

The law of energy conservation is the most basic natural law that we know. Energy can neither be destroyed nor created out of nothing. The real point is that we need energy in certain useful forms such as gasoline or battery power. Other forms, such as the hot exhaust gases of cars or jet engines, are not very useful, and we need to find ways to produce the least of the useless energy and to obtain the energy that we actually can use.

All useful energy originates from the sun and either is derived directly from sunlight, or has been derived in the past from the sun in the form of the so-called fossil fuels or even further back at the beginning of our planetary



system in the form of nuclear material. Unfortunately, it is not possible to obtain and use the energy that we need in a way that is 100% environmentally friendly. We know that it is not possible to generate useful mechanical energy without generating also random heat



energy. As we will outline below in more detail, we can therefore not use any energy sources without changing something in the environment. Some of you, who have already heard about many methods that supply us with energy may say: “oh, this is not true, there are some ways to obtain energy that do nothing to our environment, for example one can generate energy by using the tides.”



The tides are the rise and fall of ocean water due to the gravitational influence of the moon and the sun on the oceans of the rotating earth. Thus one could store the rising waters during high tide and then, during low tide, let the waters flow back and drive an electrical generator, so-called turbine. This sounds like a real winner with no influence on the environment.

However, we know that energy is conserved and can not come from nothing. [Where does the tide energy come from?](#)

Energy gained from tides originates mainly from the rotation of the earth. Therefore, that rotation of the earth will be influenced if we take energy out of that system. In fact, such tidal energy consumption happens automatically but slowly. The tidal distortions of a planet or moon (even without water) lead to the so-called tidal lock which means that in the very distant future the earth will only rotate once a year around itself and thus have always the same side facing the sun.

The moon is already now in tidal lock with earth, and, therefore, we can only see one side of the moon. If we influence the tides to generate much electrical power, we influence the tidal



Tidal power is non-polluting, reliable and predictable. Tidal barrages, undersea tidal turbines – like wind turbines but driven by the sea – and a variety of machines harnessing undersea currents are under development. Unlike wind and waves, *tidal currents are entirely predictable.*

Tidal energy can be harvested in two ways:

- By building semi-permeable barrages across estuaries with a high tidal range.
- By harnessing offshore tidal streams.

process. The forces created by influencing the tides may also shift the outer crust of the earth relative to the inner viscous or even liquid parts. Is this shift dangerous? Here lies the crux of all environmental considerations and concerns. How do we define dangerous? If we require no change over hundreds or even thousands of years, then we have a problem, even with energy from tides. The earth rotation would change considerably in thousands of years if we take a large portion of the energy that we need from tidal power. Even a very small shift of the upper crust of the earth could change the flow of liquid lava in the hot inner earth and therefore rechannel volcanos, say those of Hawaii.

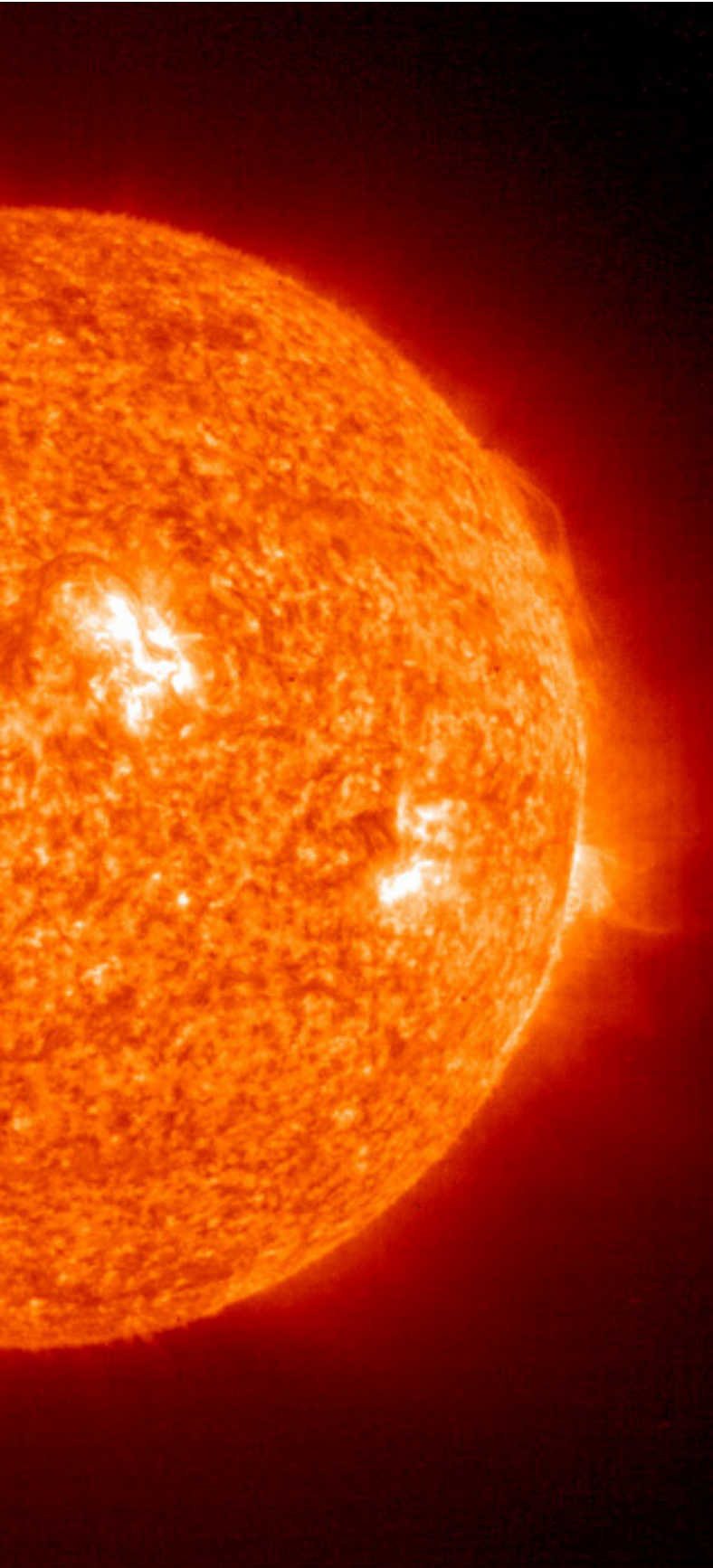
The Hawaiians may not like this! It is extremely important to realize that there exists no zero tolerance solution for the environment. We cannot obtain and use energy without perturbing the environment. Even photosynthesis (see below) changes the environment and reduces carbon dioxide while producing oxygen. All we can look for and hope to find is the most inexpensive way to create renewable energy resources that disturb the environment as little as possible. In the following we describe a few possible pathways to such solutions. The author does not claim that anybody knows which procedure is going to win in the future.

We only know that this is a great and important topic for future STEM experts.

The Warmth of Sunlight

The most elementary form of energy that humans use is the warmth of sunlight. The sun emits a broad spectrum of electromagnetic waves, ranging from waves in the radio-frequency range to the infrared, to the visible, to the ultraviolet, and even up to radiation.

The rays of the sun are partly absorbed in our atmosphere and finally on the ground and in the oceans. Much of this energy is turned into heat that warms all of our surroundings and keeps us alive. Any heated body also emits electromagnetic radiation depending on its temperature. The earth, therefore, emits mostly infrared back into space, particularly during the night and cools down in that way. Heating and cooling during summer and winter and day and night, respectively, leads to average temperatures at the different locations on earth that determine the climate from the cool arctic regions to the warm temperatures of the equator.



The balance of heating and cooling of the earth depends on many factors including the absorption of light on the ground and in the oceans, the angle of incidence of the sunlight (that changes depending on geographic location and season), the composition of the atmosphere and its humidity, the formation of clouds, and the wind patterns and ocean currents.

Some of the gases of our atmosphere, particularly carbon dioxide and water vapor, are so-called greenhouse gases. These gases lead to an increased absorption of infrared sunlight and to a decreased radiation of infrared back into space. Thus they have an extra warming effect, comparable to the warming in a greenhouse from which their name derives.

Greenhouse gases are, therefore, partially responsible for the comfortable temperatures that we enjoy on earth. The earth's climate has changed in the distant past from ice ages, during which glaciers have formed (even in Hawaii), to heated periods during which the north pole was green. Greenhouse gases are, at least in part, thought to be responsible for these climate changes.



Recently scientists have become concerned that too much of a warming may occur if we generate large quantities of greenhouse gases, such as carbon dioxide, due to the exhaust of our machines and the burning of coal and oil.

It has been proven, that the influence of human energy production and use has indeed already led to measurable effects on earth and that “global warming” is on the increase. Pollution can also cool the planet due to the effect of pollution clouds that transmit less sunlight to the surface of the earth. All of these conflicting and complicated effects make it very difficult to precisely predict the effects of human influence and what we should do about it.

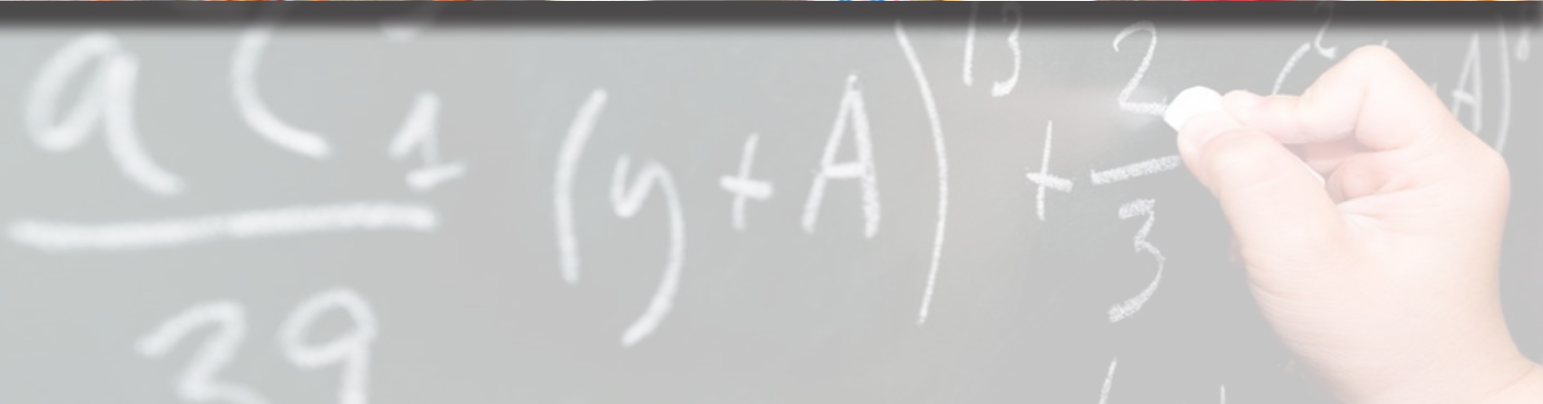
Much more research is needed here, and it is imperative that present and future STEM experts explore this area in great detail. The necessities of energy use to sustain our life and, at the same time, to disturb and pollute earth as little as possible present us with two conflicting demands of greatest importance.

Science has currently not progressed far enough to present us a “royal road” solution to the problem of global warming. It is clear, however, that we need to be careful and not pollute our planet beyond repair. At the same time, we need to use energy to sustain our life.

These conflicting problems will be covered in future articles.

Uncovering **MATH** in *Everyday Life*

By Dr. Richard C. Larson, MIT



How does math relate to my life? Why should I care? I'm not going to grow up to be a mathematician. My textbook only gives me more of what my teacher said in class. All math, all the time. Where does it apply? I can spend my time better on other things.

Well, perhaps no student has said all of these things at one time. But certainly many feel this way. The situation is complicated by the fact that mathematicians often do not know of applications of their theory, nor do they care. If they are the textbook authors, then the in-class teacher gets scant book support for motivating students with math applications.

So, here is an idea: Ask each student in the class to pick one day of their week, maybe a Saturday when there are lots of things happening outside the classroom, and keep a diary of what they did and saw that day.

Then have them pick a small number of these diary entries and write about how math applies to that entry. And then share with the class, perhaps with each student picking her favorite example and explaining it in front of the class, say 3 to 5 minutes for each.

Shopping. I went with my dad to the supermarket on Saturday. I noticed something for diary. Why is the price per ounce of everything less when he buys a bigger can or box of stuff? Here, the teacher could speak about a fixed cost of getting a can or box of 'stuff' to the market, regardless of its size, and then a variable cost that relates directly to the amount of 'stuff' inside the can or box.

This can be explained by a positive-sloped linear equation with a positive intercept on the vertical ("y") axis.



Sports. We watched my big brother play ice hockey today. His team was down by one goal with one minute to play. The coach took out his goalie and added a forward attack guy. But the other team got the puck, shot it all the way down into my brother's net, no one there, and my brother's team lost by two goals, not one.

Why did the coach pull the goalie? This case opens a nice discussion of applied probability. The discussion does not have to be rigorous or formal, so any level of high school would be fine.

Essentially, removing the goalie near the end of the game—when trailing by one goal—changes the probabilities of two events: (i) tying the game; (ii) losing by two goals, not one. It increases BOTH probabilities!

This can yield a very interesting class discussion. Like, where did the increased probabilities come from?

What event has a lower probability? And the situation gets students interested in probability!



TV. Saturday night we spent some time flipping around channels on our TV. There were kids' channels, news, sports, cooking, music videos, all sorts of things. But we noticed that the ads on each channel were very different.

News channels had pills ads for old people. Sports channels were trying to sell pickup trucks and razor blades. Kids channels were selling sugary cereal. How does math relate to all of this?

The answer is in fractions. What fraction of the viewers of a TV program fall into a particular category? The category may be by age, males or females, or even hobby! People who spend money on TV advertising look at these fractions very carefully. It turns out that older viewers tend to look at news programs more than young viewers do.

The older viewers' fraction is high, maybe $\frac{2}{3}$ of viewers are more than 50 years old, and the younger viewer's fraction is very low (maybe $\frac{1}{20}$). So, the ads on news programs are aimed at the older audience, and unfortunately this audience is more likely to have health problems that are helped with 'pills.' And kids' program sell to kids, even though they don't buy the products, but they let their parents know!

Maybe kids are $\frac{9}{10}$ of viewers of kids' programs! TV people spend lots of money figuring out these fractions.

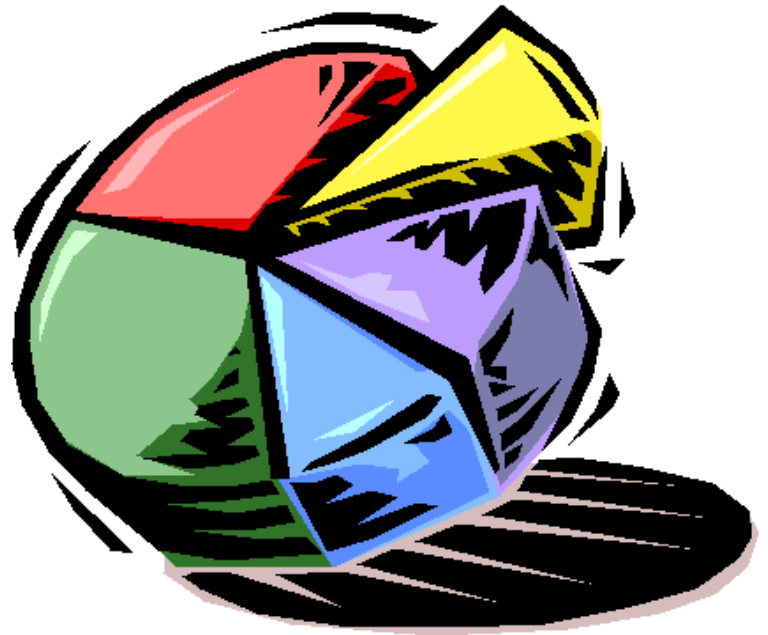




Cooking, fertilizing the garden,
cutting the lawn, putting air in the car
tires, driving two hours to Aunt Lizzie's
house...

You can spark interesting in-class
discussions —about math!

Have fun with this!



CLASS STEM LESSON

Math I use everyday.

What time do you have to be at school?

- Are you taking a shower? How long will that take?
- Doing your hair? How long will that take?
- Breakfast? How long will that take?
- Last minute homework? How long will that take?
- Walk to bus stop? How long will that take?
- Walk to school? How long will that take?
- *What time should you set your alarm for?*

This is just one simple example of how we use basic math daily. You'll use this example for the rest of your life as you go to work and play.

Yes, you will use math (usually easy math) everyday. Don't be afraid of it. Your brain is actually wired for it.

10

Profitable Reasons to Major in Math or Science

by Sarah O'Brien

Good news for all you math and science whizzes out there: You sort of own the job market.

Most of the top 10 best jobs—based on work environment, income, job outlook, stress and other factors—call for backgrounds in those two fields, according to a recent report released by career website CareerCast.com.

“We see every year that STEM [science, technology, engineering and math] jobs are rising on the list for a variety of reasons,” said Tony Lee, publisher and editor for CareerCast. “Their hiring outlook, salary, better work environment brought on by competition for employees ... all walk hand-in-hand to make these jobs more appealing than any others.”

CareerCast annually examines the 200 most populated U.S. jobs and then ranks them based on a variety of metrics. Lee said that while there are three health care–related jobs in CareerCast’s 2105 Jobs Rated Report, they used to dominate the top of the list. Now STEM jobs have taken over.

“The jobs that are rising into the top 10 are jobs that didn’t even exist a few years ago,” Lee said. Also, most of the top 10 jobs in the report are on pace to grow by at least 20 percent between 2012 and 2022.

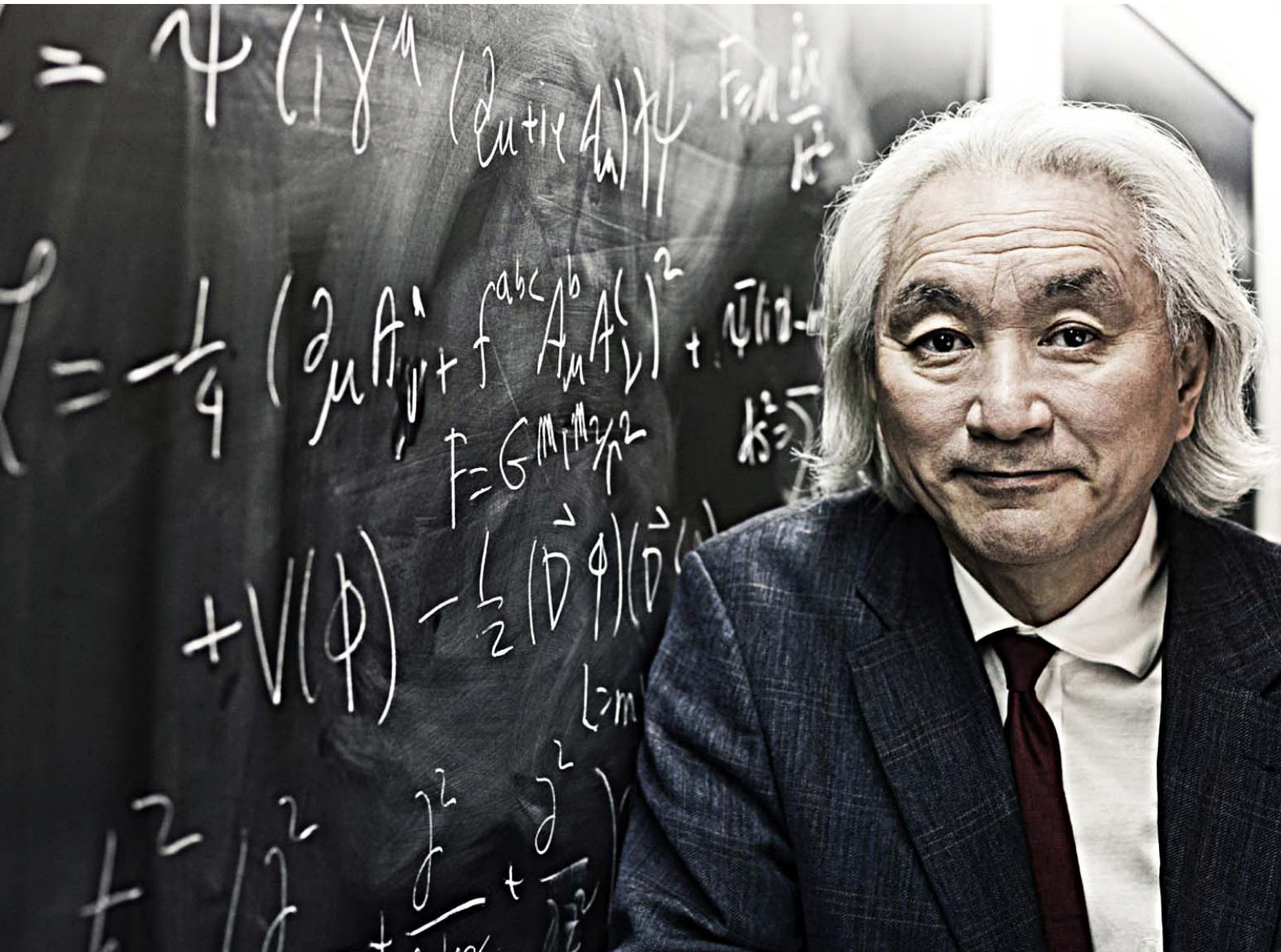
Topping CareerCast’s list is *Actuary*.

Actuaries analyze statistics to determine the financial consequences of current and future risk. They often work for insurance and financial companies, along with an array of other businesses.

An actuary also is a specialized job with specific education and training requirements. Actuaries must hold a bachelor’s degree—typically with a math or business bent—and pass a series of exams to become certified professionals.

“The exam process is rigorous and relies on the individual to self-study,” said Brad Paulis, a partner at CCRC Actuaries. Because of those things, he said, actuaries generally enjoy good job security because there aren’t easily replaced.

Third on the list is mathematician. These professionals do, well, math. They work in a variety of private industries and government agencies, using advanced mathematics to develop and understand mathematical principals, analyze data and solve real-world problems. Their median pay is more than \$101,000.



World famous futurist and theoretical physicist **Michio Kaku**

He added, most actuaries truly enjoy mathematics and problem-solving. “Often our problem-solving extends beyond math into other areas, but the process is why we entered the profession,” Paulis said.

The U.S. Department of Labor’s latest data show that an actuary’s median salary tops **\$93,000**.

Audiologist ranked second on the list, making it one of three health care–related jobs in the report’s top 10. An audiologist diagnoses and treats patients’ hearing and balance problems using advanced technology and procedures. Becoming an audiologist requires earning a doctorate degree, along with getting licensed in the state in which you work.

The employment outlook for audiologists is good, because the field is expected to grow at a 34 percent clip over the decade ending in 2022. Their median salary is about \$70,000.

Numbers and nature.

Ranking fourth is another math-related profession: statistician. Statisticians use statistical methods to collect and analyze data and help solve problems in all sorts of industries. Typically, a statistician needs to have a master’s degree or higher.

Their median income is about \$76,000.

In the fifth spot is biomedical engineer. Often armed with a degree in biomedical engineering, these professionals analyze and design solutions to solve problems in biology and medicine. The goal is to improve the quality and effectiveness of patient care. Bio-med engineers typically earn \$87,000 annually.

In sixth place is data scientist, which Lee said has never been included in the report until now. The job is growing in popularity because, with businesses having tons of data at their disposal, someone needs to have the skills to break down raw numbers into easily digested information. Data scientists’ median annual salary is \$124,000.

Rounding out the top 10 are dental hygienist (No. 7), software engineer (No. 8), occupational therapist (No. 9) and computer systems analyst (No. 10).

10 BEST JOBS 2015

RANK	OCCUPATION	MEDIAN SALARY
1	ACTUARY	\$94,209
2	AUDIOLOGIST	\$71,133
3	MATHEMATICIAN	\$102,182
4	STATISTICIAN	\$79,191
5	BIOMEDICAL ENGINEER	\$89,165
6	DATA SCIENTIST	\$124,149
7	DENTAL HYGIENIST	\$71,102
8	SOFTWARE ENGINEER	\$93,113
9	OCCUPATIONAL THERAPIST	\$77,114
10	COMPUTER SYSTEMS ANALYST	\$81,150

The other positive aspect for job seekers interested in these fields is the effect that competition has on hiring packages. For instance, new research shows that job seekers increasingly want more say in when and where they do their job.

“What we’re seeing is lots of people out there wanting flexible work arrangements,” said Tara Sinclair, chief economist for global job search engine Indeed and head of its Hiring Lab research arm, which just released a report called “The Talent Driven Economy,” which looks at the emerging interests of job seekers. She said that during the last recession, when the job market was tight, employers pulled back on providing flex hours or allowing telecommuting.

“I think we’re going to see a dramatic shift back to remote work and jobs that explicitly allow work from home,” Sinclair said.

Part of that is a tightening job market. The report points out that during the worst of the recession in 2009, there were 2 million job openings, or one opening for every 6.2 unemployed job seekers.

As of four or so months ago, there were 5 million job openings, or one job for every 1.7 unemployed job seeker. Additionally, although the STEM and health-care jobs comprise the top 10 best jobs on the CareerCast list, there continues to be more jobs available than there are qualified people to fill them.

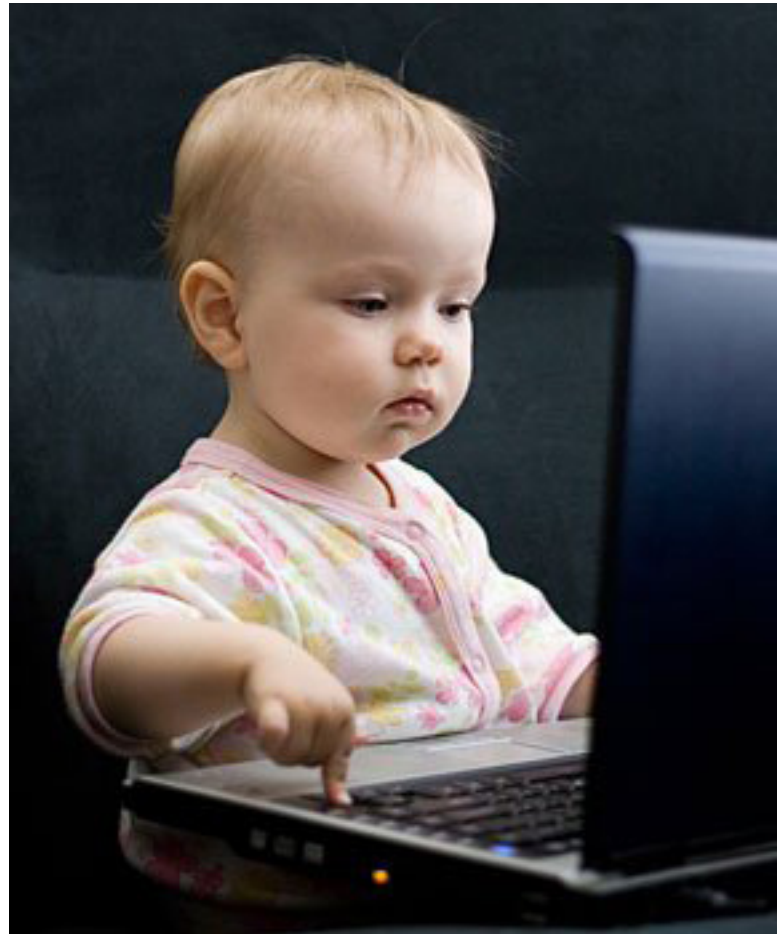
According to the Indeed report, 14.2 percent of job postings are for health-care practitioners and technicians, but less than 7 percent of job seekers are looking for those jobs.



Another disparity exists for jobs in the computer and mathematical fields: 8.4 percent of postings are for them, but just 5.5 percent of job seekers are exploring them.

Nevertheless, there has been an increase in searches for tech-related positions, which is viewed as a positive. “There is a dominance of tech-related job searches coming from job seekers,” Sinclair said. “We’ve talked so much about the persistent mismatch between not enough tech talent to fill the tech-job opportunities.

But now there’s growth in the amount of people seeking tech jobs, so that’s encouraging.” Sinclair added, however, that the opportunities still are outstripping the available talent. “Almost every company needs new hires to have significant tech skills,” she said. “So the growth is reassuring, *but we have a long way to go.*”



Teaching-



The Only Profession *Without* An Expense Account

*A Look at the Way that Classroom Teachers Spend Their Own Money...
...on Other Peoples' Kids*

Dr. Linda Karges-Bone

When was the last time you spent \$23.00 on worms and you weren't headed out to the lake for a fishing trip? Ask third grade teacher "Carmen" of Berkeley County. She anted up to provide the worms for her compost pile, which was built by her faithful classroom volunteer, her husband. It was the only way to completely and effectively teach the rigorous state standards for science to a group of active, academically diverse youngsters.

These pupils have to see and touch science experiences in order to make them viable, especially since a number of them do not read on grade level and cannot rely on the textbook.

And what about reading? During the Martin Luther King celebration period when I visited her classroom, Carmen had an impressive display of books on Dr. King and other African-American history figures and events. Most of the books belong to her personal collection. She figures that the books in her classroom library are valued at about \$2000; all purchased from her own account.

Carmen is not alone.

When I visit classrooms all over the country in my work as a university supervisor of interns and as an educational consultant, I see hundreds of classrooms that are absolutely amazing. They are full of children's literature, packed with displays of science projects, strewn with colorful art projects, and buzzing with technology.

Much of the time, probably most of the time, the materials that make the lessons meaningful were purchased by the teachers themselves. And, here's an unscientific but defensible analysis. I believe that the classrooms in which one sees the highest test scores and the fewest discipline problems are those in which teachers have paid a price too, as one committed educator told me:

"I teach the way I want to; the only way I can."



As we consider budgets and ballots in the next election, how much longer can we ask teachers who are paid so little to contribute so much of their own meager salaries to educate “other people’s kids?”

What the Experts Say:

The problem of teachers spending their own money on classroom necessities and enhancements is not new. I remember back to my first year of teaching (1981) which was also my first year as a married woman. My husband, the frugal engineer, was astonished to see that I had spent about 15% of my \$11,000 salary on “teaching stuff.” Those were the receipts that I had stuffed into an envelope, the ones that he saw.

The problem is national in scope and teachers are getting frustrated. In a NYCLU complaint, the American Civil Liberties union brought suit against the state, representing public school teachers who were routinely spending between \$600 and \$1000 per year to purchase basic teaching materials such as pencils and paper. In a press release, the Council of the City of New York Office of Communications reported that a City Council investigation found that New York City teachers spend an average of \$426 out-of-pocket dollars for basic classroom supplies.

Council member Eric Gioia said: “Teachers already put their hearts and souls into the classroom-they shouldn’t need to put in their paychecks too.”

One first grade teacher, Marla Garnter, reports that she spends \$500 to \$600 a year on everything from Popsicles as a class reward to crayons and scissors for children whose families cannot afford school supplies. She notes: “It’s those extras that make learning really fun and add that extra quality to the class.”

A 2013 study found that K-12 teachers spent over **1.6 billion dollars of their own money on classroom materials**. <http://thejournal.com/articles/2013/07/01/k12-teachers-out-of-pocket-1-point-6-billion-on-classroom-tools.aspx>

“The research was not conducted by a teacher advocacy group; rather it was conducted by an organization that represents the retailers that supply learning aids, classroom supplies, and other tools to educators, the National School Supply and Equipment Association (NSSEA). The study found that 99.5 percent of all public school teachers spent some amount of money out of pocket, with the national average for 2013-2013 coming in at \$485 among those surveyed.”

The average amount spent by teachers was \$485, but a full 10% of those surveyed reported spending over \$1000. Spending by teachers varies widely, according to experience, school affluence, and ethnic makeup of the school population. Another study, reported



in Forbes magazine, found that teachers spend closer to \$500 each and that parents are actually contributing less to classroom supplies and materials.

“Georgia based special education teacher Brandi Poole is among this crowd, stating that she spends up to \$1000 a year on her small classroom of students.

“I probably spend between \$800 to \$1000 a year, and I have a small class of less than 15 students. A lot of students do not bring in school supplies at all. Although we have a couple of churches that donate, it’s not enough to supply the 400 plus students in our school. We are not given money to purchase stuff that we need to teach the material that we are supposed to teach,” Poole states.

Free Labor

Columnist Kathleen Modenbach, a 20-year teaching veteran writes about the issue of “Teachers’ Free Labor, Out-of-Pocket Expenses Aid School System” and recalls teachers who paint their own classrooms, build lofts and shelves, and even wire entire schools for technology.

Admittedly, they sometimes persuade good-natured spouses or friends to help out. One school librarian “equipped her library with enough computers so each child in class could work at a computer.” She scoured thrift stores for computers and printers and then she and her son refurbished them for use.

I remember visiting the home of one of my favorite new education graduates. She proudly showed me her personal copier, set up in her “school room,” an entire room in their charming home set up just for preparing lessons. Victoria’s husband had surprised her with her own small copy machine for Christmas. It was all she wanted.

Many teachers resort to purchasing their own copiers, digital cameras, and iPads. Modenbach reports that “After a high school teacher’s proposal for an elective history class was approved, she spent her own money to make copies for the balance of the year.” There was no funding for textbooks and this social studies teacher had already “used up” her allotment of copies. The class, like the “show,” must go on.

How far will it go? With average beginning teachers’ salaries hovering at around the \$30,000 mark according to the American Federation of Teachers, compared to graduates in other majors who “start” at about \$40,000, teachers do not have much on which to rely. How much can they take?

How much will the public continue to drain off of these generous civil servants?

- Part 2 next issue

Energy

A person wearing a green sweater is holding a bundle of harvested grain, possibly wheat or barley, in front of a green and white machine. The machine has a large green arrow pointing to the right. The background is a bright, overcast sky. The overall scene suggests a connection between agriculture and renewable energy.

Green energy-

Research into renewable, non-polluting energy sources is advancing at such a fast pace, it's hard to keep track of the many types of green energy that are now in development. Here are 6 of the most common types of green energy:

Solar Power - The most prevalent type of renewable energy, solar power is typically produced using photo-voltaic cells, which capture sunlight and turn it into electricity. Solar energy is also used to heat buildings and water, provide natural lighting and cook food. Solar technologies have become inexpensive enough to power everything from small hand-held gadgets to entire neighborhoods.

Wind Power - Air flow on the earth's surface can be used to push turbines, with stronger winds producing more energy. High-altitude sites and areas just offshore tend to provide the best conditions for capturing the strongest winds. A network of land-based, 2.5-megawatt wind turbines in rural areas operating at just 20% of their rated capacity could supply 40 times the current worldwide consumption of energy.

Hydro-power - Also called hydro-electric power, hydro-power is generated by the Earth's water cycle, including evaporation, rainfall, tides and the force of water running through a dam. Hydro-power depends on high precipitation levels to produce significant amounts of energy.

Geothermal Energy - Just under the earth's crust are massive amounts of thermal energy, which originates from both the original formation of the planet and the radioactive decay of minerals. Geothermal energy in the form of hot springs has been used by humans for millennia for bathing, and now it's being used to generate electricity. In North America alone, there's enough energy stored underground to produce 10 times as much electricity as coal currently does.

Biomass - Recently-living natural materials like wood waste, sawdust and combustible agricultural wastes can be converted into energy with far fewer greenhouse gas emissions than petroleum-based fuel sources. That's because these materials, known as biomass, contain stored energy from the sun.

Biofuels - Rather than burning biomass to produce energy, sometimes these renewable organic materials are transformed into fuel. Notable examples include ethanol and biodiesel. Biofuels provided 2.7% of the world's fuels for road transport in 2010, and have the potential to meet more than 25% of world demand for transportation fuels by 2050. It's available now if we'd use it, and we should.

To the students reading this article I can only ask:

“Will you save our planet please?”

To teachers I would ask:

“No matter what subject you teach, this issue directly affects you, your students and their families. Please find the time to make them *aware* of our shared plight and the challenges they face here on our world?”

Wayne Carley

Geothermal Energy

Clean, abundant....just waiting





THIS IS TODAY. THIS IS YOUR FUTURE



Living Green

STEM Magazine is excited to propose and participate in a visually and mentally engaging STEM classroom experience.

The group experience includes the real time use of:

- Several computer stations and class-wide interaction
- Use of binary translation and commands to and from Lander flight and decent control
- Social media and internet activity
- Live video feed from Mars Lander for targeted site objects
- Classroom projections from Lander camera
- Interaction with Mission Control
- Verbal communications skills between mission stations /
- Use of state of the art technologies that directly correlate to careers

LIVE FEED

The MARS Lander and event is provided and operated by STEM Magazine staff to simulate an actual MARS landing.

All STEM skills and direct applications will be in use in

* We are looking for national sponsors for this program. You can have a **"National STEM Outreach"** from your school at any school in the nation and STEM Magazine Education can help you implement all of the CC curriculum and hands-on activities. 501c3 Grant Qualifying. missiondirector@stemmarslander.com

LANDING

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