S.T.E.M.

MAGAZINE

Reversing Math Negativity

Dr. Judy Willis

A *Delicious* STEM / STEAM Career

Wayne Carley

Tomatosphere

Canadian Space Agency

einstein™ Tablet+

Revisiting STEM Problems

October 2014
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STEM Innovations

A Math and Science Partnership Initiative in Northwest Indiana

Dear Educators,

We hope you enjoyed your first issue of *S.T.E.M. Magazine.* During the Summer Institute, teachers were able to design learning sequences across the math and science disciplines by building lessons from one of the following challenges:

- Solar bottle bulbs
- Waterwheel
- Recycling-Let's Sort it Out
- Concrete Planters

Now that school has started, if you have more specifics on when those lessons will be taught please complete the survey below letting us know the dates. Please take another look at the survey even if you have already completed it as we have added an inquiry regarding visitation during implementation to take pictures or videotape.

https://docs.google.com/forms/d/1INEYp9-VwLRZkQtfjbNNEoa87orp-MFEd_4kugAahgA/viewform?usp=send_form

It is important that you discuss and review the lesson implementation with your lead STEM Innovations program contact. If you have questions, they are your first line of contact. They are:

Crown Point: Jim Hardman
Gary: Dr. Cordia Moore
Hammond: Teresa Mayerik
MSD Boone: Dr. Nathan Kleefisch
Hobart: Brent Martinson
Merrillville: Lorri Covaciu
Munster: Dr. Phyllis Gilworth

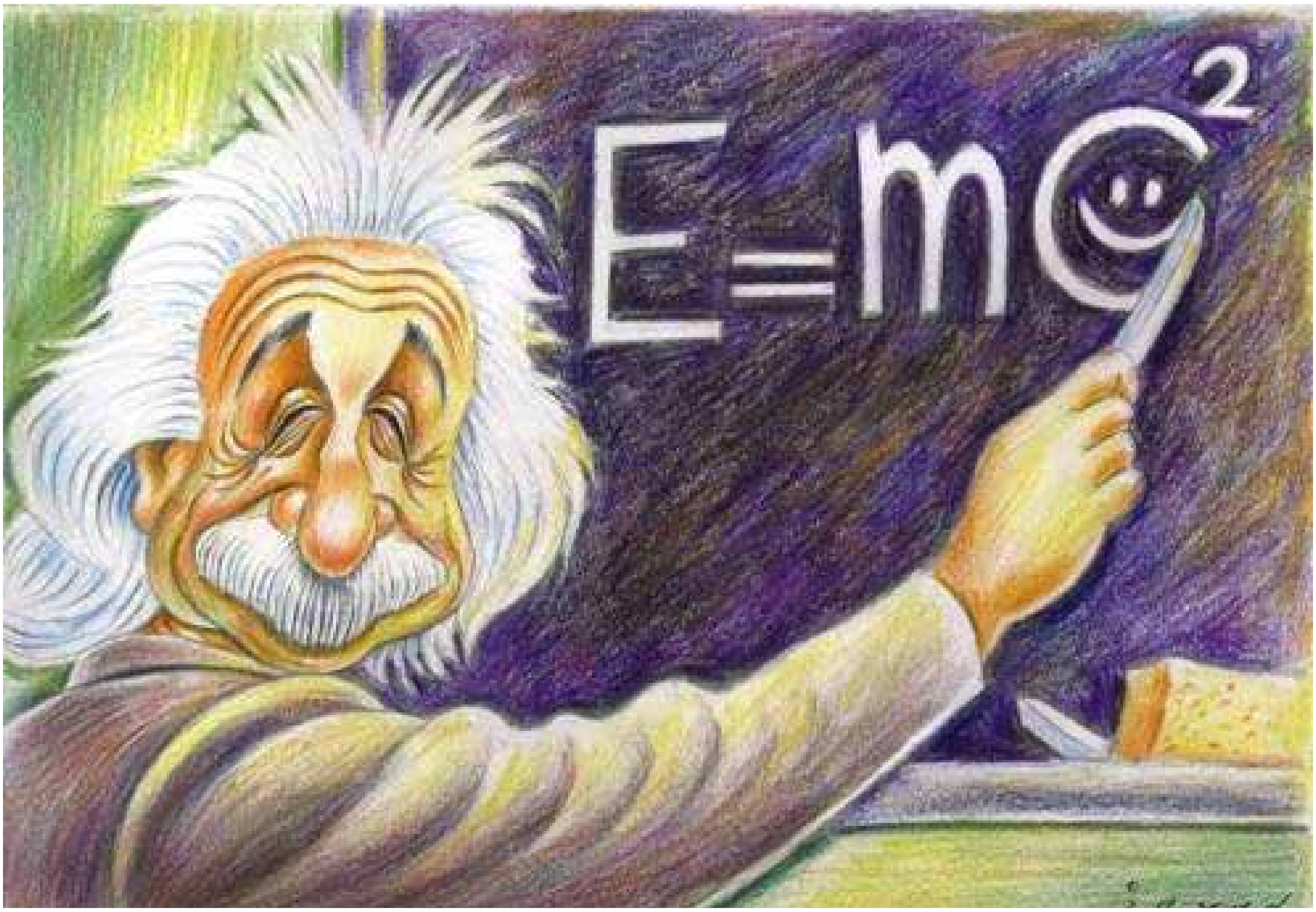
SAVE THE DATE! STEM Innovations offers 80 hours of professional development. The remaining hours (after the summer sessions) will be delivered through three follow-up sessions during the 2014-2015 school year and 8 hours online. The follow up session dates are:

- Thursday, December 4, 2014
- Thursday, February 5, 2015
- Thursday, March 19, 2015

We hope you are settling in to a wonderful 2014-2015 school year. If you have any questions or needs, don't hesitate to contact us!

Regards,
Your STEM Innovations Team

MERRILLVILLE COMMUNITY SCHOOL CORPORATION
Crown Point Community School Corporation · School City of Hammond · School City of Hobart · GCSC Gary Community School Corp · MSD of Boone Township · School Town of Munster · College Acceleration Network · Purdue University North Central



Use it in class. Send it home.

Curiosity and learning are ageless.

Please enjoy this issue. You have unlimited distribution, so your students and their families may enjoy it too.

Features

S.T.E.M. Magazine Inc. is a non-profit monthly education publication for teachers, students, their parents and administrators. CEO Wayne Carley is the publisher and senior editor for all content in S.T.E.M. Magazine.

S.T.E.M. Magazine believes that the key to success in seeing higher graduation rates, improved testing results, student inspiration and a strong work-force rests 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. The atmosphere and tone of the class directly influence the learning and retention process of students.

Student curiosity, interest and career considerations are a direct result of educator influence. S.T.E.M. Magazine will focus on issues and resources to support educators and their students. Inspiring and fueling the creative process of curriculum presentation while also addressing the personal needs associated with the relentless pressures of instruction, testing preparation, classroom discipline and school district demands will be a high priority in every issue.

Wayne Carley
Publisher

S.T.E.M.
Magazine

Subscriptions

S.T.E.M. Magazine is provided to individual schools and districts across the nation and customized to include your local education authors to address your regional needs and concerns.

S.T.E.M. Magazine Inc.
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The numbers are COMING!

Help your children learn to love ***math*** by reversing math negativity

by Dr. Judy Willis

Many students, like their parents before them, attend school with feelings that make them unhappy doing math. In fact, a 2005 AP/AOL News poll of 1,000 adults in the United States revealed that 37 percent recalled they hated math in school. In the poll, more than twice as many people said they hated math as said they hated any other subject.

One would think that once they were out of school, these individuals would have found the real-world value of the math they disdained in school. But in a 2007 evaluation of math literacy of a random sampling of adults in the United States, 71 percent could not calculate miles per gallon on a trip, and 58 percent were unable to calculate a 10 percent tip for a lunch bill. Yet only 15 percent of those polled said they wished that they had learned more about or studied more math in school.

Most elementary arithmetic skills are "learned" by rote memorization and assessed on tests of memory recall. Children who do not excel at memorizing isolated facts are less successful, feel inadequate and lose confidence in their ability to do math. The result is a cascade of increased math anxiety, lowered self-confidence, alienation and failure.

"The result is a cascade of increased math anxiety, lowered self-confidence, alienation and failure."

The first step

to success in math is a positive attitude. Yet, this is actually the last thing that many teachers expect from students. It is up to parents to help change these attitudes.

DO

- *understand the myths and misconceptions about math*
- *recognize the consequences of math negativity*
- *apply math in real-life ways*
- *grasp the effects of math-related stress*

DON'T

- forget to act as a math ally
- underestimate the importance of retests in math class
- fail to encourage memories of positive school experiences
- shy away from sharing your negative personal experiences

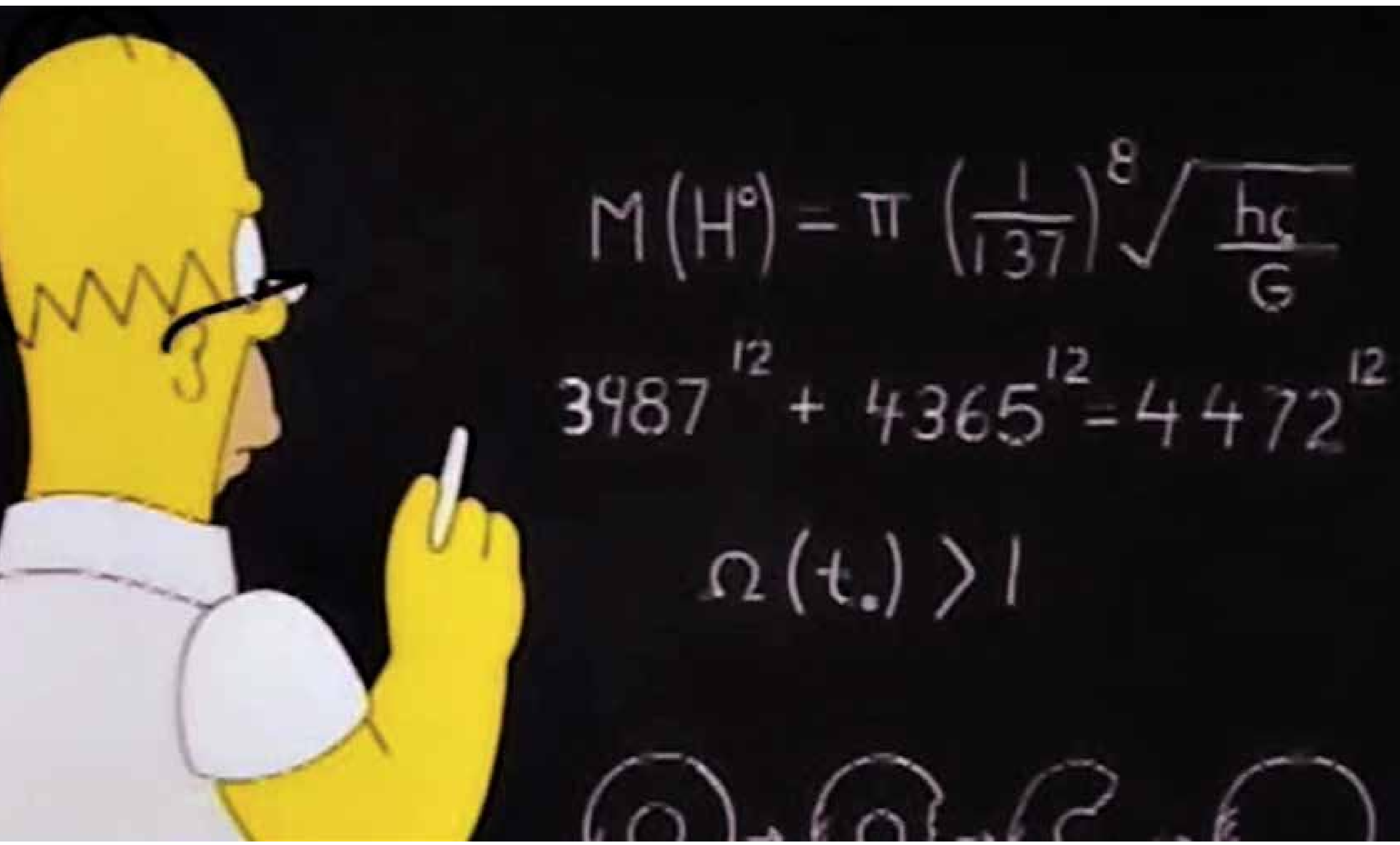
There are numerous myths and misconceptions about math. These include:

- You have to be very intelligent to be good at math.
- It is acceptable to be bad at math because most people are.
- Math is not really used much outside of special occupations.

In addition, many kids believe that because their parents were never good at math, parents don't expect their kids to be any different. But why is there so much negativity about math?

Some causes include low self-expectations as a result of past experiences with math, parental bias against math, inadequate skills to succeed at learning math, failure to engage math through learning strengths and fear of making mistakes.

As teachers know all too well, math negativity has various consequences. These can include stress, low motivation, decreased levels of participation, boredom, low tolerance for challenge, failure to keep pace with class lessons, behavior problems and



avoidance of advanced math classes necessary for subsequent professional success.

DO apply math in real-life ways

Why wouldn't students develop math negativity, frustration and stress? They are routinely asked to memorize procedures and are then told—without explanation or conceptual connections—that what was correct last year is no longer acceptable.

The curriculum rarely primes their interest with opportunities to want to know how to represent remainders in different forms. Without clearly evident personal value, the brain—operating at the level of information intake and memory formation—does not care.

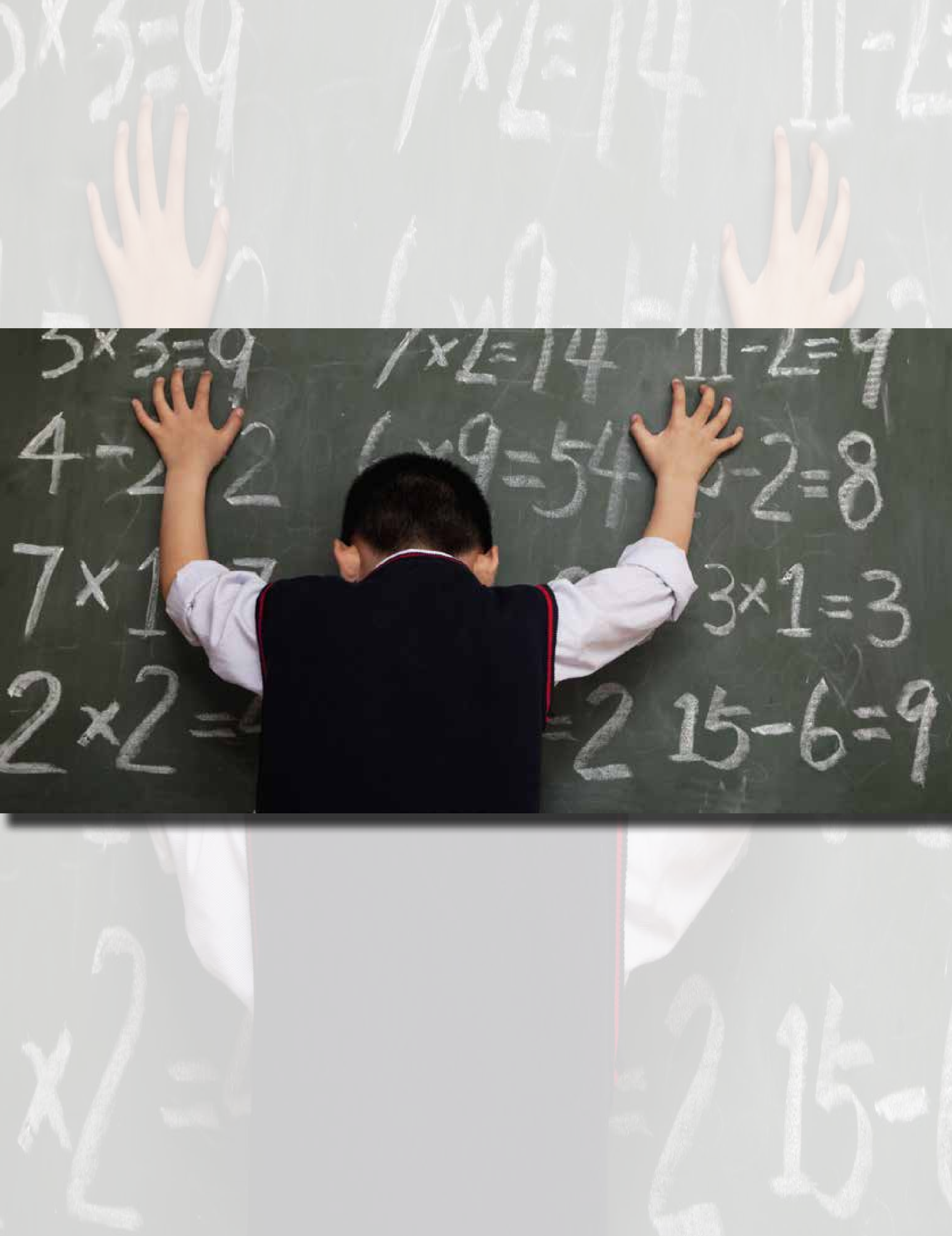
Students truly grasp math when they see it applied in real-life ways that they care about. In other words, when they see math as a tool they need and want. This motivation is not promoted in word problems about the number of books or the number of students in a classroom.

However, when you give small groups of students 67 toothpicks and some index cards, and then ask them to model the pizza party seating problem described earlier, they will build the experiential knowledge of a real- world situation where remainders are not helpful.

When they consider dividing leftover pieces of pizza into parts, they will see that fractions or decimals are a valuable tool to make the pizza sharing process fair, whereas a remainder would imply that perfectly good pieces of pizza sit in the box because there is no way to divide them.

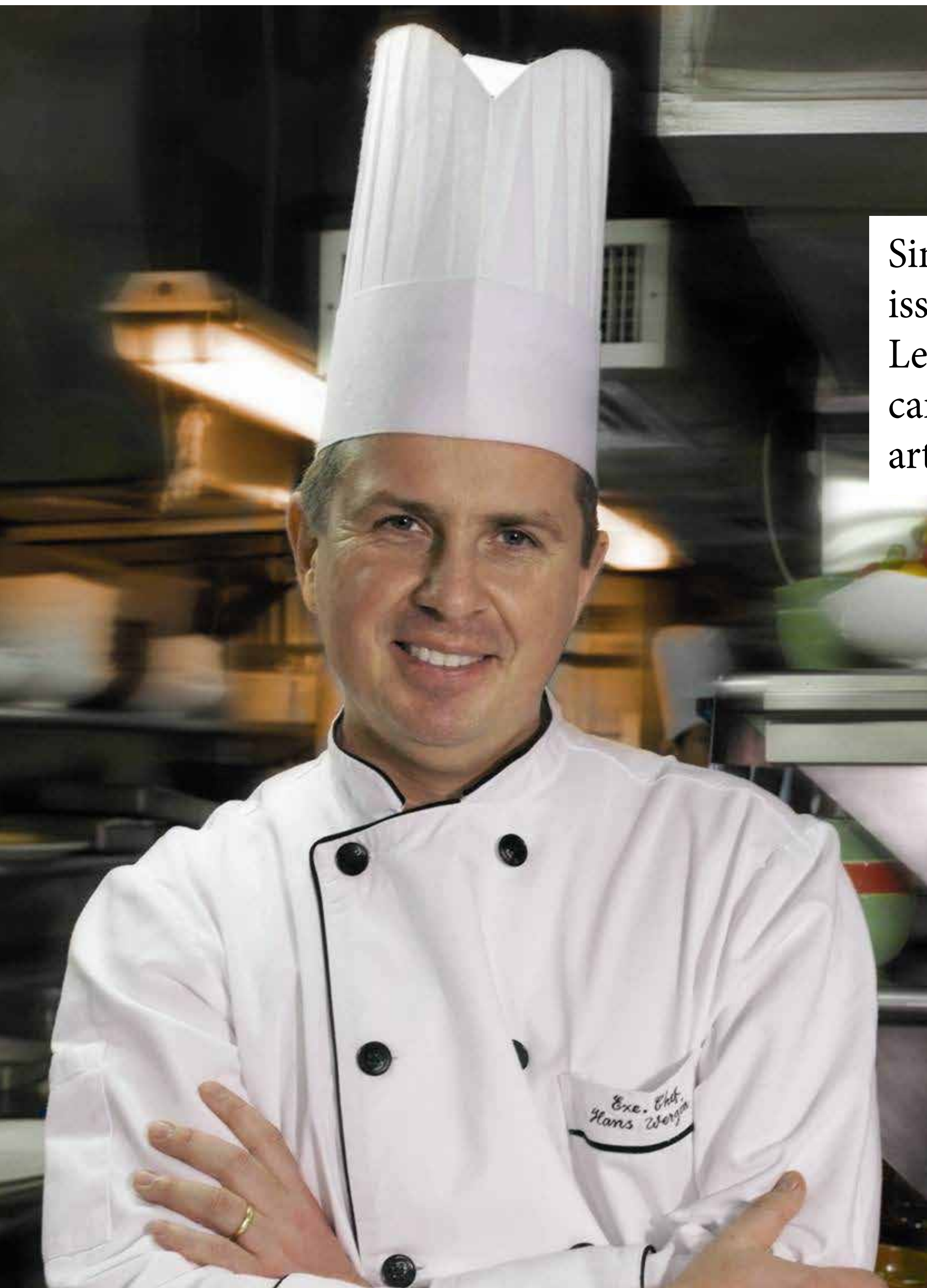
Next issue:

The effects of math-related stress. (a must read)


7×2=14
11-2=9
3×1=3
15-6=9

Another great STEM / STEAM career:

CHEF



Since Pi is a theme this issue, why not add Pie. Let's talk about a career in the culinary arts.

Ever wondered why you're not supposed to bake with cold eggs or whether marinating really tenderizes meat?

A delicious career in culinary arts incorporates all of the STEM and Arts skills found in any STEM career....and we get to eat our work.

The executive chef is the top dog, and there's typically only one in a restaurant. But not everyone has executive chef aspirations. While you're in culinary school or working in a restaurant you may find that you're either really good at one element of cooking or that you love one aspect enough to do only that. It works out nice if they happen to be one in the same.

Many chefs specialize in these fields and become well-known and successful within that specialty. French chef Pierre Herme is a good example. He's known as the "Picasso of Pastries" -- not a bad title.

Some of the following jobs are stepping stones to becoming an executive chef, also known as chef de cuisine, but some are great stand-alone careers:

- Sous chef -- the executive chef's right hand

- Patissier -- or pastry chef, works with pastries and desserts only

- Chef de partie -- or station chef; they're in charge of a particular part of the kitchen

- Saucier -- prepares the sauces and sautés
- Poissonier -- works with seafood

- Entremetier -- in charge of soups, vegetables, starches and egg dishes

- Rotisseur -- cooks roasted, braised and broiled meats and gravies
- Gard manger -- also known as pantry chef; prepares cold items

- Cook -- works under the various station chefs

Some kitchens are even broken down more specifically with separate chefs in charge of soups, cold desserts, vegetables and bread, to name a few. The fact that these jobs all have French names is no mistake. The basis of fine dining is French food, and when you hear about a chef being "classically trained," that means French cuisine and techniques. Even if it's not fine dining, chances are there's a lot of French technique involved, so unless you have some experience with it, you won't have much success as a chef.

Cooking Science and Technology:

From blenders to broilers the modern kitchen is full of technologies, some old, some more like science fiction such as the use of liquid nitrogen, hot air fryers, and centrifuges.

Sous vide is French for under vacuum and describes a method of cooking in vacuum sealed plastic pouches at low temperatures for long times.

The method was developed by Georges Pralus in the mid-1970s for the Restaurant Troisgros (of Pierre and Michel Troigros in Roanne, France) but remains mostly used by high class restaurants or for industrial purposes.

Sous vide cooking method differs from conventional cooking methods in two fundamental ways: the raw food is vacuumed sealed in plastic pouches and the food is cooked using precisely controlled heating.

Molecular gastronomy is a sub-discipline of food science that seeks to investigate the physical and chemical transformations of ingredients that occur in cooking. Its program includes three axes,

as cooking was recognized to have three components, which are social, artistic and technical. Molecular cuisine is a modern style of cooking, and takes advantage of many technical innovations from the scientific disciplines.

The term “molecular gastronomy” was coined in 1988 by late Oxford physicist Nicholas Kurti and the French INRA chemist Hervé This. Some chefs associated with the term choose to reject its use, preferring other terms such as multi sensory cooking, modernist cuisine, culinary physics, and experimental cuisine.

Of the three chemical senses, smell is the main determinant of a food item’s flavor. While the taste of food is limited to (savory), pungent or piquant, and metallic – the seven basic tastes – the smells of a food are potentially limitless. A food’s flavor, therefore, can be easily altered by changing its smell while keeping its taste similar.

Nowhere is this better exemplified than in artificially flavored jellies, soft drinks and candies, which, while made of bases with a similar taste, have dramatically different flavors due to the use of different scents or fragrances.

The flavorings of commercially produced food products are typically created by flavorists. A flavorist, also known as flavor chemist, is someone who uses chemistry to engineer artificial and natural flavors. The tools and materials used by flavorists are almost the same as that used by perfumers with the exception that flavorists seek to mimic or modify both the olfactory and mouth feel properties of various food products rather than creating just abstract smells.

Cooking Engineering: the decision making process of how to prepare a variety of foods for a meal that all end up being ready at the same time. When to start cooking the ingredients, how long will each take, what food goes with what food, what flavors complement each other, what technologies to use and many more decisions have to be made each and every meal.

Math: Accurate measurements are critical to meet recipe requirements. Cooks often have to convert metrics, adjust for portion changes by multiplying ingredient amounts for larger groups. Cooking time calculations and estimations are critical to cooking, even at home.

The Arts: Visual appeal is very important in culinary preparation, thus all the effort put into the menu photos. You can only hope it really looks like that when delivered to your table. The amount of creativity can be impressive when staging food items for best presentation.

Desserts get a lot of attention in this regard, maybe because they are the finale to a wonderful meal. None the less, artistic presentation in combination with flavors, temperature, texture, creativity and imagination make the culinary arts truly art.

Artist

Education:

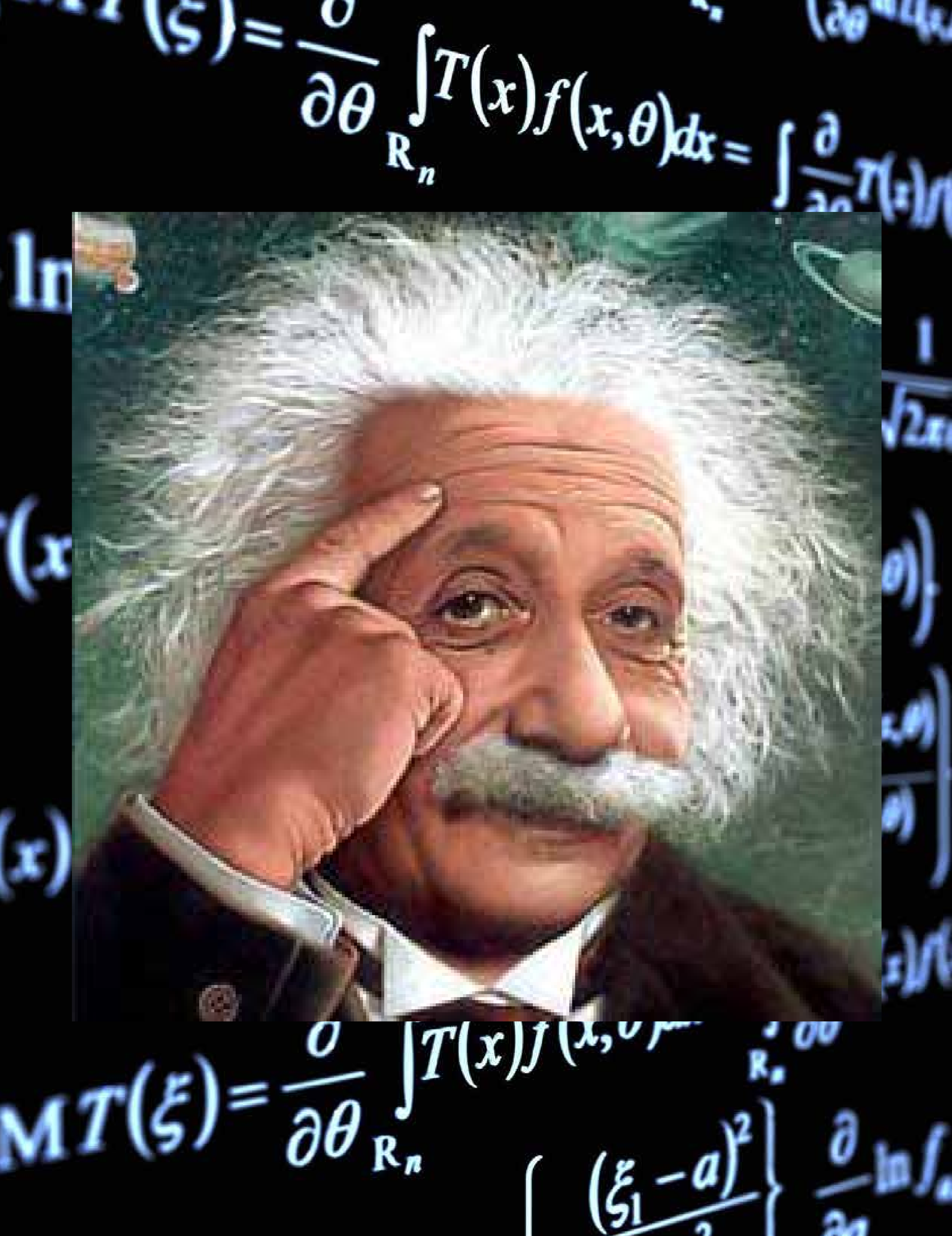
Diplomas, Associates degrees, Bachelors and Masters Degrees are available depending on your career intentions, financial recourses, but most of all, level of passion to make this dream come true.

The scope of culinary employment is vast. Professional cooks work at hotels, restaurants, resorts, casinos, hospitals, and corporate headquarters; and in private homes, aboard yachts, and as vendors on street corners. To place yourself on the best path forward, refine your culinary dreams before you launch.

Envision yourself working at your dream job, and then ask a few questions to help choose your culinary direction.

Are you interested in post-graduate employment as a chef or kitchen manager? If so, advanced studies may be required. Instead, is your passion fueled by hands-on creation of delicate desserts? Your study track should include a Pastry Arts specialty. Or are you a restaurant entrepreneur, who needs business and management training to live your dream?

Consider the practical side of your education too. Be realistic about your ability to tackle work and schooling obligations simultaneously. Many culinary arts programs account for your need to earn while you learn; so if you need flexible scheduling, be sure to investigate night and weekend learning options.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einstein™ Tablet+ Wins 2014-15 Readers' Choice Award!

By *Renee Emery*

This past spring, more than 1,300 educators and administrators from K-12 schools and districts across North America nominated their favorite ed-tech products or services to eschool News, a publisher of K-12 ed-tech news and information.

einstein™

CHICAGO, ILLINOIS--*Fourier Education's einstein™ Tablet+ is the recipient of an eSchool News 2014-15 Readers' Choice Award, honoring the best products and services in educational technology as chosen by readers.*

This past spring, more than 1,300 educators and administrators from K-12 schools and districts across North America nominated their favorite ed-tech products or services to eschool News, a publisher of K-12 ed-tech news and information. "*The result is a list of ed-tech products and services that have proven to be effective,*" said Editorial Director Dennis Pierce.

The einstein™ Tablet+, is a revolutionary mobile science exploration tablet for learners of all ages. This revolutionary tablet includes eight built-in sensors that are commonly used in standard science curricula (Humidity, UV, Heart Rate, Ambient Temperature, Light Accelerometer, Microphone, and GPS).

According to Fourier, using its internal and external sensors, the einstein™ Tablet+ can be used to conduct hands-on experiments to experience first-hand phenomena and to learn about the scientific process. Other platforms require switching devices to move from e-book to lab work or going from the "regular" classroom to the computer room or lab.

The einstein™ Tablet+ is such a small device, it allows the science lab to be truly mobile, which means that students can easily go outside of the lab to explore their surroundings, collecting data and analyzing it on the spot. Pre-installed is the award-winning MiLAB™ data analysis app as well as the recently released einstein™ World app which delivers access to NGSS aligned content from the einstein™ Activity Store.

"Considering the einstein™ Tablet+ itself, and the data collection capabilities and the internal sensors, the Tablet+ is a very cost effective solution for science learning ($299.00). Plus, all of our software is freely available either from the web, the Apple App Store or the Play Store," says Tamar Shen-Orr, Fourier Education's Director, Product Marketing.

"*I'm always looking for the best tools for teachers to use to engage their Students in authentic scientific inquiry,*" said Kenneth Linsley, regional STEM Coordinator for the Northeast Georgia Regional Educational Service Agency.

The einstein™ Tablet+ is exactly what teachers and students need to engage in collecting real data in real time, just like scientists.

If data collection was all the einstein™ Tablet+ did, it would be a great value, but it also functions as a regular tablet, making it a versatile resource in all content areas."

"*What is so cool about the Activity Maker is that teachers can not only use the activities they created, but share them with the einstein™ community around the world. Activities, created by our team, by partners and by teachers can be downloaded and used by anyone using einstein™*," says Shen-Orr.

Fourier says that they are currently working on introducing additional assessment tools and interactive modules to the Activity Maker so activities created can be even more engaging.

Fourier Education (www.fourieredu.com) is a global leader in science education technology. Founded in 1989, the company is committed to bridging the gap in children's science education.

www.einsteinworld.com

Why Is Pi important?

Pi is the 16th letter (π) of the Greek alphabet which is used to represent this mathematical constant.It is typically written as "pi" in text.

Pi is perhaps the most important mathematical constant. It appears in various formulas throughout math and science in fields as diverse as physics, statistics, and sociology. Although pi is defined in terms of the geometry of a circle, most applications of this number do not directly involve circles.

If the circumference or the area of a circle is known, pi can be used to find the diameter and the radius of that circle. Likewise, if the radius or diameter is known, pi can be used to find out the circumference or the area.

The ratio equals about 3.1415. This value is a constant for any circle. The circumference of a circle is always equal to pi times the diameter. The area of a circle is always equal to pi times the radius squared. These formulas are used constantly by engineers, physicists, designers and mathematicians. The uses of pi extend beyond merely finding

circumferences or radii. NASA uses pi to calculate the trajectories of spacecraft, to determine the sizes of craters and to estimate the sizes of planets outside our solar system.

The computation of pi has a long and fascinating history. Some of the most elaborate mathematical methods have been used in devising various formulas for pi.

By the late 19th century, its value had been computed by hand to several hundred decimal places. Since the dawn of the computer age in the mid-20th century, the number of calculated digits of pi has skyrocketed. Since 2002, its value has been known to over a trillion decimal places - enough to fill a large library!

Revisiting the STEM Problems
and
Why STEM **Must Not** Leave Math or Math **Teachers** Behind!

Dr. Susan A. Pruet
President, STEMWorks, LLC

Everyone's talking about STEM (science, technology, engineering and mathematics) - from the corporate board room to K-12 schools leaders and teachers, and including national afterschool organizations like Boys and Girls Clubs and the Girl Scouts - as well as government agencies such as the Departments of Defense, Education, and Energy.

These conversations are driven in large part by our country's concern that we have a growing STEM problem: The US is not producing enough high school and post-secondary graduates who are prepared and eager to fill this growing need for STEM citizens and workers.


N = ?

While there may be disagreement across different sectors about the specific numbers or specific fields that need STEM workers, we can relate to this headline from a recent Discovery Education presentation which pretty clearly highlights the gap problem:

US Students fall short in STEM scores, while **3 million STEM jobs go unfilled.** The recently released 2012 PISA results reveal once again that many US students are lacking in STEM skills with US scoring below the international average in mathematics proficiency, and only 8% of our students scoring at the proficiency level in science which, while close to the international average, is still shockingly low (National Center for Education Statistics, 2012).

We've heard repeatedly that STEM-dependent jobs are rapidly growing. An article In the January 2013 STEM Magazine by the STEM Education Coalition describes this growth and problem in detail, reporting that over the past 10 years growth in STEM jobs is three times more than that of non-STEM jobs (Brown, J. and Peterson, J., January, 2013).

It is alarming that one dimension of our STEM problem is that too many of our students – even those capable of pursuing STEM careers - are not interested, or do not believe they would be successful, in high school STEM courses, much less STEM careers. And the problem starts much earlier than high school.

Disturbing reports show that interest in STEM and STEM careers decline in the middle grades, particularly for girls, and at a time when critical STEM course selection decisions are often made. Additionally, many of our high school students simply are not reaching their potential in STEM subjects. According to the President's Council of Advisors on Science and Technology (PCAST) reports, too many American students and parents believe that STEM subjects are too difficult, boring or exclusionary. The STEM problem is even more troublesome when we focus on mathematics.

A 2010 Department of Education report specifically points to attitudes towards mathematics as a critical part of the STEM problem, stating that only 16% of US high school seniors who are considered proficient in mathematics also indicate an interest in a STEM career. Of those few who do complete a STEM major in college, only about half end up working in STEM fields (http://www.ed.gov/sites/default/files/stem-overview.pdf).

So, addressing the STEM problem is two-fold: developing interest and self-efficacy in STEM on the part of all students, and also increasing their capacity related to STEM (Hossain, Robinson 2012; PCAST, 2010, 2012).

Many in education and industry are counting on K-12 STEM curricula and programs to be the catalyst to produce these future graduates eager and able to pursue STEM. While there are a variety of definitions of STEM and STEM education, this discussion focuses on integrated STEM programs, which in my opinion, and based on current research of how deep learning occurs, hold the most promise for addressing our STEM problem. (Proceedings of the National Academy of Sciences, June, 2014; Harlan, et. al., 2014).

This type of K-12 STEM program involves the integration all four of the STEM disciplines and is intended for all students. Such curricula use engineering and the engineering design process to bring relevance, interest, and deeper learning to mathematics and science as students apply that content to produce solutions and technologies while addressing problems of importance in local communities and the world.

This is the type of instruction that the STEM Education Coalition and others are saying is needed to address our growing STEM problem (Brown, J. and Peterson, J., 2013; Proceedings of the National Academy of Sciences (PNAS), 2014; TPSE-Math, January, 2014).

The really good news is that research findings are beginning to emerge associating use of this type of curriculum and instruction with

positive increases in students' STEM capabilities, as well as their interest and confidence in pursuing STEM (National Academy of Engineering, 2014; Harlan, et. al., 2014; PNAS, 2014).

For many teachers, this type of integrated STEM through engineering requires a major transformation from "school as usual" teaching and learning. This is especially true for math teachers. It involves students collaborating in teams as they go through an iterative engineering design process to research, create, test, improve and communicate solutions. Teachers serve more in the role of a facilitator of learning and use more of an inquiry-based approach to teaching.

Assuming that we want to impact all students, another aspect of these integrated STEM curricula is that they need to be implemented as part of a school's required curriculum – which logically could be part of the science, math or technology curriculum.

Ideally, implementation would be done in conjunction with all three classes. Teachers would collaborate across the disciplines while students work on a particular engineering challenge as they move from math to science and/or a technology class.

My own experience shows that this particular model is especially powerful in breaking down those rigid math and science silos – both for teachers and students. But, so far, not very many STEM curricula appear to include core

math classes, must less are designed to use a collaborative model.

Up until recently, the primary place we typically saw STEM being integrated was in technology classes, often as part of a career technology program. Besides the fact that in many schools all students are not enrolled in such technology classes, some early findings indicate that while the curricula is supposed to integrate STEM as described above, it is the T & E that get emphasized in these programs, while the M and S content either aren't emphasized or opportunities to deepen math and science content are inadvertently glossed over (Roehrig, G, et. al., 2012).

With the release of the Next Generation Science Standards (NGSS) and its new emphasis on including engineering as part of the science framework, science classes are a likely a new home for integrated STEM.

Although it is unlikely all states will adopt NGSS, it is likely that over the next few years the vast majority of US school districts will be influenced by these standards and that many districts will require the implementation of integrated STEM through engineering as part of their required science curriculum for all students; additionally, they may well continue to include similar curriculum in technology classes, at least for some students.

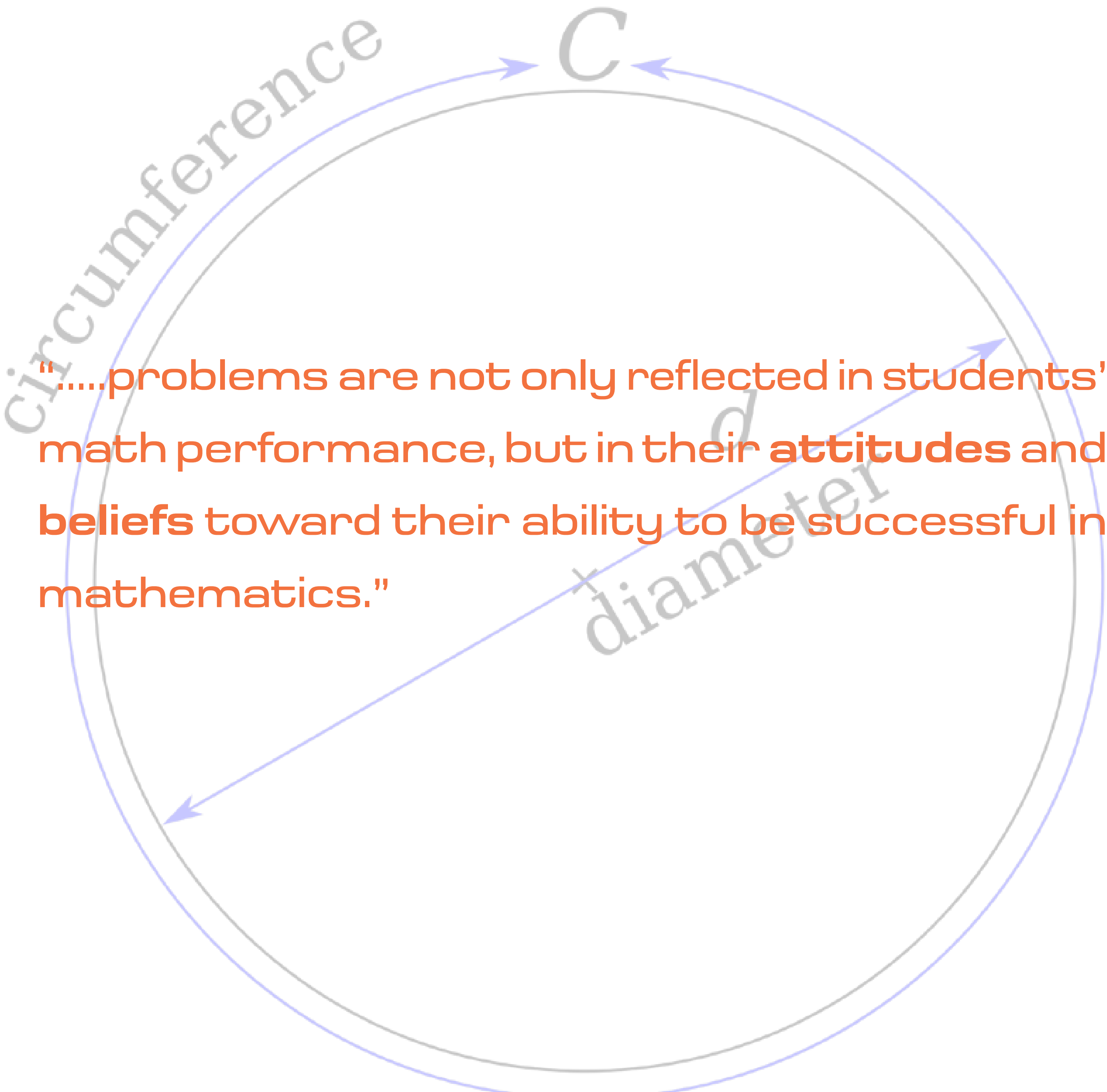
These potential changes may seem sufficient to meet our country's needs—but something critical is not in this equation. This approach leaves out math courses—and, importantly, math teachers. The truth is that our mathematics curriculum and the way we have been typically teaching mathematics is becoming recognized as a key barrier to STEM.

The problems are not only reflected in students' math performance, but in their attitudes and beliefs toward their ability to be successful in mathematics. In a recent panel discussion, Jo Handelsman, a microbiologist at Yale and one of the authors of PCAST's Engage to Excel report related to the STEM crisis, highlights the finding that "math was the single biggest barrier to training STEM majors."

Another study points out that the key to even succeeding in the sciences in colleges is more dependent on the number of high school math courses taken than on whether students have taken physics, chemistry, or biology.

The message was - if a student wants to be successful in college-level science, s/he should take more high school math! (Tai and Sadler, 2007). Dr. Handelsman also addressed instructional strategies, saying that improving K-12 math teaching to include active learning and making mathematics more relevant is the key to improving both performance and, as importantly, interest in mathematics.

This is exactly the description of teaching and learning associated with integrated STEM. And this is consistent with the description of the mathematical practices as part of the Common Core State Standards for Mathematics (CCSS) currently guiding K-12 math curriculum in most all of the states.



"…..problems are not only reflected in students' math performance, but in their **attitudes** and **beliefs** toward their ability to be successful in mathematics."

These and other reports, coupled with my own experience throughout my career - as a math teacher, teacher educator and leader of two NSF funded K-8 STEM education reform projects - demonstrate that STEM education must not leave mathematics or math teachers behind.

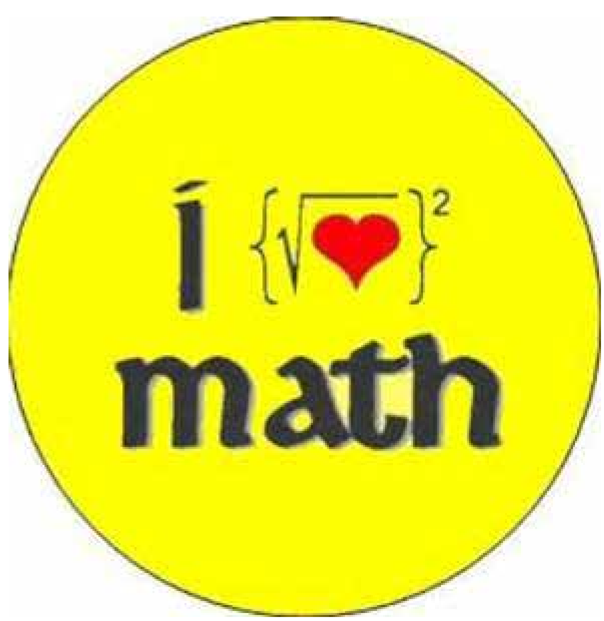
While the teaching of mathematics and thus math teachers have certainly contributed to our STEM problem, there are other powerful factors influencing that teaching and students' negative attitudes.

I believe it is our math teachers themselves who could prove to be a key and powerful resource to combat our STEM problem.

They have day to day contact with every single youngster and the opportunity to be a positive, rather than a negative, influence on our youth's STEM capabilities, as well as their attitudes and beliefs toward mathematics and STEM careers.

An opportunity to be a positive influence.

These include mathematics curriculum, pacing guides, textbooks, and assessments prevalent in many of our districts, compounded by a prevailing culture in the US that it is perfectly acceptable to not do well in mathematics.



Remember what it felt like when YOU didn’t understand?

With quality integrated STEM curriculum, resources, and support our math teachers can help our youth see how mathematics contributes to solving problems and meeting our human needs, from addressing environmental issues to designing both innovative medical technologies that improve lives and stronger homes and buildings that can better withstand natural disasters.

Meaningful mathematics can be introduced, developed and/or reinforced through integrated STEM. Some important middle grades math concepts are particularly suited for STEM design challenges, e.g., rates and proportional reasoning; probability, statistics, and data analysis; and fundamental function concepts.

We need to capitalize on our enormous resource, the math teachers, and include required math courses in our state, district and school plans for STEM, especially at the middle grades.

As business and STEM education leaders, we need to harness our resources and creative energies in support of including mathematics and math teachers in STEM. We must help math teachers understand more deeply the STEM problem, perhaps through teacher-industry field trips and internships, and how critical they are to solving our country's STEM problem.

Using integrated STEM and engineering design challenges to support math learning will involve very different instructional practices for most math teachers, even if we just target middle grades. Math teachers will need quality integrated STEM curriculum linked to their required content objectives, along with needed technology, equipment and materials. The shift to STEM instructional practices requires effective and efficient STEM professional development and implementation support.

Ideally, implementing a well-integrated STEM curriculum will also involve science and technology teachers who likewise will need such support; this collaborative model requires additional time for teachers to collaborate, plan, reflect and learn together.

The bottom line is ---

---solving our pervasive STEM problem will not be easy, but it is doable if we thoughtfully and strategically engage, prepare and support our math teachers, so they can become a key part of the cadre of the STEM educators our youth and country sorely need.

Dr. Susan Pruet has been actively involved in STEM education throughout her career – as a teacher, educator, professional developer, grant writer, and program director. From 1998-2013 she directed two reform initiatives for the Mobile Area Education Foundation: the Maysville Mathematics Initiative and, most recently, K-12 Engaging Youth through Engineering (EYE) which included the development of several middle grades STEM instructional units.

Dr. Pruet has served on a number of education boards and committees including vice chair of the Board of Directors of the Alabama Mathematics, Science, Technology, and Engineering Coalition (AMSTEC) and the Executive Board of the American Society of Engineering Educators (ASEE) K-12 Division. Dr. Pruet now leads her own consulting company, STEMWorks, to support organizations in designing and implementing successful integrated-STEM programs.

susan.stemworks@gmail.com
on twitter @SusanPruet and join her LinkedIn community http://tinyurl.com/myrw6xa.

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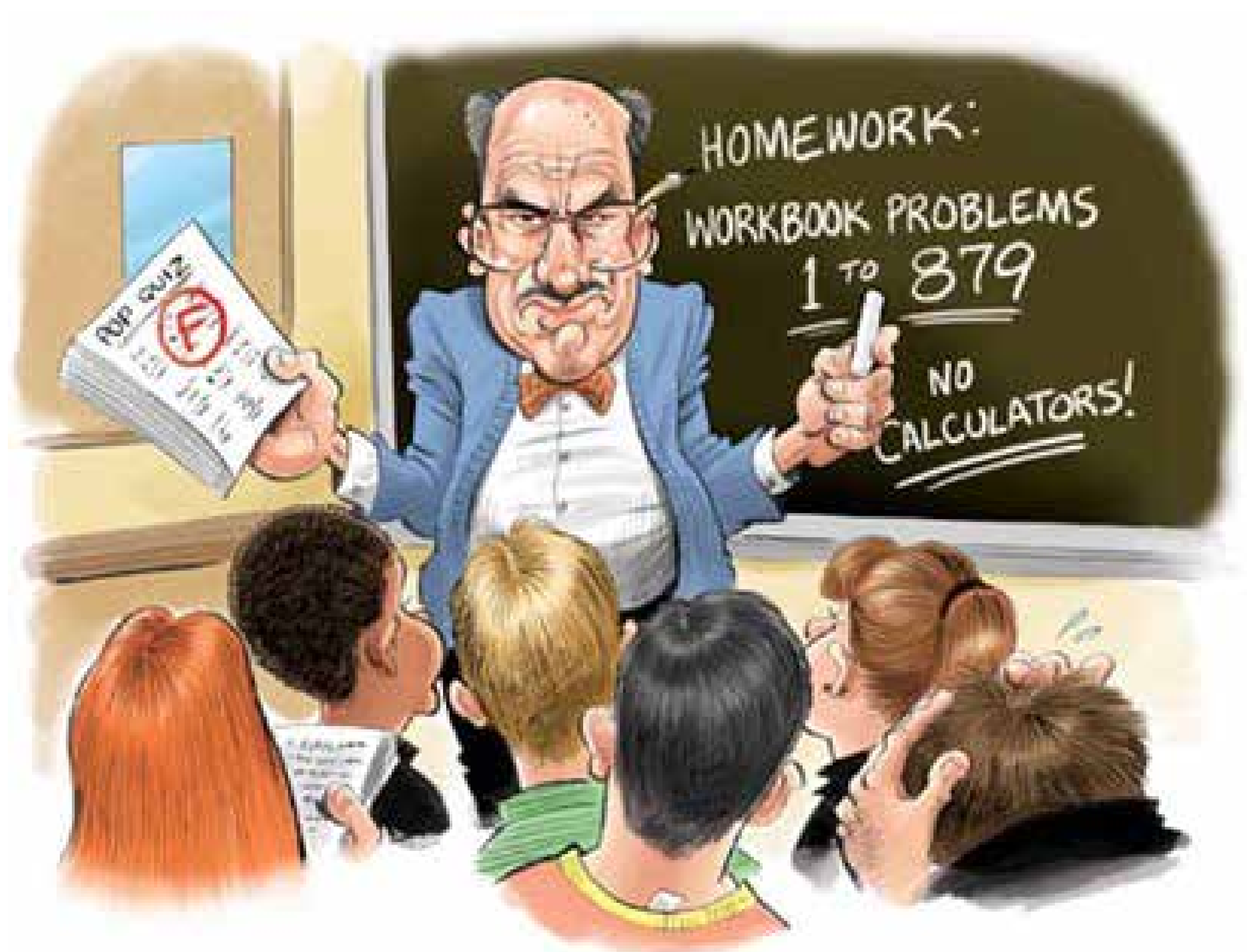


The Universe
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Adaptive learning –
departure from the lockstep model of education

by Mohamad Jebara

Adaptive learning caters to the individual and aims to meet them exactly where they are at any point in time. Mohamad Jebara from Mathspace explains how technology can help to take adaptive learning to the next level.

Adaptive learning is a popular term of late. No doubt you've heard it when looking into apps and tools to support students' learning both in and out of the classroom. What is adaptive learning, exactly?

Differentiated -> personalized -> adaptive

Differentiated, personalized, and adaptive are three of the biggest buzzwords in the education world at the moment. But what do they mean exactly? And what is the difference between them?

Differentiated learning is an easy one, and something that we all know about. Streaming is the most obvious example of this. Commonly, this will involve students being placed in a group according to their ability level and the group following a set pathway through the curriculum. Most math classes that we come across these days are differentiated in some way to cater for the different levels of ability within the class.

For example, within a school, you may have an advanced class or a remedial class, or even have these groups within a single classroom.

Personalized learning is where individual students, rather than a group of students, have their own pathway through the curriculum.

This could be based on a diagnostic test that the student takes at the start of the year/semester to see what level they are working at for different topics within the syllabus.

For example, one Grade 8 student may have fractions covered but may struggle with decimals. A personalized learning path could be designed for her whereby she learns Grade 9 content in fractions, and work through some Grade 6 material on decimals to help her get up to speed in that topic.

So personalized learning is essentially individualized differentiation.

Adaptive learning takes it a step further and introduces a time element. With adaptive learning, not only do you have differentiation based on ability and individualized pathways through the curriculum, but there is a recognition that the pathway can change at any time. Going back to our Grade 8 student, she might work through the Grade 6 decimals material more quickly than expected. With adaptive learning we'd recognize that she has demonstrated mastery of the Grade 6 level quickly, and then we could start giving her some more advanced material to work on – immediately, and not based on deadlines or when the work pace was due.

Alternatively, if she was struggling with the new Grade 9 fractions content, we could continue to allow her to work on questions suited to her ability at her own practice and more time to attain mastery of the topic, before moving on to harder questions and/or the next topic.

We can see that differentiated learning begets personalized learning, and from personalized learning comes adaptive learning. It seems a natural progression towards a learning program that caters specifically to the individual and aims to meet them exactly where they are at any point in time. This is a radical departure from the traditional lockstep model of education that the world has been following for the last hundred years or so.

Adaptive learning – how to deliver?

To a degree, it is possible for a teacher to facilitate adaptive learning in their classrooms without any additional technological aids. In fact, all good teachers will already deliver some degree of adaptive learning. Recognizing which students are ready to move on and which need a little more attention goes with the territory.

But to deliver a truly adaptive program, you need more than just spreadsheets and a good memory. Perhaps this explains why it's only recently that adaptive learning has jumped to the forefront of the education frontier.

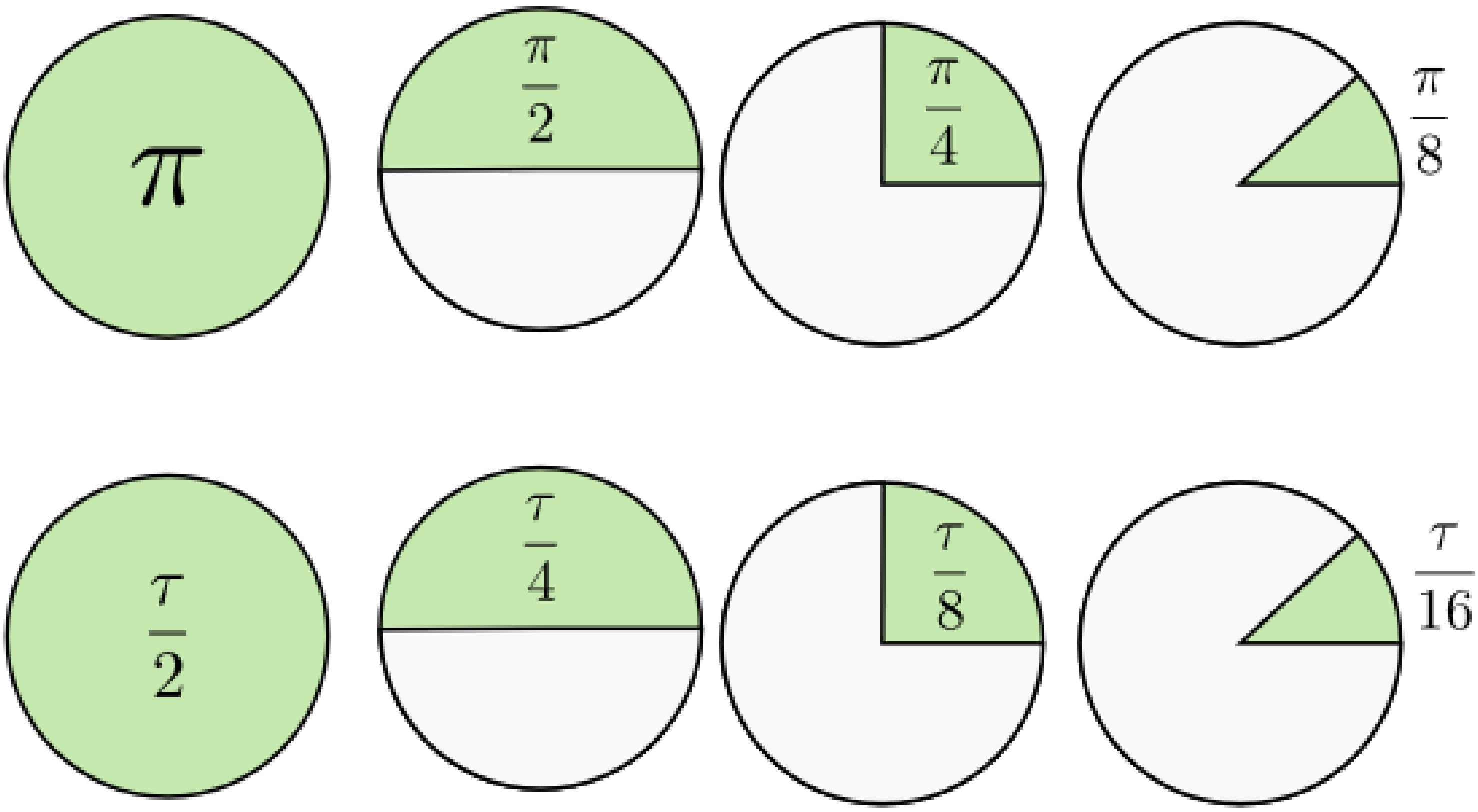
Technology helps us take adaptive learning to the next level and allows us to offer a truly personalized, granular, real-time learning program.

If our Grade 8 student demonstrates competence in adding fractions at a Grade 9 level but needs more practice with multiplying fractions, an adaptive learning technology can at once give them more difficult addition questions and make the multiplication questions simpler until they get the hang of the concept.

We can follow the student via reports and progress matrices, make adjustments where needed and, of course, be present in the classroom to explain concepts and help with difficult problems. The teacher's role shifts towards facilitating self-directed student learning. Thanks to technology, all this is now possible.

Mohamad Jebara is the founder and CEO of Mathspace.

MATHSPACE



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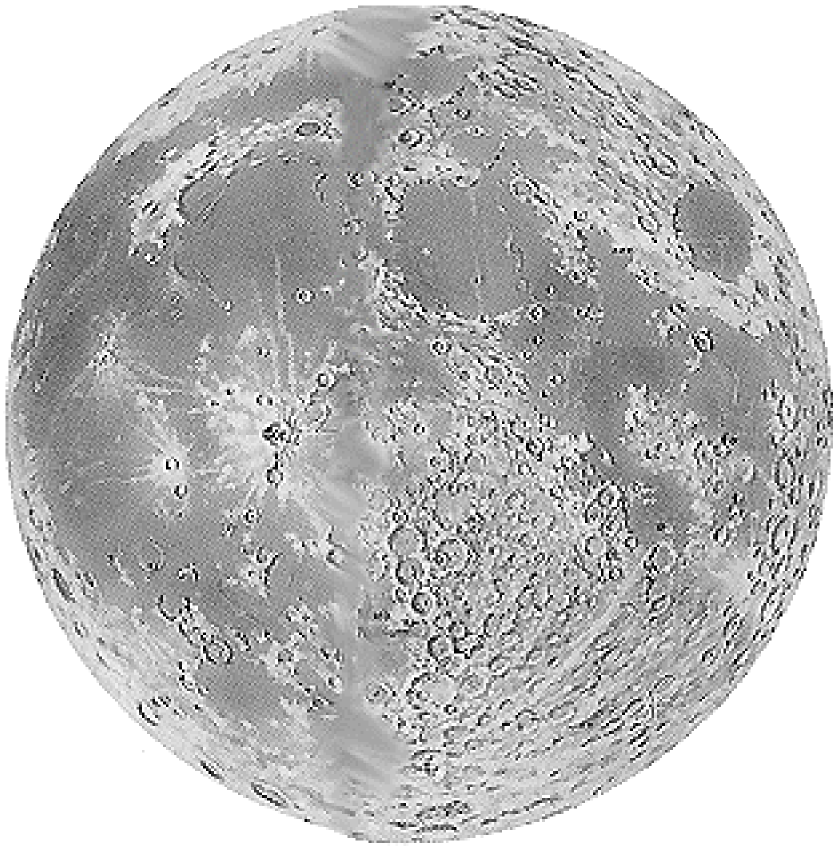
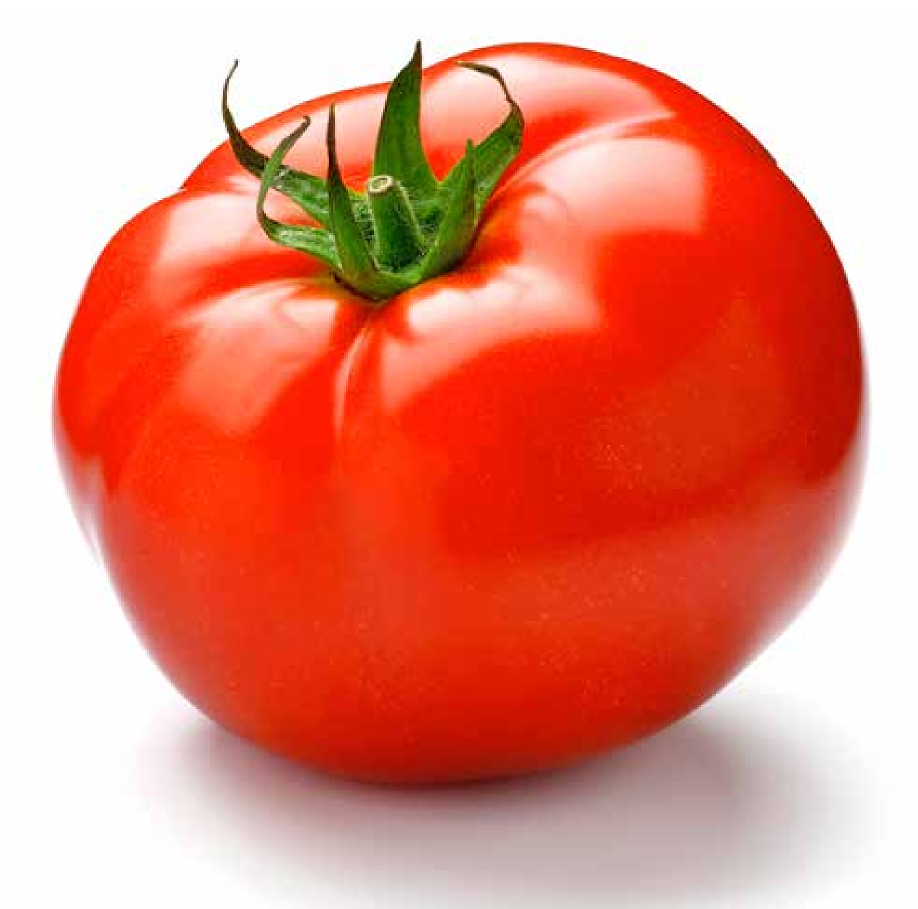




Tomatosphere

by Dr. Robert B. Thirsk, Ruth Ann Chicoine, Robert Morrow,
Canadian Space Agency

A research base on the Moon. Flights to passing asteroids. Bootprints on Mars. The world's space-faring nations envision astronaut missions beyond Earth orbit and to increasingly distant destinations. However, the challenges of living far away from our home planet are not insignificant. As humans venture farther away, new technologies must be developed to support their lives and well-being.

Bringing along three years of food supplies for a crew voyaging to and from Mars, for instance, would be impractical. Future astronauts will need to be more self-sufficient and grow some of their own food en route to and from Mars as well as on the planetary surface.

Space horticulture may sound fantastical but researchers are already considering this issue. Some of these researchers are students who are taking part in an innovative educational project called Tomatosphere.

Tomatosphere started in Canada but has always been available to teachers in the United States.

What is Tomatosphere?

Tomatosphere promotes science learning at three different levels – grades 2 – 4 with a focus on plants, grade 6 – 7 with a focus on space and grade 9, also with a focus on space. The project connects students' fascination with space travel and the role that green plants could someday play in the life support system of a space craft or habitat.

In each year of the Tomatosphere project, approximately 600,000 tomato seeds have been exposed to a harsh environmental condition such as actual or simulated spaceflight. The seeds have been exposed in the past to conditions such as:

- *a space shuttle flight,*
- *long-duration flights aboard the International Space Station,*
- *a simulated Mars transit flight,*
- *a simulated Mars environment,*
- *a simulated Mars greenhouse environment, and*
- *wintering in the cold, dry Canadian arctic.*

An equal number of seeds remain in a normal Earth conditions and serve as "controls" for comparison with the "space" seeds. Both groups of seeds are then mailed to each participating classroom.

(Each registered class receives approximately 30 – 40 of each type of seed – the control group and the exposed group.)

The 600 000 space seeds that were distributed to classes for 2014 spent 23 months aboard the International Space Station, returning to Earth with Canadian astronaut Chris Hadfield in May 2013. Seeds for the spring and fall of 2015 will be treated in a simulated situation on Earth (perhaps a Mars environment simulation or a Mars greenhouse simulation). Seeds will be sent to space again in 2015 for distribution in 2016.

Without knowing which seeds are ”space” or ”control”, the students sow both sets of seeds and measure the germination and growth rates of the seedlings. This methodology introduces the ”blind study” concept to the students and adds an element of classroom mystery.

After completing the project, the teacher submits the results to the project's website.

The teacher receives a report comparing the class results to the project averages and the students are rewarded with their very own "space tomatoes" as well as a Certificate of Appreciation signed by former Canadian astronaut, Dr. Robert Thirsk and the Principal Investigator of the project, Dr. Michael Dixon (University of Guelph, Guelph, Ontario, Canada).

Curriculum Design

To enroll, teachers visit the Tomatosphere web site (www.tomatosphere.org). Everything – except the peat pots for germination – is provided for the teacher by the project team. The project website provides the teacher's guide with step-by-step instructions, videos and photographs, links to other related space and agricultural sites, and other resources for the teacher and students.

Tomatosphere was originally designed to match elements of the science curriculum in Canada, but the application fits well with school curricula in the United States. The students learn the processes involved in germination and plant growth on Earth and consider how a plant might grow in space. They study the factors associated with successful germination and seedling vigour.

The Tomatosphere curriculum fits with several aspects of environmental studies and Earth and Space studies in secondary schools. The space element of the program asks older students to consider advanced questions such as …
What type of seeds would be able to endure a long space journey and still germinate?

Would plants grow well in a low-gravity greenhouse on Mars?

Which plants would be best suited for deep-space missions?

Students also consider the role that plants could serve as an element of a life-support system.

Plants provide food for the crew and, in the closed environment of a spacecraft or space habitat, they also provide oxygen and purified water, and recycle carbon dioxide and waste.

Supporting materials have been developed to allow teachers to build student understanding on themes such as habitats, ecosystems, communities and flight.

Project Management

Tomatosphere is supported by several government, industry, academic and non-profit organizations in Canada and the United States. While Tomatosphere is certainly based on a creative concept, it is the strength of the partnership that is responsible for its success. The current partners are: the Canadian Space Agency, the University of Guelph, Heinz Canada, Heinz


Do not
open this
bag

Seed (Stockton, California) Stokes Seeds (Buffalo, New York), Let's Talk Science, and First the Seed Foundation (Alexandria, Virginia) in the United States.

Each partner organization supports science, technology, engineering and mathematics education. Each feels a social obligation to work with schools to nurture the next generation of scientists, engineers, physicians and astronauts.

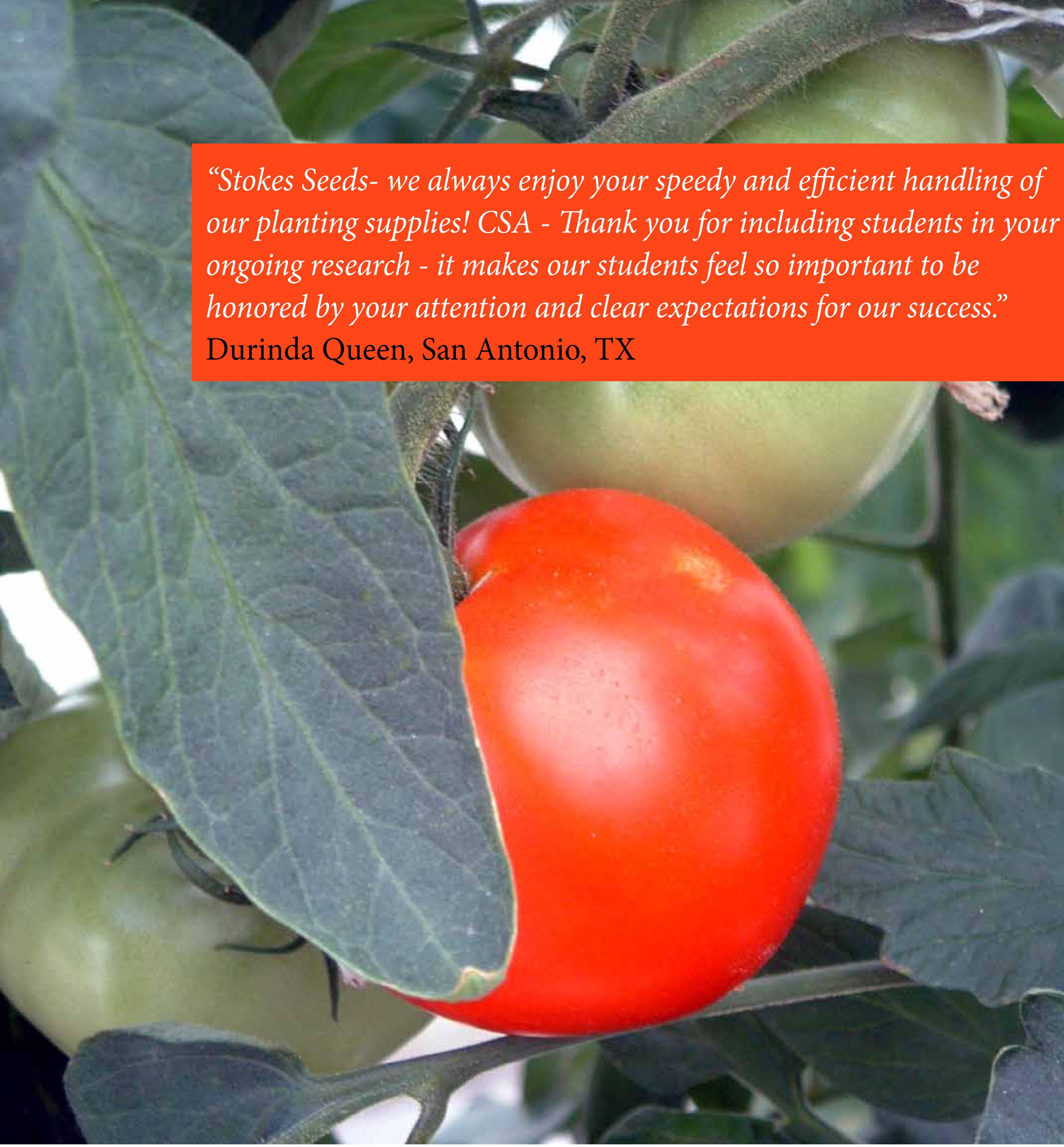
The day-to-day operations of Tomatosphere are carried out by a project manager. In addition, the project manager liaises with educational science coordinators to ensure that the project continues to be relevant to curricula, practical for classroom implementation and meaningful to students.

For its accomplishments over the past 12 years, Tomatosphere was awarded the Natural Science and Engineering Research Council Award for the "project best promoting science in Canada" [2012], and earlier [2007] received the prestigious Alouette Award to recognize an outstanding contribution to advancement in Canadian space technology, applications, science or engineering.

The Impact of Tomatosphere

The Tomatosphere Project has had a positive impact on both teachers and students. For teachers with little science background, Tomatosphere has helped them feel more at ease with science-related topics. For many of them, it is their first experience with the scientific method and a "blind" test. It is a valuable tool to promote excitement for science in their classrooms.

For teachers with more experience, Tomatosphere provides links to other science, plant and space-related topics. Some teachers have creatively built upon the Tomatosphere base to broaden student learning into other curricular areas.



"Stokes Seeds- we always enjoy your speedy and efficient handling of our planting supplies! CSA - Thank you for including students in your ongoing research - it makes our students feel so important to be honored by your attention and clear expectations for our success."
Durinda Queen, San Antonio, TX

"Thank you for encouraging our future generations to dream big, be creative, have fun and love science." Lisa Olinger, New Concord, OH

But it is the impact on the students that is most encouraging. Since 2001, an estimated three million students have participated in this initiative. The students enjoy the hands-on approach to learning and feel that they have each contributed to future space technologies. Many students who have previously participated in the project are now pursuing advanced education in math, science and engineering.

Conclusion

Leadership, innovation and jobs for tomorrow require a commitment to science education today. Experiential, curriculum-based programs motivate students to continue with science education beyond grade school. They promote science, technology and engineering as rewarding career choices.

For all of these reasons, Tomatosphere has now become a fixture in many Ontario classrooms. Currently, across Canada and the United States, there are more than 17 850 classrooms enrolled in the project. Students in these classes have enhanced their learning of plant biology, nutritional science and space exploration through Tomatosphere.

It is an interesting notion that the astronauts who will participate in those future missions to increasingly distant destinations are alive today and learning the fundamentals of science in their classrooms. Tomatosphere may be the educational spark that motivates one of them to reach for the stars.

Authors

Dr. Robert B. Thirsk, retired Canadian astronaut. Dr. Thirsk resigned as astronaut and left the Canadian Space Agency in 2012 to join the Canadian Institutes of Health Research in Ottawa. As Vice-President of Public, Government and Institute Affairs, Bob oversees the thirteen institutes dedicated to specific health care issues such as

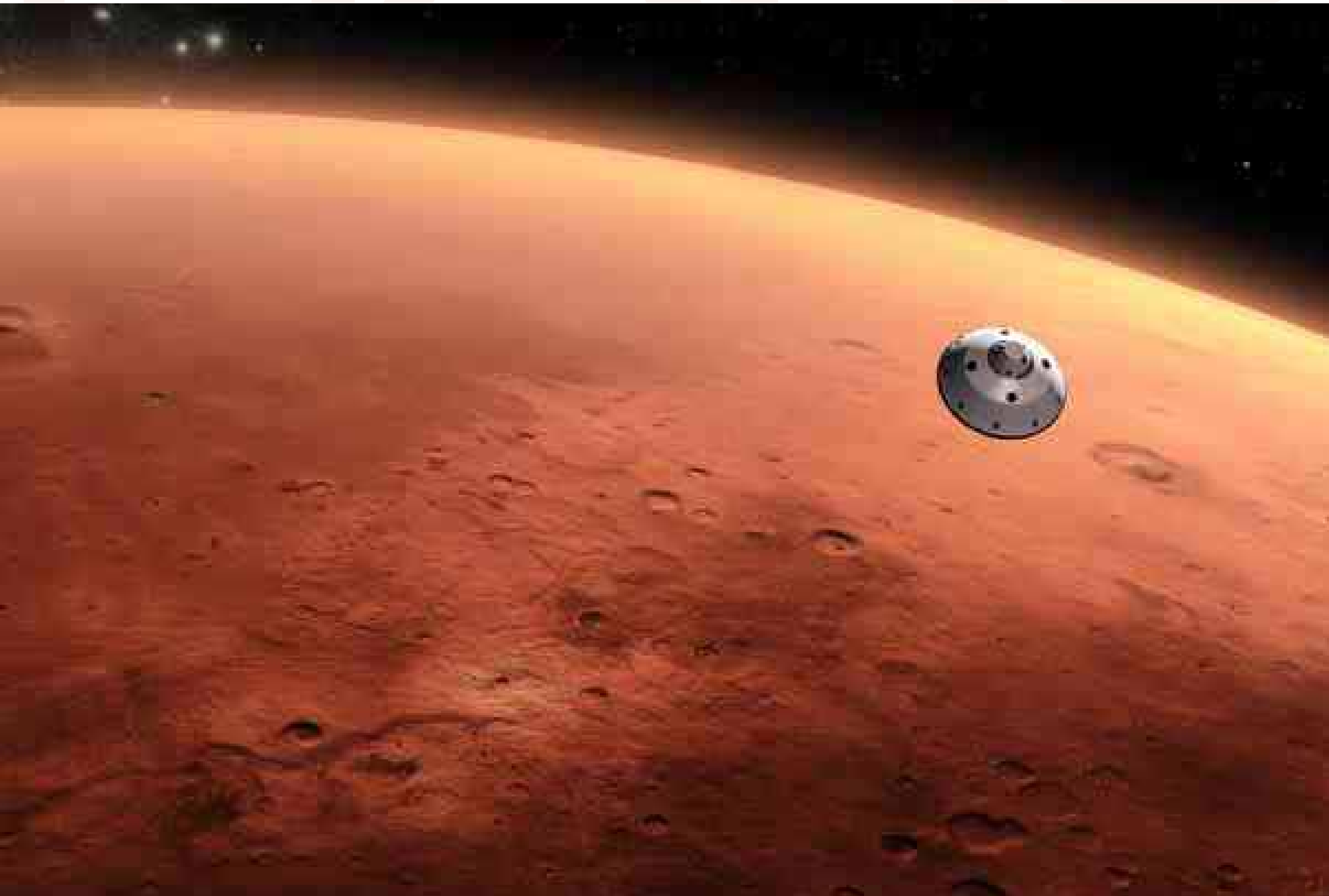
aging and cancer research.

Ruth Ann Chicoine, Senior Communications Advisor with the Canadian Space Agency. Ruth Ann has responsibility for the International Space Station and space science and exploration.

Robert Morrow, Project Manager for Tomatosphere [2002 – 2014]. Bob is a former curriculum coordinator and Education Officer with the Ministry of Education and Training, Ontario.

Next stop....

MARS



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Tell us about it: wayne@stemmagazine.com

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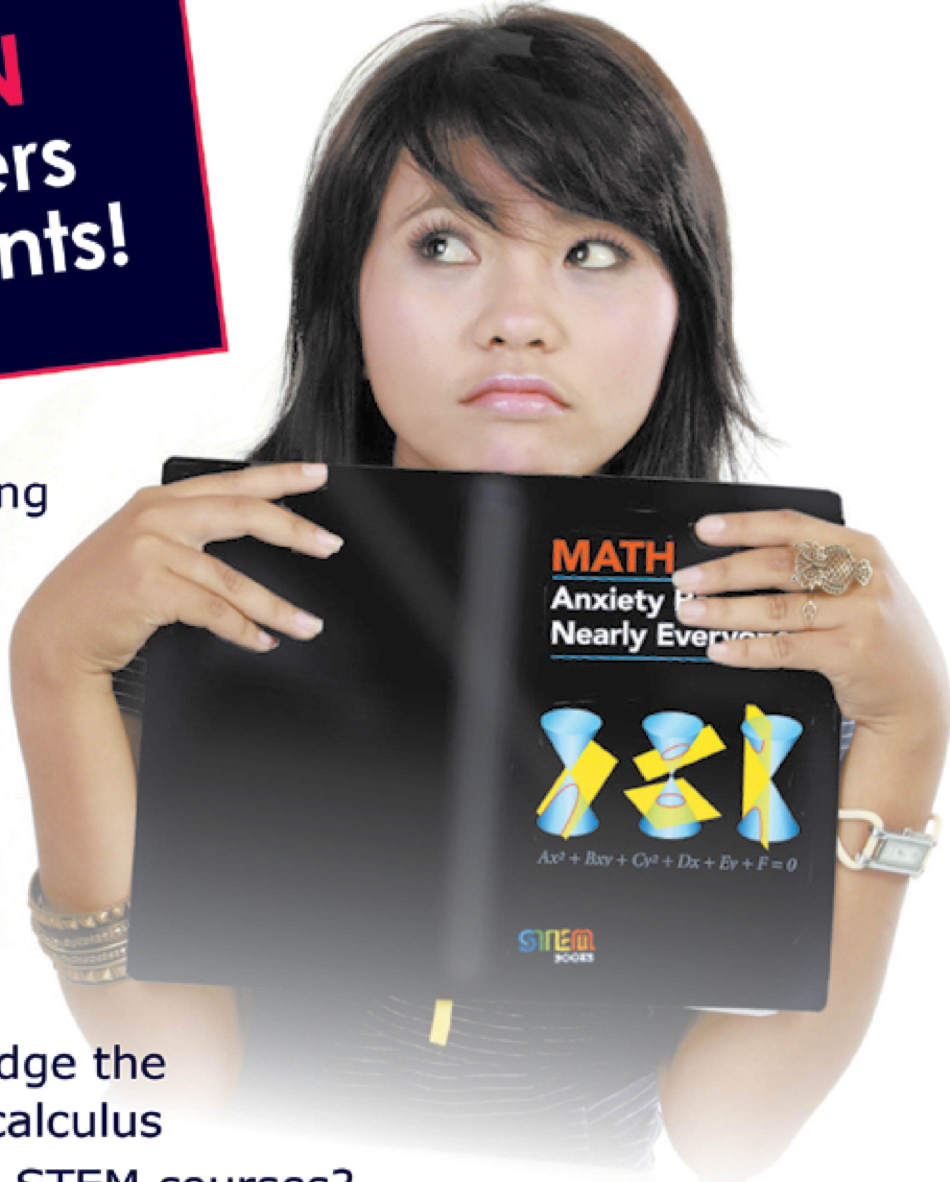
A special thank you to all of our educators that are making STEM Magazine available to students and their parents.

We are received continuing encouragement from parents who have been forwarded issues that they can discuss with their children. The increased chatter about STEM and career futures at home within families is at the heart of STEM Magazine.

Please continue to include, forward and encourage other educators and their students to flip through this and future issues to hopefully spark new interest and understanding about the importance of STEM in our daily lives.

Please send your feedback to the publisher at:

ATTENTION K-12 Teachers & STEM Students!



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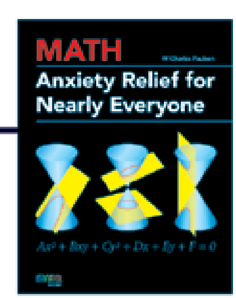

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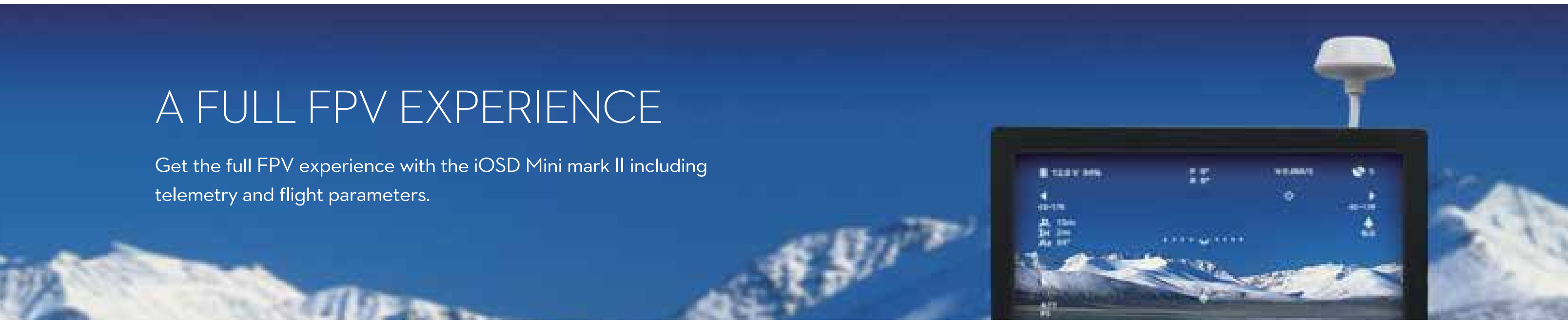

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